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# **Retek<sup>®</sup> Demand Forecasting, Curve and Promote<sup>™</sup>**

## **10.5.1**

### **User Guide**





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# Chapter 1 –Retek Demand Forecasting Overview

## What is Retek Demand Forecasting?

Retek® Demand Forecasting™ is a Windows-based statistical and causal (via Promote) forecasting solution. It uses state-of-the-art modeling techniques to produce high quality forecasts – with minimal human intervention. Forecasts produced by the Demand Forecasting system enhance the retailer's supply-chain planning, allocation, and replenishment processes, enabling a profitable and customer-oriented approach to predicting and meeting product demand.

Today's progressive retail organizations know that store-level demand drives the supply chain. The ability to forecast consumer demand productively and accurately is vital to a retailer's success. The business requirements for consumer responsiveness mandate a forecasting system that more accurately forecasts at the point of sale, handles difficult demand patterns, forecasts promotions and other causal events, processes large numbers of forecasts, and minimizes the cost of human and computer resources.

Forecasting drives the business tasks of planning, replenishment, purchasing, and allocation. As forecasts become more accurate, businesses run more efficiently by buying the right inventory at the right time. This ultimately lowers inventory levels, improves safety stock requirements, improves customer service, and increases the company's profitability.

The competitive nature of business requires that retailers find ways to cut costs and improve profit margins. The accurate forecasting methodologies provided with Retek Demand Forecasting can provide tremendous benefits to businesses.

A connection from Retek Demand Forecasting to Retek's Advanced Retail Planning and Optimization (ARPO) solutions is built directly into the business process by way of the automatic approvals of forecasts, which may then fed directly to any ARPO solution. This process allows you to accept all or part of a generated sales forecast. Once that decision is made, the remaining business measures may be planned within an ARPO solution such as TopPlan, for example.

## Forecasting challenges and RDF solutions

A number of challenges affect the ability of organizations to forecast product demand accurately. These challenges include selecting the best forecasting method to account for level, trending, seasonal, and spiky demand; generating forecasts for items with limited demand histories; forecasting demand for new products and locations; incorporating the effects of promotions and other event-based challenges on demand; and accommodating the need of operational systems to have sales predictions at more detailed levels than planning programs provide.

### Selecting the best forecasting method

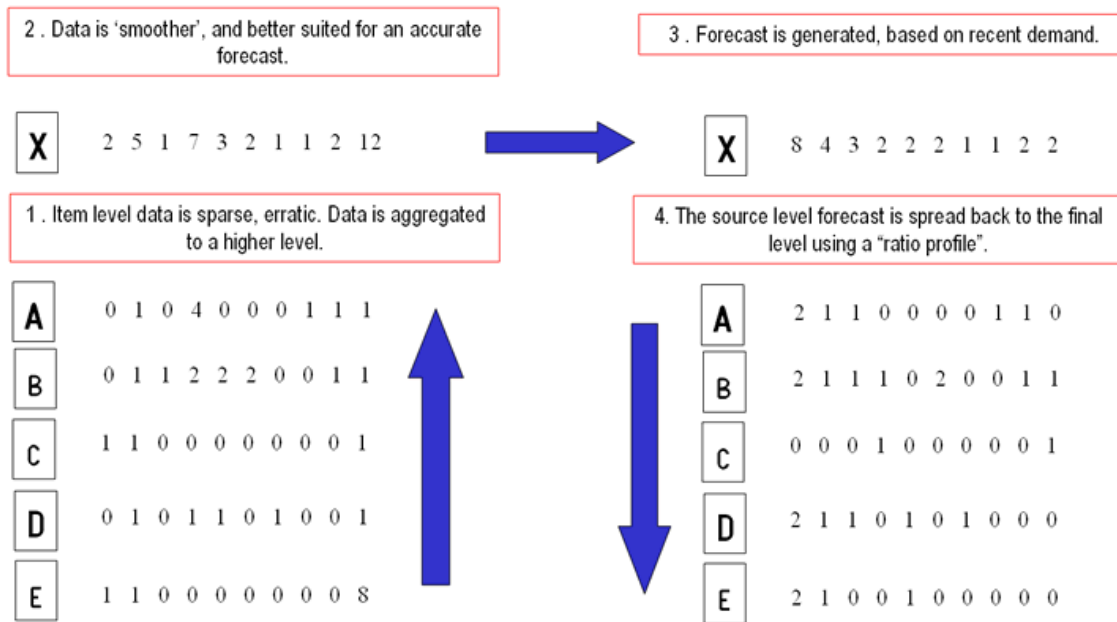
One challenge to accurate forecasting is the selection of the best model to account for level, trending, seasonal, and spiky demand. Retek's AutoES (Automatic Exponential Smoothing) forecasting method eliminates this complexity.

The AutoES method evaluates multiple forecast models, such as Simple Exponential Smoothing, Holt Exponential Smoothing, Additive and Multiplicative Winters Exponential Smoothing, Croston's Intermittent Demand Model, and Seasonal Regression forecasting to determine the optimal forecast method to use for a given set of data. The accuracy of each forecast and the complexity of the forecast model are evaluated in order to determine the most accurate forecast method. You simply select the AutoES forecast generation method, and the system finds the best model.

### Overcoming Data Sparsity through Source Level Forecasting

It is a common misconception in forecasting that forecasts must be directly generated at the lowest levels (final levels) of execution. Problems can arise when historic sales data for these items is too sparse and noisy to identify clear selling patterns. In such cases, generating a reliable forecast requires aggregating sales data from a final level up to a higher level (source level) in the hierarchy in which demand patterns can be seen, then generate a forecast at this source level. After a forecast is generated at the source level, the resulting data can be allocated (spread) back down to the lower level, based on the lower level's (final level) relationship to the total. This relationship can then be determined through generating an additional forecast (interim forecast) at the final level. Curve is then used to dynamically generate a profile based on the interim forecasts. As well, a non-dynamic profile can be generated and approved to be used as this profile. It is this profile that determines how the source level forecast is spread down to the final level. For more information on Curve, see chapter 7.

## Final Level vs. Source Level Forecasting cont.



Some high-volume items may possess sufficient sales data for robust forecast calculations directly at the final forecast level. In these cases, forecast data generated at an aggregate level and then spread down to lower levels can be compared to the interim forecasts run directly at the final level. Comparing the two forecasts, each generated at a different hierarchy level, can be an invaluable forecast performance evaluation tool.

Your Retek Demand Forecasting system may include multiple final forecast levels. Forecast data must appear at a final level for the data to be approved and exported to another system for execution.

### Handling lost sales and unusually high demand

Future forecasts should be based on past demand. Unfortunately, retailers cannot record demand, but instead record sales. These two figures can differ when inventory drops to zero and there is demand, but no sales. To deal with this situation, RPAS data preprocessing functions may be used to recognize when sales might be lower than actual demand, and adjusts sales values up to a level to a predicted level of where demand might have been.

Another situation when a retailer might want to adjust sales before using them as proxies for demand in forecasting is when past sales were unusually high due to an external event that is not expected to repeat. For example, if bad weather causes a power outage, then sales of batteries and flashlights for the week are likely to soar. These high sales values, however, are not good predictors of expected sales for the next week, when a power outage is less likely to occur. In this case, one would want to adjust sales downward, not so much to reflect true demand as to reflect "normal" demand. The same interpolation algorithms used to adjust sales up to correct for lost sales can be used to adjust sales down to correct for unusually high demand.

### Forecasting demand for new products and locations

Retek Demand Forecasting can also forecast demand for new products and locations for which no sales history exists. You can model a new product's demand behavior based on that of an existing similar product for which you do have a history. Forecasts can thus be generated for the new product based on the history and demand behavior of the existing one. Likewise, the sales histories of existing store locations can be used as the forecast foundation for new locations in the chain. For more details, see the section on Forecast Like-Item, Sister-Store Workbook in chapter 3.

### Managing forecasting results through automated exception reporting

The RDF end user may be responsible for managing the forecast results for thousands of items, at hundreds of stores, across many weeks at a time. The Retek Predictive Application Server (RPAS) provides users with an automated exception reporting process (called Alert Management) that indicates to the user where a forecast value may lie above or below an established threshold, thereby reducing the level of interaction needed from the user.

Alert management is a feature that provides user-defined and user-maintained exception reporting. Through the process of alert management, you define measures that are checked daily to see if any values fall outside of an acceptable range or do not match a given value. When this happens, an alert is generated to let you know that a measure may need to be examined and possibly amended in a workbook.

The Alert Manager is a dialog box that is displayed automatically when you log on to the system. This dialog provides a list of all identified instances in which a given measure's values fall outside of the defined limits. You may pick an alert from this list and have the system automatically build a workbook containing that alert's measure. In the workbook, you can examine the actual measure values that triggered the alert and make decisions about what needs to be done next.

For more information on the Alert Manager, see the RPAS 11.0 User's Guide.

### Incorporating the effects of promotions and other event-based challenges on demand

Promotions, non-regular holidays, and other causal events create another significant challenge to accurate forecasting. Promotions such as advertised sales and free gifts with purchase might have a significant impact on a product's sales history, as can irregularly occurring holidays such as Easter.

Using Promote (an optional, add-on module to Retek Demand Forecasting) promotional models of forecasting can be developed to take these and other factors into account when forecasts are generated. Promote attempts to identify the causes of deviations from the established seasonal profile, quantify these effects, and use the results to predict future sales when conditions in the selling environment will be similar. This type of advanced forecasting identifies the behavioral relationship of the variable you want to forecast (sales) not only to its own past, but also to explanatory variables such as promotion and advertising.

Suppose that your company has a large promotional event during the Easter season each year. The exact date of the Easter holiday varies from year to year; as a result, the standard time-series forecasting model often has difficulty representing this effect in the seasonal profile. Promote tool allows you to identify the Easter season in all years of your sales history, and then define the upcoming Easter date. By doing so, you can causally forecast the Easter-related demand pattern shift.

## **Providing detailed sales predictions based on an assortment plan**

The planning process attempts to establish the correct balance between different products in order to maximize sales opportunities within the available selling space. To facilitate this process, an assortment plan is often created. The assortment plan provides details of anticipated sales volumes and stock needs at aggregated levels. However, many operational systems require base data at much lower hierarchical levels, because these systems are responsible for ensuring that proper quantities of individual products are present in the right stores at the right time.

To address this need, RPAS contains an optional predictive solution (Curve) that transforms organization-level assortment plans into base-level weekly sales forecasts. Curve generates these lower level sales predictions by applying sets of profiles, or spreading ratios, to the assortment plan. The plan is thus allocated, across the product, location, and time hierarchies.

# **Retek Demand Forecasting Architecture**

## **The Retek Predictive Application Server and RDF**

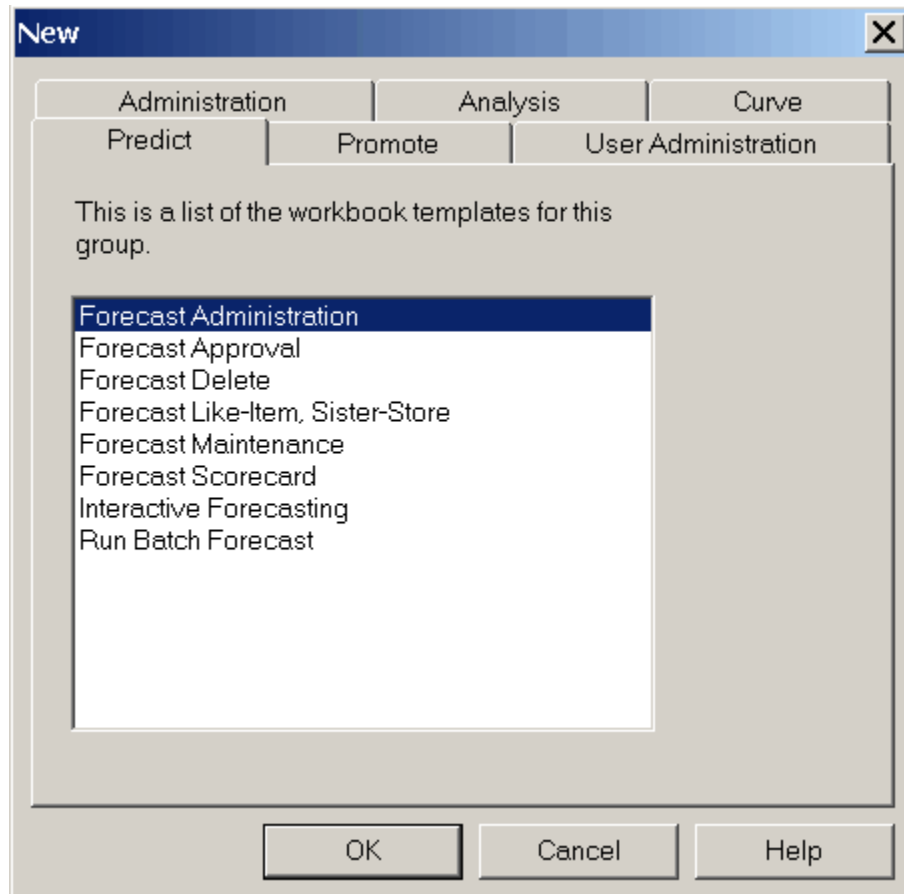
The Retek Demand Forecasting application is a member of the Advanced Retail Planning and Optimization Suite (ARPO), including other applications such as TopPlan, KeyPlan, Assort and Space Optimization. The ARPO solutions share a common platform called the Retek Predictive Application Server (RPAS). RDF leverages the versatility, power, and speed of the RPAS engine and interface. Features such as the following characterize RPAS:

- Multidimensional databases and database components (dimensions, positions, hierarchies)
- Product, location, and calendar hierarchies
- Aggregation and spreading of sales data
- Client-server architecture and master database
- Workbooks and worksheets for displaying and manipulating forecast data
- Wizards for creating and formatting workbooks and worksheets
- Menus, quick menus, and toolbars for working with sales and forecast data
- An automated alert system that provides user-defined and user-maintained exception reporting
- Charting and graphing capabilities

More details about the use of these features are in the Retek Predictive Application Server User Guide and online help provided within your RDF solution.

## Retek Demand Forecasting Workbook Template Groups

In addition to the standard RPAS Administration and Analysis Workbook Template Groups (also commonly referred to as “tabs”), there may be several template groups associated with the Retek Demand Forecasting application, these may include: Predict, Promote, Curve or any ARPO solution. (Available modules are based upon licensing agreement.)



### Predict

The Predict module refers to the primary RDF functionality and consists of the workbook templates, measures, and forecasting algorithms that are needed to perform time-series forecasting. This includes the Forecast Administration, Forecast Maintenance, Forecast Like-Item, Sister-Store, Run Batch Forecast, Forecast Approval, Forecast Scorecard, Interactive Forecasting, and Delete Forecast Workbook templates. The Predict module also includes the batch forecasting routine and all of its component algorithms.

For more information on the Predict Workbooks and Worksheets, see Chapters 3, 4 and 5. A detailed discussion of statistical forecasting methods is in Chapter 8.



### **Promote**

The Promote module consists of the templates and algorithms required to perform promotional forecasting, which uses both past sales data and promotional information (for example, advertisements, holidays) to forecast future demand. This module includes the Promotion Maintenance, Promotion Planner and Promotion Effectiveness templates.

For more information on the Promote Workbooks and Worksheets, see Chapter 6. A detailed discussion of promotional forecasting methods is in Chapter 8.

### **Curve**

The Curve module consists of the workbook templates and batch algorithms necessary for the creation, approval, and application of profiles that may be used to spread source level forecasts down to final levels as well to generate profiles, which may be used in any RPAS solution. This module includes the Profile Administration, Profile Maintenance, Profile Approval and Run Batch Profile Workbook templates, as well as the profile generation algorithm.

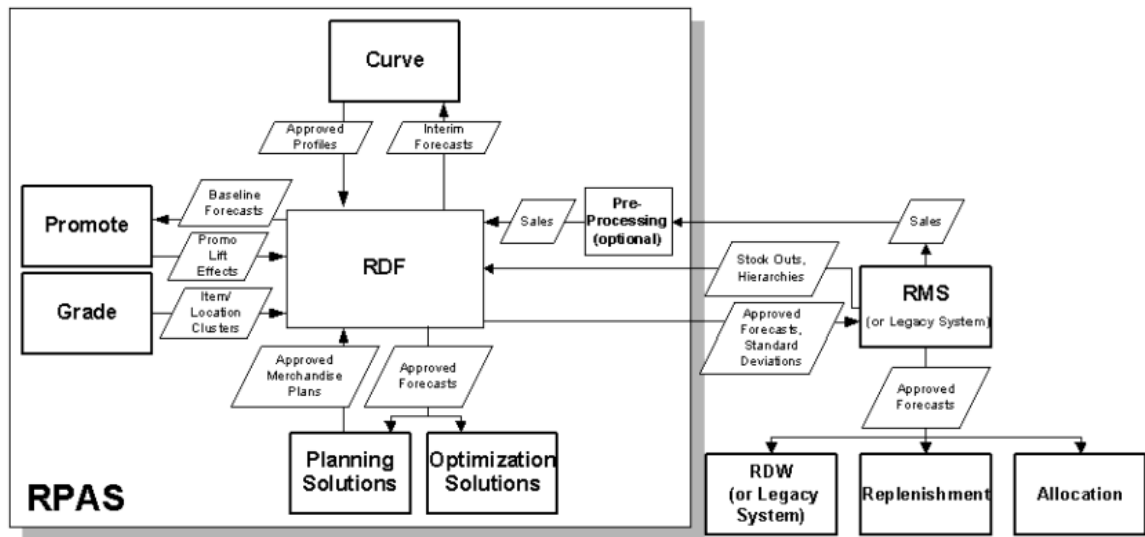
For more information on the Curve Workbooks and Worksheets, see Chapter 7. A detailed discussion of the Profile-Based forecasting method is in Chapter 8.

## RDF Solution and Business Process Overview

### RDF and the Retek Enterprise

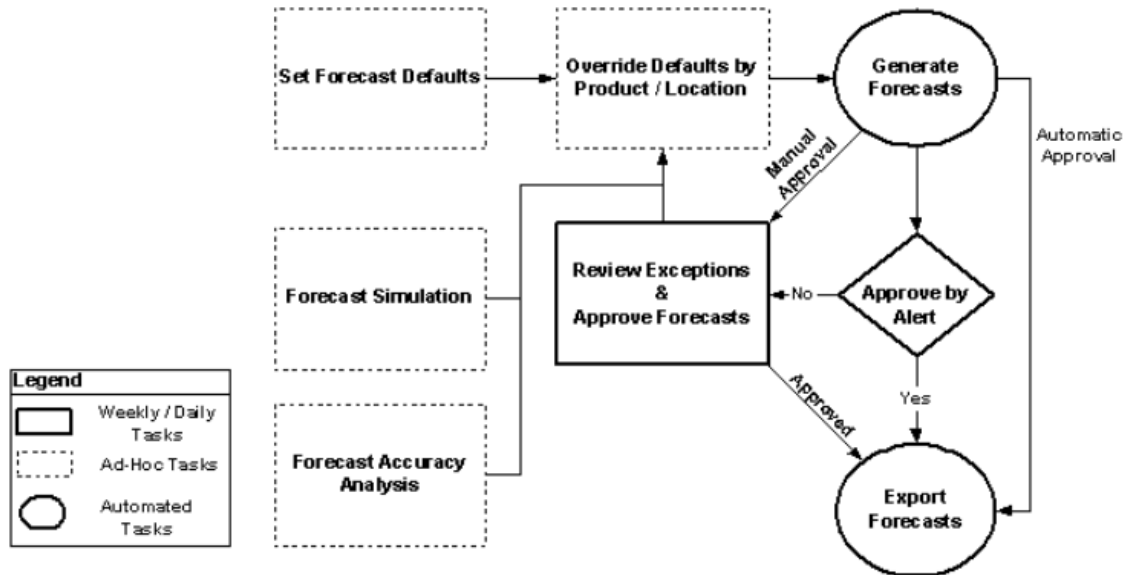
Retek has designed a forecasting solution separate from replenishment, allocation or planning. In order to provide a “single version of the truth,” it is crucial to free up the user’s time and supply the tools to focus on the analysis of forecast exceptions, historical data and different modeling techniques. This empowers the user to make better decisions, thus improving overall accuracy and confidence in the forecast downstream.

Within the Retek Enterprise, Retek Merchandising System (RMS) supplies RDF with Point-of-Sale (POS) and hierarchy data that is used to create a forecast. Once the forecast is approved, it is exported to RMS in order to calculate a recommended order quantity. Forecasts can also be utilized (no export process required) in any RPAS solution to support merchandise, financial, collaborative and price planning processes.



## RDF Primary Workflow

There are a number of core super-user/end-user forecasting steps in the RDF workflow that are essential for producing accurate forecasts for the millions of item and location combinations that exist in a domain.



## RDF Administration and Maintenance

There are a number of administrative tasks and other configuration options that can affect the modules available to the RDF end user (Preprocessing, Curve, Forecast Source Levels, etc). However, information on these tasks and configuration options lies beyond the scope of this document. For further information, refer to the RPAS 11 Configuration Tools User Guide.



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# Chapter 2 – Preparing Data for Forecasting

## Overview

The accuracy of any given forecast is directly impacted by the quality and integrity of the data on which the forecast is based. Data that is excessively noisy or sparse will result in forecasts that may not accurately reflect true demand patterns. Retek Demand Forecasting provides two methods to “smooth” data and remove unwanted spikes and dips in the demand history. These two methods are:

- Automated Preprocessing of data.
- Manual adjustment of sales history.

This chapter addresses each of these methods, and details how a RDF user may leverage either of these two methods.

### Automated Preprocessing of Data

Preprocessing, as the name implies, is an optional process that may occur prior to data being used in any RPAS solution. The process corrects past data points that represent unusual sales values not representative of a general demand pattern. Such correction may be necessary either when an item is out of stock and cannot be sold, resulting in unusually low sales. Conversely, correction of data may also be necessary in a period when demand is unusually high. Preprocessing allows the system to automatically make adjustments to raw POS (Point of Sales) data, so that subsequent demand forecasts do not replicate undesired patterns caused by lost sales or unusually high demand.

Consider the following examples:

#### Example 1: Sales Outage

An item has a raw POS history as follows:

Cola 1 Liter	Week 1	Week 2	Week 3	Week 4
Raw POS	35	42	38	0

The zero present in Week 4 could significantly impact the forecast for Week 5 if not corrected. Preprocessing receives an “Out of Stock” indicator from RMS (or some other legacy system) and automatically adjusts the POS data to a level not exceeding pre-established thresholds. The resulting data would look something like this:

Cola 1 Liter	Week 1	Week 2	Week 3	Week 4
Raw POS	35	42	38	0
Out of Stock Indicator	No	No	No	Yes
Preprocessing Adjustment	0	0	0	+39
Preprocessed POS	35	42	38	39

### Example 2: Promotional Spike

An item has a raw POS history as follows:

Cola 1 Liter	Week 1	Week 2	Week 3	Week 4
Raw POS	35	105	115	39

The high values in Weeks 2 and 3 are caused by a promotion that features a reduced price on the Cola 1 Liter item. Preprocessing “sees” the spike in data and automatically smoothes the POS data to a level not exceeding pre-established thresholds. The resulting data would look something like this:

Cola 1 Liter	Week 1	Week 2	Week 3	Week 4
Raw POS	35	105	115	39
Out of Stock Indicator	No	No	No	No
Preprocessing Adjustment	0	-65	-70	0
Preprocessed POS	35	40	45	39

More information on Preprocessing can be found in Retek Predictive Application Server Users Guide.

## Manual Adjustment of Sales History

In addition to the automated preprocessing of sales data that may occur prior to use in RDF, there may still be reasons for additional user adjustment to sales histories. Some of these reasons might include:

- The need to create a fake history for an item that has no Like Item if not using RDF's Like Item functionality.
- Smoothing spikes or dips in demand data that weren't sufficiently smoothed during preprocessing.
- Manually creating a lift effect on a promoted item's history, so that the lift will be replicated in the appropriate forecast horizon.

From an analysis perspective, it is very important to keep an accurate record of actual sales data vs. any system or user made adjustments to sales data. To this end, there are a number of standard sales measures that are insertable into an RPAS workbook, and available for user manipulation. These may be:

- Fake History Adjustments: A measure that can be used to create a history where none existed prior.
- User Made Adjustments: A measure that can be used to increase or decrease the raw POS value.
- Total Adjusted Sales: The final sales figure, after all system and User-made adjustments are accounted for.

**Non-editable: Actual Weekly Sales = 10**

**Non-editable: Preprocessed Weekly Sales = 3**

**Editable: User-made Adjustments = -1**

**Editable: Total Adjusted Weekly Sales = 12**

- Outage Indicator (Boolean): This is a Boolean measure (meaning the measure is either flagged as "on" or "off") that indicates whether there was a sales outage present.



**Note:** All of the measures mentioned above are configured through the RPAS Configuration Tools. As such, the measures and measure names are completely customizable based on customer requirements. There may be additional or fewer measures which contribute to the Total Adjusted Sales.

## Viewing Adjusted Sales Measures in a Workbook

Since sales measures and measures for adjustments are completely customizable, the customer has the option to configure workbooks to support their individual needs. However, for analysis purposes only, the Measure Analysis workbook is a free-form workbook that can be used for many purposes, and more importantly, has access to all measures in a domain. This makes it the easiest workbook to use when one needs to review sales measures. The Measure Analysis workbook is found by clicking on the Analysis tab. However, for adjusting and committing sales measures, a workbook may need to be configured with Commit rules. See the RPAS Configuration Tools User's Guide for information on workbook template creation.

## Inserting Adjusted Sales Measures into an existing workbook.

Adjusted Sales measures may be inserted into many other workbooks. For example, a user may wish to view the Adjusted Sales Measures in the Forecast Approval workbook.

To insert a measure into an open workbook, follow these steps:

1. Open the workbook where you wish to insert the Adjusted Sales measures.
2. Click on the Edit button in the menu bar, and select Edit>Insert Measure. The Insert Measure dialogue box will open.
3. Select the Adjusted Sales measure and select click OK.

The Adjusted Sales measures selected should now appear in your workbook.



# Chapter 3 – Setting Forecast Parameters

## Overview

The Predict Workbook template group allows you to perform functions related to statistical time series forecasting. This chapter provides information on defining and maintaining the parameters that govern the generation of forecasts in RDF.

### Workbooks and Wizards

The forecasting workbooks covered in this chapter include:

- Forecast Administration Workbook
- Forecast Maintenance Workbook
- Forecast Like-Item, Sister-Store Workbook

## Forecast Administration Workbook Overview

### Basic vs. Advanced Tabs

Forecast Administration is the first workbook used in setting up RDF to generate forecasts. It provides access to forecast settings and parameters that govern the whole domain (database). These settings and parameters are divided into two areas, accessed through the Basic and Advanced tabs beneath main tool bar.

The Basic Tab is used to establish a final level forecast horizon, the commencement and frequency of forecast generation; and the specification of aggregation levels (Source Levels) and spreading (Profile) methods used to yield the final level forecast.

The Advanced Tab is used to set default values for parameters affecting the algorithm and other forecasting techniques used to yield final level and source level forecasts, thus eliminating the need to define these parameters individually for each product and location in the database. If certain products or locations require parameter values other than the defaults, these fields can be amended on a case-by-case basis in the Forecast Maintenance Workbook. The Forecast Maintenance Workbook will be discussed in more detail later in this chapter.

### Final Forecasts vs. a Source Level Forecasts

Often, forecast information is required for items at a very low level in the hierarchy. Problems can arise, however, in that data is often too sparse and noisy to identify clear patterns at these lower levels. For this reason, it sometimes becomes necessary to aggregate sales data from a low level to a higher level in the hierarchy in order to generate a reasonable forecast. Once this forecast is created at the higher or source level, the results can be allocated to the lower or final level dimension based on the lower level's relationship to the total.

In order to spread this forecasted information back down to the lower level, it is necessary to have some idea about the relationship between the final level and the source level dimensions. Often, an additional interim forecast is run at the low level in order to determine this relationship. Forecast data at this low level might be sufficient to generate reliable percentage-to-whole information, but the actual forecast numbers are more robust when generated at the aggregate level.

The Final Level Worksheet represents forecast parameters for the lower (final) level, the level to which source forecast values are ultimately spread. Forecast data must appear at some final level in order for the data to be approved or exported to some other system. The Source Level Worksheet represents the default values for forecast parameters at the more robust aggregate (source) level.

### Forecasting Methods available in Retek Demand Forecasting

A forecasting system's main goal is to produce accurate predictions of future demand. Retek's Demand Forecasting solution utilizes the most advanced forecasting algorithms to address many different data requirements across all retail verticals. Furthermore, the system can be configured to automatically select the best algorithm and forecasting level to yield the most accurate results.

The following section summarizes the use of the various forecasting methods employed in the system. This section is referenced throughout this document when the selection of a forecasting method is required in a workflow process. Some of these methods may not be visible in your solution based on configuration options set in the RPAS Configuration Tools. (See also Chapter 8 for more details on forecasting algorithms and the RPAS Configuration Tools User Guide for configuration options.)

#### Average

Retek Demand Forecasting uses a simple moving average model to generate forecasts.

#### AutoES

Retek Demand Forecasting fits the sales data to a variety of exponential smoothing models of forecasting, and the best model is chosen for the final forecast. The candidate methods considered by AutoES are: Simple ES, Intermittent ES, Trend ES, Multiplicative Seasonal, Additive Seasonal, and Seasonal ES. The final selection between the models is made according to a performance criterion (Bayesian Information Criterion) that involves a tradeoff between the model's fit over the historic data and its complexity.

#### Simple ES

Retek Demand Forecasting uses a simple exponential smoothing model to generate forecasts. Simple ES ignores seasonality and trend features in the demand data and is the simplest model of the exponential smoothing family. This method can be used when less than one year of historic demand data is available.

#### Intermittent ES

Retek Demand Forecasting fits the data to the Croston's model of exponential smoothing. This method should be used when the input series contains a large number of zero data points (that is, intermittent demand data). The original time series is split into a Magnitude and Frequency series, then the Simple ES model is applied to determine level of both series. The ratio of the magnitude estimate over the frequency estimate is the forecast level reported for the original series.

#### Simple/IntermittentES

A combination of the Simple ES and Intermittent ES methods. This method applies the Simple ES model unless a large number of zero data points are present, in which case the Croston's model is applied.

### TrendES

Retek Demand Forecasting fits the data to the Holt model of exponential smoothing. The Holt model is useful when data exhibits a definite trend. This method separates base demand from trend, then provides forecast point estimates by combining an estimated trend and the smoothed level at the end of the series.

### Multiplicative Seasonal

Also referred to as Multiplicative Winters Model, this model extracts seasonal indices that are assumed to have multiplicative effects on the un-seasonalized series.

### Additive Seasonal

Also referred to as Additive Winters Model, this model is similar to the Multiplicative Winters model, but is used when zeros are present in the data. This model adjusts the un-seasonalized values by adding the seasonal index (for the forecast horizon).

### Seasonal ES

This method, a combination of several Seasonal methods, is generally used for known seasonal items or forecasting for long horizons. This method applies the Multiplicative Seasonal model unless zeros are present in the data, in which case the Additive Winters model of exponential smoothing is used. If less than 2 years of data is available, then a Seasonal Regression model is used. If there is too little data to create a seasonal forecast (in general, less than 52 weeks), then the system will select from the Simple ES, Trend ES and Intermittent ES methods.

### Seasonal Regression

Seasonal Regression cannot be selected as a forecasting method, but is a candidate model used only when the Seasonal ES method is selected. This model requires a minimum of 52 weeks of history to determine seasonality. Simple Linear Regression is used to estimate the future values of the series based on a past series. The independent variable is the series history one-year or one cycle length prior to the desired forecast period, and the dependent variable is the forecast. This model assumes that the future is a linear combination of itself one period before plus a scalar constant.

### Causal

Causal is used for promotional forecasting and can only be selected if Promote is implemented. Causal uses a Stepwise Regression sub-routine to determine the promotional variables that are relevant to the time series and their lift effect on the series. AutoES utilizes the time series data and the future promotional calendar to generate future baseline forecasts. By combining the future baseline forecast and each promotion's effect on sales (lift), a final promotional forecast is computed. See Chapter 6 for more information on Promote.

### No Forecast

No forecast will be generated for the product/location combination.

### Bayesian

Useful for short lifecycle forecasting and for new products with little or no historic sales data, the Bayesian method requires a product's known sales plan (created externally to RDF) and considers a plan's shape (the selling profile or lifecycle) and scale (magnitude of sales based on Actuals). The initial forecast is equal to the sales plan but as sales information comes in, the model generates a forecast by merging the sales plan with the sales data. The forecast is adjusted so that the sales magnitude is a weighted average between the original plan's scale and the scale reflected by known history. A Data Plan must be specified when using the Bayesian method.

### Profile-Based

Retek Demand Forecasting generates a forecast based on a seasonal profile that can be created in Curve or a legacy system. Profiles can also be copied from another profile and adjusted. Using historic data and the profile, the data is de-seasonalized and then fed to the Simple ES method. The Simple forecast is then re-seasonalized using the profiles. A Seasonal Profile must be specified when using the Profile-Based method.

## Working in the Forecast Administration Workbook

### Forecast Administration Wizard

To create a Forecast Administration Workbook, one must perform the following steps.

1. Select New from the File menu.
2. Select the Predict tab to display a list of workbook templates for statistical forecasting. Highlight Forecast Administration and click OK.
3. The Forecast Administration wizard opens and prompts you to select the level of the final forecast. The final forecast level is a level at which approvals and data exports can be performed. Depending on your organization's setup, you may be offered a choice of several final forecast levels. Make the appropriate selection and click the Finish button to open the workbook.

### Basic Settings workflow tab

The Basic Settings workflow tab contains forecast administration settings that may have to be reviewed and changed on a regular basis. On the Basic Settings workflow tab, there are two worksheets:

- Final Level Parameters Worksheet
- Final and Source Level Parameters Worksheet

## Final Level Worksheet – Basic Settings

The Final Level Worksheet allows you to set the forecast horizon information, frequency of review, and all default parameters for the lower or final level forecast (the level to which aggregate forecast data will ultimately be spread). Forecast approvals and data exports can only be performed on forecasts at a final level.

Final Level Parameters	
Data	
	1: itm/str/week-Final
Data Source	pos
Default Approval Method	Automatic
Default History Start Date	10/16/1998
Default Keep Last Changes	None
Default Source Level	3
Forecast Cycle (Days)	7
Forecast Start Date	2/6/2004
Next Run Date	2/13/2004
Store Interim Forecast	<input checked="" type="checkbox"/>

Measure ◀ ▶

The following is a description of the Basic Settings parameters contained in the Final Level Worksheet:

### Data Source

This is a read-only value that displays the sales measure that will be the data used for the generation of forecasts (for example, POS). The measure that will be displayed here is determined at configuration time in the RPAS Configuration Tools.

### Default Approval Method

A drop-down list from which you select the default automatic approval policy for forecast items. Valid values are:

- Manual – The system-generated forecast will not be automatically approved. Forecast values must be manually approved by accessing and amending the Forecast Approval Workbook.
- Automatic – The system-generated quantity will be automatically approved as-is.
- By Alert – This list of values may also include any alerts that have been configured for use in the forecast approval process. Alerts are configured during the implementation. See the RPAS Configuration Tools User's Guide for more information on the Alert Manager.

### Default History Start Date

This measure indicates to the system the point in the historical sales data at which to use in the forecast generation process. If no date is indicated, the system will default to the first date in your calendar. It is also important to note that the system ignores leading zeros that begin at the history start date. For example, if your history start date is January 1, 1999 and an item/location does not have sales history until February 1, 1999, the system will consider the starting point in that item/location's history to be the first data point where there is a non-zero sales value.

### Default Keep Last Changes

A drop-down list from which you select the default change policy for forecast items. Valid values are:

- Keep Last Changes (None) –There are no changes that are introduced into the adjusted forecast.
- Keep Last Changes (Total) –Considers only the Last Approved Forecast in determining change policy. For each forecasted item/week-combination, Retek Demand Forecasting automatically introduces the same quantity that was approved in the Last Approved Forecast into the change, only if that quantity differed from that in the Last System Forecast. If the quantities are the same, then Retek Demand Forecasting will introduce the current system-generated forecast into the adjusted forecast.
- Keep Last Changes (Diff) –Considers both the Last System Forecast and the Last Approved Forecast in determining approval policy. For each forecasted item/week-combination, Retek Demand Forecasting determines the difference between the Last System Forecast and the Last Approved Forecast. This difference (positive or negative) is then added to the current system forecast, and calculated as the adjusted forecast.
- Keep Last Changes (Ratio) –Considers both the Last System Forecast and the Last Approved Forecast in determining change. For each forecasted item/week-combination, Retek Demand Forecasting determines the difference between the Last System Forecast and the Last Approved Forecast; this difference is expressed as a percentage. This same percentage is used to calculate the adjusted forecast.

### Default Source Level

This is the level number associated to the aggregate level that will be used to generate the source forecast. The default source levels are set up in the RPAS Configuration Tool, so the user must be aware of the level naming conventions for to set any source level options.

### Forecast Cycle

The amount of time (measured in days) that the system waits between each forecast generation. Once a scheduled forecast has been generated, this field automatically updates the Next Run Date field.

### Forecast Start Date

The starting date of the forecast. The default is the system date unless otherwise specified.

### Next Run Date

The date on which the next batch forecast generation process will automatically be run. Retek Demand Forecasting automatically triggers a set of batch processes to be run at a pre-determined time period, usually at night. When a scheduled batch is run, the Next Run Date automatically updates based on the value in Forecast Cycle.

### Store Interim Forecast

A Boolean measure that can be flagged to store the interim forecast. The Interim Forecast is the forecast generated at the Final Level. This forecast is then used by Curve to generate the profile for spreading the source level forecast down to the final level. It is recommended that the interim forecast be stored if it is necessary for any analysis purposes, otherwise you will save on storage space by not storing it.

## Final and Source Level Parameters Worksheet – Basic Settings

The Final and Source Level Worksheet allows you to set the default parameters that are common to both the final and source level forecasts. (The aggregate levels from which forecast data is spread to the lower level.)

	1: itm/str/week-Final	2: itm/str/week	3: itm/chn/week	4: sbc/str/week	5: itg1/str/week
Data Plan					
Default Forecast Method	Simple	AutoES	AutoES	AutoES	AutoES
Forecast Length	13	13	13	13	13
Seasonal Profile					
Spreading Profile			01	03	05

The following is a description of the Basic Settings parameters contained in the Source Level Worksheet:

### Data Plan

Used in conjunction with the Bayesian forecast method, Data Plan is used to input the measure name of a sales plan that should be associated with the final level forecast. Sales plans, when available, provide details of the anticipated shape and scale of an item's selling pattern.

### Default Forecast Method

A drop-down list from which you can select the default forecast generation methods for items forecasted at both the final and source level. Valid method options depend on your system setup. (A summary of methods is provided earlier in this chapter and Chapter 8 covers each method in greater detail.)

### Forecast Length

Used to input the length of the forecast (forecast horizon). The forecast length is based on the calendar dimension for each level. For example, if the forecast length is to be 10 weeks then the setting for a final level at day is 70 (10 x 7days) and a source level at week will be 10. It is important to note that a final level and its source levels must have equivalent Forecast Lengths (that is, 70 days = 10 weeks).

### Seasonal Profile

Used in conjunction with the Profile Based forecasting method, this is the measure name of the seasonal profile that will be used to generate the forecast at either the source or final level. Seasonal profiles, when available, provide details of the anticipated seasonality (shape) of an item's selling pattern. The seasonal profile can be generated or loaded, depending on your configuration. The original value of this measure is set in the Configuration Tools.

### Spreading Profile

Used for Source Level Forecasting, the value of this measure indicates the profile level that will be used to determine how the source level forecast is spread down to the final level. No value is needed to be entered at the final level. For dynamically generated profiles, this value is the number associated with the final profile level (for example 01)—note that profiles 1 through 9 have a zero (0) preceding them in Curve—this is different than the forecasting level numbers. For profiles that must be approved, this is the measure associated with the final profile level. This measure is “apvp”+level (for example: apvp1). A Spreading Profile can include multiple profiles separated by commas (for example: 09,apvp11). These types of profiles are multiplied by each other to determine the final level results.

### Advanced Settings workflow tab

The Forecast Administration Advanced Settings workflow tab is used to set advanced forecasting parameters. The parameters on this workflow tab aren’t as likely to be changed on a regular basis as the ones on the Basic Settings workflow tab.

### Final Level Parameters Worksheet – Advanced Settings

The Final Level Worksheet allows you to set the advanced parameters for the final level forecasts.

	1: itm/str/week-Final
Generate Baseline Forecasts	<input type="checkbox"/>
Generate Cumulative Intervals	<input checked="" type="checkbox"/>
Generate Intervals	<input checked="" type="checkbox"/>
Generate Methods	<input checked="" type="checkbox"/>
Generate Parameters	<input checked="" type="checkbox"/>
Like TS Duration (Periods)	0
Max Number of Forecasts	10
Updating Last Week Forecast	No Change
Updating Last Week Forecast Number of Weeks	0

The Final Level Worksheet – Advanced Settings contains the following parameters:

#### Generate Baseline Forecasts

Specifies whether you want Retek Demand Forecasting to output the baseline forecast. This parameter must be selected if you are using Promote to support promotional forecasting. (See Chapter 6 for more information on Promote.)



### **Generate Cumulative Interval**

Specifies whether you want Retek Demand Forecasting to generate cumulative intervals (also known as cumulative standard deviations) during the forecast generation process. Select the check box to generate cumulative intervals. Cumulative Intervals are a running total of Intervals. The cumulative interval is necessary if forecast information is to be exported to a Retek Replenishment application. If you do not need cumulative intervals, you can eliminate excess processing time and save disk space by clearing the check box. The calculated cumulative intervals can be viewed within RDF. (See Forecast Approval Workbook in chapter 4 for more details on the calculation of Cumulative Intervals when the user adjusts forecasts.)

### **Generate Interval**

Specifies whether you want Retek Demand Forecasting to generate intervals (also known as Standard Deviations). Select the check box to generate intervals. Intervals can be displayed in the Forecast Approval Workbook. If you do not need intervals, you can eliminate excess processing time and save disk space by clearing the check box. For many forecasting methods they are calculated as standard deviation but for Simple, Holt, and Winters, the calculation is more complex. Intervals are not exported. Also, Intervals are capped. (See Chapter 6 for more details on interval calculations.)

### **Generate Methods**

Specifies whether you want Retek Demand Forecasting to output the chosen forecast method for each fitted time series. The chosen method can be displayed in the Forecast Approval Workbook. Select the check box if you want these methods generated, or clear it if you do not.

### **Generate Parameters**

Specifies whether you want Retek Demand Forecasting to output the alpha, level, and trend parameters for each fitted time series. These parameters can be displayed in the Forecast Approval Workbook. Select the check box if you want these parameters generated, or clear it if you do not.

### **Like TS Duration (weeks)**

The number of weeks of history required after which Retek Demand Forecasting stops using the substitution method and starts using the system forecast generated by the forecast engine. A value must be entered in this parameter if using Like item/Sister Store functionality. See Forecast Like-Item, Sister-Store Workbook in chapter 3 for more information on Like Time-Series functions.

### **Max Number of Forecasts**

The maximum number of generated forecasts that will be stored in the system. If the number of generated forecasts in the system is more than the max number of forecasts, the forecasts are deleted in FIFO order (that is, the oldest generated forecast is deleted first).

### Updating Last Week Forecast

A drop-down list from which you can select the method for updating the last week(s) of the forecast horizon for the Approved Forecast measure. This option is valid only if the approval method set in the Forecast Maintenance Workbook was selected to be Manual or Approve by alert and the alert was rejected.

- **No Change** – The last Updating Last Week Forecast Number of Weeks week(s) of the forecast horizon for Approved Forecast measure are not updated.
- **Replicate** – The last Updating Last Week Forecast Number of Weeks week(s) of the Approved Forecast will be filled in by replicating the value of the Forecast Length minus Updating Last Week Forecast Number of Weeks week of the Approved Forecast measure.
- **Use Forecast** – The last Updating Last Week Forecast Number of Weeks week(s) of the Approved Forecast measure will be filled in using the Adjusted Forecast value(s).

### Updating Last Week Forecast Number of Weeks

The number of weeks that have to be updated in the Approved Forecast using the method specified from the updating method pick list.

### Final and Source Level Worksheet – Advanced Settings

The Source Level Worksheet allows you to set the advanced parameters for the source level forecasts.

The screenshot shows the 'Final and Source Level Parameters' dialog box with the 'Advanced Settings' tab selected. The dialog contains a table with the following parameters and values:

	1: itm/str/week-Final	2: itm/str/week	3: itm/chn/week	4: sbc/str/week	5: itg1/str/week
Bayesian Alpha	1.00	1.00	1.00	1.00	1.00
Causal Aggregation Profile					
Causal Calculation Intersection					
Causal Calculation Intersection Periodicity	0	0	0	0	0
Causal Data Source					
Causal Higher Intersection					
Causal Spread Profile					
Croston's Min Gaps	5	5	5	5	5
DD Duration (Periods)	0	0	0	0	0
Holt Min Hist (Periods)	13	13	13	13	13
Max Alpha (Profile)	1.00	1.00	1.00	1.00	1.00
Max Alpha (Simple Holt)	1.00	1.00	1.00	1.00	1.00
Max Alpha (Winters)	1.00	1.00	1.00	1.00	1.00
Trend Damping Factor	0.50	0.50	0.50	0.50	0.50
Winters Min Hist (Periods)	104	104	104	104	104

At the bottom of the dialog, there is a 'Measure' dropdown menu and navigation arrows.

The Source Level Worksheet – Advanced Settings contains the following parameters:

**Bayesian Alpha (range (0,infinity))**

When using the Bayesian forecasting method, historic data is combined with a known sales plan in creating the forecast. As POS data comes in, a Bayesian forecast is adjusted so that the sales magnitude is a weighted average between the original plan's scale and the scale reflected by known history. This parameter displays the value of alpha (the weighted combination parameter). An alpha value closer to 0 weights the sales plan more in creating the forecast, whereas alpha closer to infinity weights the known history more. The default is 1.

**Causal Aggregation Profile**

Used only for Daily Causal Forecasting. The measure name of the profile used to aggregate promotions defined at “day” up to the “week”. This measure value will be “apvp”+level (for example: apvp1), as well, a Causal Aggregation Profile can include multiple profiles separated by commas (for example: 09,apvp11). These types of profiles are multiplied by each other to determine the final profile results.

**Causal Calculation Intersection**

Used only for Daily Causal Forecasting. This is the intersection in which to run the causal forecast. The format needs to match the hierarchy dimension names set in the Configuration Tools—such as “itemstr\_week”. Each dimension must have only 4 characters; order of the dimension does not matter. There is no validation of correct format of this intersection.

**Causal Calculation Intersection Periodicity**

Used only for Daily Causal Forecasting. This measure needs to be set to the periodicity of Causal Calculation Intersection. Periodicity is the number of periods within 1 year that correspond to the calendar dimension.

**Causal Data Source**

Used only for Daily Causal Forecasting. An optional setting that contains the measure name of the sales data to be used if the level's Data Source is different than the causal data source.

**Causal Higher Intersection**

This intersection is the aggregate level to model promotions if the causal intersection cannot produce a meaningful causal effect. This intersection will apply to promotions whose Promotion Type is set to “Override From Higher Level” (set in the Promotion Maintenance workbook). The format of this intersection needs to match the hierarchy dimension names set in the Configuration Tools—such as “itemstr\_week”. Each dimension must have only 4 characters; order of the dimension does not matter. There is no validation of correct format of this intersection.

**Causal Spread Profile**

Used only for Daily Causal Forecasting. The measure name of the profile used to spread the causal baseline forecast from the Causal Calculation Intersection to the Final Level. This measure value will be “apvp”+level (for example: apvp1), as well, a Causal Spread Profile can include multiple profiles separated by commas (for example: 09,apvp11). These types of profiles are multiplied by each other to determine the final profile results.

### Croston Min Gaps

The default minimum number of gaps between intermittent sales for Retek Demand Forecasting to consider Croston's as a potential AutoES forecasting method. If there are not enough gaps between sales in a given product's sales history, then the Croston's model is not considered a valid candidate model. The system default is five minimum gaps between intermittent sales. The value must be set based on the calendar dimension of the level. For example, if the value is to be 5 weeks then the setting for a final level at day is 35 (5x7days) and a source level at week will be 5.

### DD Duration (weeks)

The number of weeks of history required after which Retek Demand Forecasting stops using the DD (De-seasonalized Demand) approach and defaults to the "normal" Profile-Based method for all time series, for which the Default Forecast Method is set to Profile Based. The value must be set based on the calendar dimension of the level. For example, if the value is to be 10 weeks then the setting for a final level at day is 70 (10x7days) and a source level at week will be 10.

### Holt Min Hist (Periods)

The default minimum number of periods of historical data necessary for Retek Demand Forecasting to consider Holt as a potential AutoES method of forecasting. Retek Demand Forecasting fits the given data to a variety of AutoES candidate models in an attempt to determine the best method; if not enough periods of data are available for a given item, then Holt will not be considered as a valid option. The system default is 13 periods. The value must be set based on the calendar dimension of the level. For example, if the value is to be 13 weeks then the setting for a final level at day is 91 (13x7days) and a source level at week will be 13.

### Max Alpha (Profile) (range (0,1])

In the Profile based model fitting procedure, alpha, which is a model parameter capturing the level, is determined by optimizing the fit over the de-seasonalized time series. The time series is de-seasonalized based on a seasonal profile created by the Curve tool. This displays the maximum value (that is, cap value) of alpha allowed in the model fitting process. An alpha cap value closer to 1 allows more reactive models (alpha = 1, repeats the last data point), whereas alpha cap closer to 0 only allows less reactive models. The default is 1.

### Max Alpha (Simple, Holt) (range (0,1])

In the Simple or Holt model fitting procedure, alpha, which is a model parameter capturing the level, is determined by optimizing the fit over the time series. This parameter displays the maximum value (that is, cap value) of alpha allowed in the model fitting process. An alpha cap value closer to 1 allows more reactive models (alpha = 1, repeats the last data point), whereas alpha cap closer to 0 only allows less reactive models. The default is 1.

### Max Alpha (Winters) (range (0,1])

In the Winters model fitting procedure, alpha, which is a model parameter capturing the level, is determined by optimizing the fit over the time series. This displays the maximum value (that is, cap value) of alpha allowed in the model fitting process. An alpha cap value closer to 1 allows more reactive models (alpha = 1, repeats the last data point), whereas alpha cap closer to 0 only allows less reactive models. The default is 1.

**Trend Damping Factor (range (0,1])**

The default value of the trend damping factor. A value close to 0 is a high damping, while a value of 1 implies no damping. The default is 0.5.

**Winters Min Hist (Periods)**

The default minimum number of years of historical data necessary for Retek Demand Forecasting to consider Winters as a potential AutoES method of forecasting. If not enough years of data are available for a given item, then Winters will not be considered as a valid forecasting model. The system default is two years of required history. The value must be set based on the calendar dimension of the level. For example, if the value is to be 104 weeks/2 years then the setting for a final level at day is 728 (104 weeks x 7 days) and a source level at week will be 104.

## **Forecast Maintenance Workbook**

The Forecast Maintenance Workbook allows you to select and modify forecasting parameters for product/location combinations when the values of these parameters differ from the default values that are assigned in the Forecast Administration Workbook.

Suppose, for example, that the default forecast method of all the products in the database was set in the Forecast Administration Workbook to be AutoES. For a particular product, however, you know that a seasonal model is a better predictor of sales performance. To make this change, you must access the Forecast Maintenance Workbook, select the product / location intersection to be reviewed, make the appropriate change to the forecast method, and commit the workbook to the Retek Demand Forecasting master database.

The Forecast Maintenance Workbook is split into two workflow tabs:

- **Basic Settings** – Includes all Final Level Worksheets and their respective Source Level Worksheets.
- **Advanced Settings** – This tab includes the Forecast Start Date, End Date and History Start Date measures for the selected Final Level.

### **Forecast Maintenance Wizard**

To create a Forecast Maintenance Workbook, perform the following steps:

1. Select New from the File menu.
2. Select the Predict tab to display a list of workbook templates for statistical forecasting. Highlight Forecast Maintenance and click OK. The Forecast Maintenance Wizard opens and prompts you to select the level of the final forecast. The final forecast level is a level at which approvals and data exports can be performed. Depending on your organization's setup, you may be offered a choice of several final forecast levels.
3. Make the appropriate selection and click Next.
4. Select the locations to include in the workbook, whose parameters will be viewed or edited. Click Next.

5. Select the products to include in the workbook, whose parameters will be viewed or edited. Click Next. Additional wizard screens may prompt you to select any additional measures (that is, measures not standard in the Forecast Maintenance Workbook) that you would like included. The measure options available in this screen are set in the RPAS Security Administration Workbook / Workbook Template Measure Rights Worksheet.
6. Make the appropriate selections (if any) and click the Finish button to display the workbook.

### Basic Settings workflow tab

The Basic Settings workflow tab of Forecast Maintenance includes all Final Level Worksheets and their respective Source Level Worksheets.

### Final Level Worksheet – Basic Settings

The Final Level Worksheet allows you to view and override basic parameters for the final level forecasts.

Location	Approval Method Override 1	Forecast Method Override 1	Keep Last Changes Override 1	Source Level Override 1	
Barcelona					
10000124Chunky Shrunkn Sweater - Blac		Seasonal	None		4
10000125Chunky Shrunkn Sweater - Blac		Seasonal	None		4
10000126Chunky Shrunkn Sweater - Blac		Seasonal	None		4
10000344Ladies cashmere jersey - Pink	Manual		None		0
10000345Ladies cashmere jersey - Pink	Manual		None		0
10000346Ladies cashmere jersey - Pink	Manual		None		0

The Final Level Worksheet – Basic Settings contains the following parameters:

#### Approval Method Override

A drop-down list from which you select the approval policy for individual product/location combinations. No value will be in this measure if the system default set in the Forecast Administration Workbook is to be used. Valid values are:

- **Manual** – The System Forecast and Adjusted Forecast are not automatically approved. Forecast values must be manually approved by accessing and amending the Forecast Approval Workbook.
- **Automatic** – The Adjusted Forecast is automatically approved as-is.
- **By alert “name of the alert”** - This is not one alert, but actually a set of alerts, which could be an empty set. If you have an alert hit, the system will use the Manual setting, in other words it will not automatically approve that product/location. If the alert is not triggered, the system will automatically approve that product/location.



**Note:** If you select a specific alert as your approval method and later on you delete the alert, the approval will work as manual. The same will happen if the alert is on a wrong intersection.

### Forecast Method Override

A drop-down list from which you can select the interim forecast generation method for items forecasted at the lowest level. No value will be in this measure if the system default set in the Forecast Administration Workbook is to be used. Valid options depend on your system setup. A summary of methods is provided earlier in this chapter and Chapter 8 covers each method in greater detail.

### Keep Last Changes Override

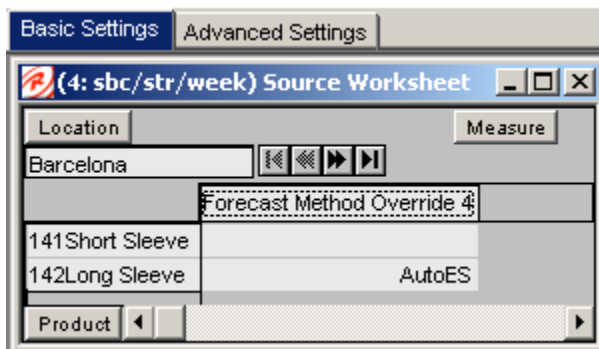
The Keep Last Changes Override measure may be used to override default setting at a product/location intersection. No value will be in this measure if the system default set in the Forecast Administration Workbook is to be used.

### Source Level Override

The level at which the aggregate, more robust forecast is run. Forecast data from this level is spread down to the lowest level based on the relationship between the two levels in the hierarchy. Zero (0) will be displayed in this measure if the system default set in the Forecast Administration Workbook is to be used. A valid value to use in this parameter is the level number associated to the source level that will be used to generate the source forecast.

## Source Level Worksheet – Basic Settings

The Source Level Worksheet(s) allows you to modify the forecast method for intersections at source level forecast that vary from the default method. There should be a Source Worksheet for every Source Level associated to the Final Level that was selected in the wizard process.



The Source Level Worksheet – Basic Settings contains the following parameter:

### Forecast Method Override

Displays a drop-down list from which you can select the forecast generation method for items forecasted at the lowest level. No value will be in this measure if the system default set in the Forecast Administration Workbook is to be used. A summary of methods is provided earlier in this chapter, and Chapter 8 covers each method in detail.

## Advanced Settings workflow tab

The Advanced Settings workflow tab is used to override the dates that are used in the forecast generation process as well as historical start dates for any intersection at the final level that varies from the default settings in the Forecast Administration Workbook.



The Advanced Settings workflow tab displays the following worksheet:

- Advanced Parameter Worksheet – Advanced Settings

	Forecast End Date Override 1	Forecast Start Date Override 1	History Start Date Override 1
10000124Chunky Shrunkn Sweater - Blac	4/30/2004		10/4/2002
10000125Chunky Shrunkn Sweater - Blac	4/30/2004		10/4/2002
10000126Chunky Shrunkn Sweater - Blac	4/30/2004		10/4/2002
10000127Chunky Shrunkn Sweater - Blac	4/30/2004		10/4/2002
10000344Ladies cashmere jersey - Pink		3/5/2004	
10000345Ladies cashmere jersey - Pink		3/5/2004	
10000346Ladies cashmere jersey - Pink		3/5/2004	

## The Advanced Parameter Worksheet

### Forecast Start Date Override

This parameter represents the date to start forecasting at a particular intersection. If this date is set to the past, it is ignored in favor of the Forecast Start Date from the Forecast Administration Workbook. This means that you do not need to change the Forecast Start Date once it is no longer in the future. It is important to also understand how Forecast Start Date should be used in conjunction with Forecast End Date. (See below.) No value will be in this measure if the system default set in the Forecast Administration Workbook is to be used.



**Note:** This measure can also be set in the Forecast Like-Item, Sister-Store Workbook. Changes to this measure can be seen in the Forecast Maintenance Workbook and the Forecast Like-Item, Sister-Store Workbook. The most recent commit (between either workbooks) will be the value used by the system.

### Forecast End Date Override

This parameter represents the last point in time for which the forecasting engine will forecast for a particular intersection. Should this parameter be set to a date less than the Forecast Start Date plus the Forecast Length (in Forecast Administration), the engine will forecast 0 past this date. If Forecast End Date is more than Forecasting Start Date plus Forecasting Length, you do NOT get a forecast outside Forecasting Start Date plus Forecasting Length. In other words, both Forecast Start Date and Forecasting End Date are relevant for time periods within the forecast horizon set at the global level. No value will be in this measure if the system default set in the Forecast Administration Workbook is to be used.



**Note:** This measure can also be set in the Forecast Like-Item, Sister-Store Workbook. Changes to this measure can be seen in the Forecast Maintenance Workbook and the Forecast Like-Item, Sister-Store Workbook. The most recent commit (between either workbooks) will be the value used by the system.



### History Start Date Override

This parameter represents the first point in time from which the Forecasting Engine will begin training and modeling (that is, if there are 2 years of history but you only want to use one year, you set the start date to a year ago). This parameter overrides at the item/store level from the global settings in the Forecast Administration Workbook. This can be used to level out past sales. For example, if you have a large spike in the first 3 weeks of sales for an item was on sale, you can set the Historical Start Date to one week past that period, and those first few weeks will not be used when generating the forecast.

It is also important to note that the system ignores leading zeros that begin at the history start date. For example, if your history start date is January 1, 1999 and an item/location does not have sales history until February 1, 1999, the system will consider the starting point in that item/location's history to be the first data point where there is a non-zero sales value.

If this parameter is set into the future, there would be no modeling as the training window is read as zero (for example, there will be no forecast).



**Note:** This measure can also be set in the Forecast Like-Item, Sister-Store Workbook. Changes to this measure can be seen in the Forecast Maintenance Workbook and the Forecast Like-Item, Sister-Store Workbook. The most recent commit (between either workbooks) will be the value used by the system.

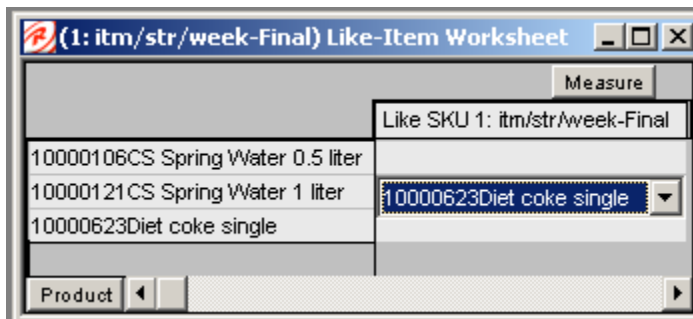
## Forecast Like-Item, Sister-Store Workbook

The Forecast Like-Item, Sister-Store Workbook provides the ability to model a new product's demand after an existing product. Forecasts can thus be generated for the new product based on the selected history or the forecast of the existing product plus an Adjustment %. Likewise, the sales history or the forecast of existing store locations can be used as the forecast foundation for new locations. This workbook includes the following worksheets:

- The Like-Item Worksheet
- The Sister-Store Worksheet
- The Advanced Parameter Worksheet

### Like-Item Worksheet

The Like-Item Worksheet is used to forecast a new item by modeling it after an existing item.



The Like-Item Worksheet contains the following parameters:

### Like SKU

Displays the items selected during the wizard process. In the example shown in the above worksheet, the Like Item (existing item) is selected on the right from a pick-list, across from the new item. The Like Item's forecast or sales will be used for the new item based on the parameters selecting in the Advance Parameter Worksheet. In the example above, CS Spring Water 1 liter is a new item and Diet Coke single is being selected as the existing item that will be used to model CS Spring Water 1 liter's forecast.



Note: When working with both the Like SKU and Sister Store worksheets, if you make a change in one of the worksheets, you must select Calculate before the pick-list options are available in the other worksheet.

### Sister-Store Worksheet

The Sister-Store Worksheet is used to forecast demand for a new store by modeling it after an existing store.

	Measure
	Sister Store 1: itm/str/week-Final
Boston	San Francisco
New York City	
San Francisco	

Location: Boston

The Sister-Store Worksheet contains the following parameter:

### Sister Store

Displays the locations selected during the wizard process. In the example shown in the above worksheet, the Sister Store (existing Store) is selected on the right from a pick-list, across from the new Store. The Sister Store's forecast or sales will be used for the new Store based on the parameters selecting in the Advance Parameter Worksheet. In the screen shot above, the Boston is the new store and San Francisco is being selected as the store to be used for modeling Boston's forecast.



Note: When working with both the Like SKU and Sister Store worksheets, if you make a change in one of the worksheets, you must select Calculate before the pick-list options are available in the other worksheet.

## Advance Parameter Worksheet

The Advance Parameter Worksheet is used to set additional parameters required to support Like Item/ Sister Store functionality and to manage item/locations whose Forecast Start Date, Forecast End Date or History Start Date varies from the default settings in the Forecast Administration Workbook.

	Adjustment %	Forecasting End Date	Forecasting Start Date	Historical Start Date	Substitute Method
4 X 6X 1L Still Water	1.00			1/4/2001	None
CS Spring Water 0.5 liter	1.00				None
CS Spring Water 1 liter	1.00		1/4/2002	1/4/2002	Seasonality/SKU
CS Spring Water 6 X 0.5 liter	1.00		1/4/2002	1/4/2002	Lifecycle/SKU
Diet coke single	1.00				None

The Advanced Parameter Worksheet contains the following parameters:

### Adjustment %

The user may enter an adjustment % to apply to the forecast for the new product / location combination displayed. This is a real number between  $[0, \infty)$ . The default (NA) value is 100%; that is, 1, which translates to no adjustment.



**Example:** If demand for a new item is expected to be 30% greater than it's like item, the Adjustment % would be set to 1.30. If demand for a new item is expected to be 30% less than it's like item, the Adjustment % would set to .70

### Forecast Start Date Override

This parameter represents the date to start forecasting for an item/location combination. This parameter can be set in the future if using Like Item or Sister Store functionality and upon reaching that time, the forecast will be generated. If this date is set to the past, it is ignored in favor of the Forecast Start Date from the Forecast Administration Workbook. This means that you do not need to go in and change the Forecast Start Date once it is no longer in the future. For Like item or Sister Store the Forecast Start Date and History Start Date should be set to the same date. It is important to also understand how Forecast Start Date should be used in conjunction with Forecast End Date. (See below.) No value will be in this measure if the system default set in the Forecast Administration Workbook is to be used.



**Note:** This measure can also be set in the Forecast Maintenance Workbook. Changes to this measure can be seen in the Forecast Maintenance Workbook and the Forecast Like-Item, Sister-Store Workbook. The most recent commit (between either workbooks) will be the value used by the system.

### Forecast End Date Override

This parameter represents the last point in time for which the Forecasting Engine will forecast for an item/location combination. Should this parameter be set to a date less than the Forecast Start Date plus the Forecast Length (in Forecast Administration), the engine will forecast 0 past this date. If Forecast End Date is more than Forecasting Start Date plus Forecasting Length, you do NOT get a forecast outside Forecasting Start Date plus Forecasting Length. In other words, both Forecast Start Date and Forecasting End Date are relevant for time periods within the forecast horizon set at the global level. No value will be in this measure if the system default set in the Forecast Administration Workbook is to be used.

Forecast End Date can be used for new item or location forecasting if the item or location needs to be forecasted for a period shorter than the Like TS Duration (set globally in Forecast Administration).



**Note:** This measure can also be set in the Forecast Maintenance Workbook. Changes to this measure can be seen in the Forecast Maintenance Workbook and the Forecast Like-Item, Sister-Store Workbook. The most recent commit (between either workbooks) will be the value used by the system.

### History Start Date Override

This parameter represents the first point in time from which the Forecasting Engine will begin training and modeling (that is, if there are 2 years of history but you only want to use one year, you set the start date to a year ago). This parameter overrides at the item/store level from the global settings in the Forecast Administration Workbook. This can be used to level out past sales. For example, if you have a large spike in the first 3 weeks of sales for an item was on sale, you can set the Historical Start Date to one week past that period, and those first few weeks will not be used when generating the forecast.

It is also important to note that the system ignores leading zeros that begin at the history start date. For example, if your history start date is January 1, 1999 and an item/location does not have sales history until February 1, 1999, the system will consider the starting point in that item/location's history to be the first data point where there is a non-zero sales value.

The History Start Date for the new item or new store should be set with the same date as the Forecast Start Date.



**Note:** When using any of the Lifecycle Methods (see Substitute Methods below) the History Start Date for the substitute item or location must be set to the point in the sales history that the new item or location will begin using as its sales.



This measure can also be set in the Forecast Maintenance Workbook. Changes to this measure can be seen in the Forecast Maintenance Workbook and the Forecast Like-Item, Sister-Store Workbook. The most recent commit (between either workbooks) will be the value used by the system.

### Substitute Method

Displays a drop-down list from which you can select the substitute method. Valid options are:

- None – There is no substitution for this product/location combination. This is the default value.

- **Seasonality/New Item** - You provide a Like Item that has a similar seasonality pattern that sells at the same store. The new product's forecast will be the like item's demand forecast with the applied adjustment. The forecast will be set to 0 for all dates before the new product's start date.
- **Seasonality/New Store** - You provide a Sister Store that has a similar seasonality pattern that sells the same product. The product's forecast at the new store will be the demand forecast of the same product at the Sister Store with the applied adjustment. The forecast will be set to 0 for all dates before the new store's open date.
- **Seasonality/New Item /New Store** – You provide a Like Item that sells at a Sister Store that has a similar seasonality pattern. The new product's forecast at the new store will be the demand forecast of the Like Item at the Sister Store with the applied adjustment. The forecast will be set to 0 for all dates before the new product's start date after the new store opens.
- **Lifecycle/New Item** - You provide a Like Item that had a similar lifecycle pattern that sells at the same store. The new product's forecast will be the like items actual sales with the applied adjustment shifted such that the like item's first sales matches the new product's start date.
- **Lifecycle/New Store** - You provide a Sister Store that had a similar lifecycle pattern that sells the same product. The product's forecast at the new store will be the products actual sales at the Sister Store with the applied adjustment shifted such that the Sister Store's first sales matches the new store's open date.
- **Lifecycle/New Item /New Store** – You provide a Like Item that sells at a Sister Store that has a similar lifecycle pattern. The new product's forecast at the new store will be Like Item's actual sales at a Sister Store with the applied adjustment shifted such that the Like Item's first sales at the Sister Store matches the new product's start date after the new store opens.

### **Steps Required for Forecasting using each of the Like SKU / Sister Store Methods**

The following outlines the steps required for using each of the above Substitution Methods:

To support Like SKU / Sister Store functionality the Like TS Duration must be set in the Forecast Administration Workbook – Advance Tab. This parameter sets the number of weeks of history required after which Retek Demand Forecasting stops using the substitution method and starts using the system forecast generated by the forecast engine.

#### **Seasonality/SKU: Introduction of a new item at an existing store (like item with a similar forecast)**

1. **Like-Item Worksheet:** Select a like item from the drop-down list, across from the new item.
2. **Advanced Parameter Worksheet:** Set the Forecast Start Date for the new item at an existing store.
3. **Advanced Parameter Worksheet:** Set the History Start Date for the new item at the existing store to the same date as the Forecast Start Date.
4. **Advance Parameter Worksheet:** Set the Adjustment % (optional) for the new item at the existing store.

### **Seasonality/STR: Introduction of an existing item at a new store (sister store with similar forecast)**

1. Sister-Store Worksheet: Select a Sister Store from the drop-down list, across from the new store.
2. Advanced Parameter Worksheet: Set the Forecast Start Date for the existing item at the new store.
3. Advanced Parameter Worksheet: Set the History Start Date for the existing item at the new store to the same date as the Forecast Start Date.
4. Advance Parameter Worksheet: Set the Adjustment % (optional) for the existing item at the new store.

### **Seasonality/SKU\_STR: Introduction of a new item at a new store (like item and sister store with a similar forecast).**

1. Like-Item Worksheet: Select a like item from the drop-down list, across from the new item.
2. Sister-Store Worksheet: Select a Sister Store from the drop-down list, across from the new store.
3. Advanced Parameter Worksheet: Set the Forecast Start Date at the intersection of the new item and the new store.
4. Advanced Parameter Worksheet: Set the History Start at the intersection of the new item and new store.
5. Advance Parameter Worksheet: Set the Adjustment % (optional) at the intersection of the new item and new store.

### **Lifecycle/SKU - Introduction of a new item at an existing store (Like item's sales history to be used as the forecast for the new item)**

1. Like-Item Worksheet: Select a like item from the drop-down list, across from the new item.
2. Advanced Parameter Worksheet: Set the Forecast Start Date for the new item at the existing store.
3. Advanced Parameter Worksheet: Set the History Start Date for the new item at the existing store to the same date as the Forecast Start Date.
4. Advanced Parameter Worksheet: Set the History Start Date for the Like item at the existing store to the point in its sales history that will map to the new item's forecast.
5. Advance Parameter Worksheet: Set the Adjustment % (optional) for the new item at the existing store.

### **Lifecycle/STR: Introduction of an existing item at new store (Sister Store's sales history to be used as the forecast for the new store)**

1. Sister-Store Worksheet: Select a Sister Store from the drop-down list, across from the new Store.
2. Advanced Parameter Worksheet: Set the Forecast Start Date for the existing item at the new store.

3. Advanced Parameter Worksheet: Set the History Start Date for the existing item at the new store to the same date as the Forecast Start Date.
4. Advanced Parameter Worksheet: Set the History Start Date at the intersection of the Sister Store and existing item to the date in its sales history that will map to the new store's forecast.
5. Advance Parameter Worksheet: Set the Adjustment % (optional) for the existing item at the new store.

**Lifecycle/SKU\_STR: Introduction of a new item at a new store (Like item's and Sister Store's sales history to be used as the forecast for a new item at a new store)**

1. Like-Item Worksheet: Select a like item from the drop-down list, across from the new item.
2. Sister-Store Worksheet: Select a Sister Store from the drop-down list, across from the new store.
3. Advanced Parameter Worksheet: Set the Forecast Start Date at the intersection of the new item and new store.
4. Advanced Parameter Worksheet: Set the History Start Date at the intersection of the new item and new store to the same date as the Forecast Start Date.
5. Advanced Parameter Worksheet: Set the History Start Date at the intersection of the Like item and Sister Store to the date in its sales history that will map to the new item's and new store's forecast.
6. Advance Parameter Worksheet: Set the Adjustment % (optional) at the intersection of the new item and new store.





# Chapter 4 – Generating and Approving a Forecast

## Overview

Once a user has completed setting all global and individual forecast parameters (see chapter 3 for more details), a forecast must be generated and approved. The Predict Workbook template group provides the workbooks necessary to complete these tasks.

### Workbooks and Wizards

The forecasting workbooks and tools are covered in this chapter include:

- Run Batch Forecast Workbook
- Delete Forecasts Workbook
- Forecast Approval Workbook
- The Alert Manager

## Run a Batch Forecast

The forecast generation process creates sales forecasts for all product/location combinations whose forecast generation method is set to any method other than No Forecast. Forecasts are typically run automatically as scheduled batch jobs. Retek Demand Forecasting regularly triggers a set of processes to be run at a pre-determined time when system use is at a minimum, such as overnight.

Scheduling of the automatic batch forecasting process is performed in the Forecast Administration Workbook, where a default value is set for the forecast cycle (number of days between forecast runs). The Forecast Cycle measure and Next Run Date field in the Forecast Administration Workbook control the automatic scheduling of batch forecasting jobs in the Retek Demand Forecasting application. Refer to the Forecast Administration Workbook description for further information.

The Run Batch Forecast wizard allows you to manually start the forecast generation process at a time other than the regularly scheduled batch job. **Prior** to using the Run Batch Forecast wizard, you must at minimum have performed the following tasks:

1. Create or access a Forecast Administration Workbook.
2. In the Forecast Start Date measure, enter the starting date of the forecast horizon; otherwise the system will default to the system date (today).
3. Select a Default Forecasting Method for the Final Level.
4. Set the Forecast Length if there is no value already in this measure.
5. Commit any changes by selecting File < Commit Now.
6. Close the workbook.



**Note:** Ensure that there are no other users logged on to the system. Other users cannot access the system until the forecast generation process has run to completion.

### Batch Forecast Wizard

To run a batch forecast manually, perform the following steps.

1. Select New from the File menu.
2. Select the Predict tab to display a list of workbook templates for statistical forecasting. Highlight Run Batch Forecast and click OK.
3. The Run Batch Forecast Wizard opens and prompts you to select the Final Level(s) to forecast. Click Next.
4. Select which batch type to run.
  - **Scheduled Runs and Overrides.** Generates all regularly scheduled batch forecasts set to be generated on today's date. When a scheduled batch forecast is run, the Next Run Date measure in the Forecast Administration Workbook is updated with an appropriate value, based on the established Forecast Cycle. If you select this option (Scheduled Runs and Overrides) and no batch runs are scheduled for this date, the system reads the Forecast Start Date field of the Forecast Administration Workbook. If the Forecast Start Date contains a value, a forecast will be generated now (based on the established Forecast Start Date value) and the Next Run Date value will be updated based on the Forecast Cycle length. If the Next Run Date is set to some future date, then no forecast will be run.



**Note:** After a forecast is generated, the Forecast Start Date field is cleared. This ensures that the same forecast will not be generated again on the same date.

- **Overrides Only.** Causes the system to consider only the Forecast Start Date field in the Forecast Administration Workbook. If Forecast Start Date contains a value, a forecast will be generated now. The Next Run Date value is not updated; as a result, any regularly scheduled run for this date will be performed during the overnight batch process. If no value is set for the Forecast Start Date (that is, Forecast Start Date = NA), then no forecast will be generated.
5. Click Next to begin the forecast generation process. The wizard will not advance to the next screen (step 6) until the forecast has been generated. Depending on the amount of product/locations to be forecasted, and the forecast horizon, it may take a few minutes before the system advances to the final screen.
  6. When the forecast generation is completed, the wizard will display a screen that notifies the user of the forecast generation ID.

### Delete Forecasts

Occasionally a user may have a need to delete a previously generated forecast. Some reasons for this might include:

- A forecast was run with the wrong source levels selected.
- The forecast horizon was not properly set.
- Old forecasts need to be deleted to save space on the server.

However, the Max Number of Forecast measure in the Forecast Administration Workbook is used to automatically delete previous forecasts.

The Delete Forecasts Wizard guides you through the process of deleting unwanted forecasts from the system. Deletions of forecasts are permanent.

### Delete Forecasts Wizard

To access the Delete Forecasts Wizard to permanently remove a forecast from the Retek Demand Forecasting system, perform the following steps.

1. Select New from the File menu.
2. Select the Predict tab to display a list of workbook templates for demand forecasting. Highlight Delete Forecasts and click OK.
3. Select the forecast generation date(s) of the forecast you want to delete. Click Next.
4. Select Yes to verify forecast deletion, or No to cancel deletion and exit the Forecast Deletion Wizard. Remember that deletion of forecasts from Retek Demand Forecasting is permanent!
5. Click Finish to process the request. If Yes was selected on the final wizard screen, the forecast is deleted.

## Forecast Approval Workbook

After the forecast is generated, the next steps in the forecasting process are analysis and approval. Approval of forecasts is required before the forecasted data can be exported to other processes, such as replenishment programs. The Forecast Approval Workbook allows you to view, analyze, adjust, and approve forecast results.

Some system forecasts may be set to be automatically approved by the system. The default approval method for items in a forecast is set in the Forecast Administration Workbook, and these policies can be amended for individual product/location combinations in the Forecast Maintenance Workbook. Any forecasts not set to Automatic Approval may require evaluation, adjustments, and ultimately approval before subsequent processes are executed.

You can view and analyze forecast data at multiple forecast levels (source level and final level) simultaneously. Revisions to and approvals of final level forecast values are made on the appropriate worksheets in the Forecast Approval Workbook. The Forecast Approval Workbook can contain up to five types of worksheets:

- Final Forecast Worksheet – Allows you to review final level system-forecasted quantities and make revisions to them if needed
- Source Level Worksheet – Displays the system-generated source level forecast, and allows you to compare this data with final level forecast values.
- Approval Worksheet – Allows you to specify the manual approval policy of forecasts by product and location.
- Final System Parameters Worksheet – this option is only available if “Generate System Parameters” or “Generate Methods” is turned on in the Forecast Administration Workbook.
- Source System Parameters Worksheet(s) – this option is only available if “Generate System Parameters” or “Generate Methods” is turned on in the Forecast Administration Workbook, and a Source Level was designated in Forecast Administration.

When the Forecast Approval Workbook is displayed, you may review the system-generated forecast and measures for any levels included in the workbook and make adjustments to forecast values at the final level. Forecast values are overwritten in the Adjusted Final Forecast measure on the Final Forecast Worksheet. Approvals are made for each product/location combination in the Approval Method measure of the Forecast Approval Worksheet.

After you complete your work, you can save the workbook using the Save function on the File menu. To update the master database with the approved forecast values, you must commit the workbook using the Commit Now or Commit Later option on the File menu. Once the workbook is committed, the forecast values are stored in the master database and can be used by other processes.

### Forecast Approval Wizard

To access Forecast Approval, select Open from the File menu to bypass the Forecast Approval Wizard and open an existing Forecast Approval Workbook, or perform the following steps:

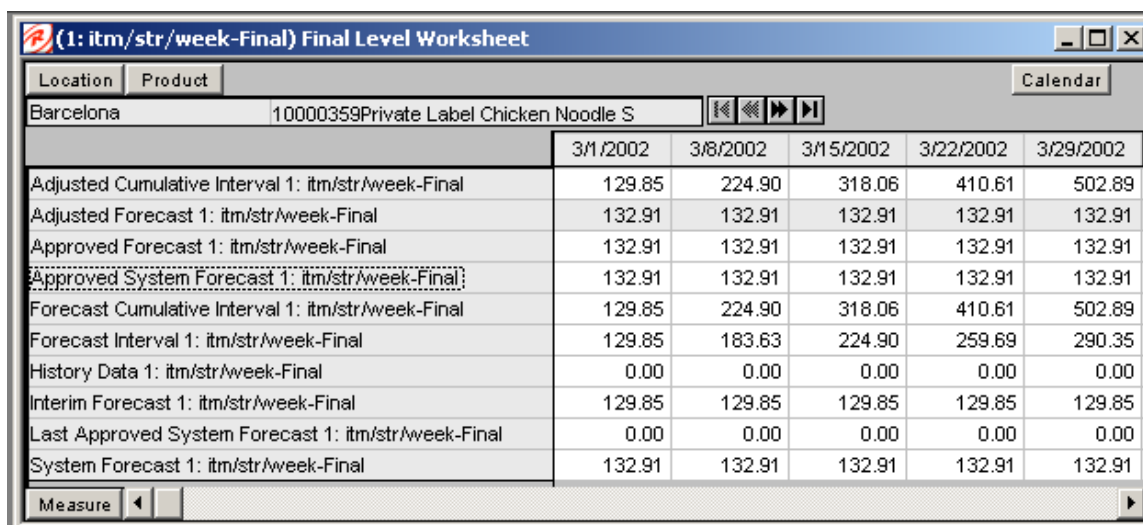
1. Select New from the File menu.
2. Select the Predict tab to display a list of workbook templates for statistical forecasting. Highlight Forecast Approval and click OK. The Forecast Approval wizard opens and prompts you to select the final level at which to approve forecast values.
3. Make your selection and click Next.
4. Select the forecast level(s) to include in the Forecast Approval Workbook. Select as many forecast levels as necessary for comparison, and then click Next.
5. Select the generation date of the forecast you wish to approve. Click “Use the most recent generated forecast” to build a workbook containing the most recent forecast values, or click “Select from a list of forecast” to select from a list of previously generated forecasts stored in the system. Click Next.
6. Select the specific locations you want to view. It is important to include all locations that are members of the location dimensions in the forecast levels to be analyzed. For example, if you select to view a forecast level that is defined at item/chain/week, you must include all locations that are members of the particular chain to be analyzed. Aggregating the Location hierarchy to Chain and selecting the entire Chain easily accomplishes this. Click Next.
7. Select the merchandise you want to view. It is important to include all products that are members of the Merchandise dimensions in the forecast levels to be analyzed. For example, if you select to view a forecast level that is defined at subclass/store/week, you must include all items that are members of the particular subclass to be analyzed. Aggregating the Merchandise hierarchy to subclass and selecting the entire subclass easily accomplishes this. Click Next.
8. Specify time periods to include in your workbook. This must include all time periods within the forecast horizon of the forecast selected to be viewed. You may also include historical and future time periods. Click Next.
9. Place checkmarks next to any additional registered measures you would like to view in your workbook. The valid values of these measures may only be viewed if “Generate Intervals”, “Generate Cumulative Intervals”, “Generate Methods”, “Generated Parameters”, “Generated Baselines” or “Store Interim Forecasts” were selected in the Forecast Administration Workbook. Click Next.

10. From the list provided, check any additional forecasting measures specific to this forecast that you would like to view. The measure options available in this screen are set in the RPAS Security Administration Workbook / Workbook Template Measure Rights Worksheet. Click Next.
11. Click Finish to build and open your workbook.

## Final Forecast Worksheet

The Final Forecast Worksheet allows you to review the system-forecasted quantities and make revisions to those forecasted amounts if needed.

Your main objective in the Forecast Approval Workbook is to review and edit forecast values using the Adjusted Forecast field on the Final Level Worksheet and, ultimately, to approve forecasts that have been user-adjusted or require manual approval.



The screenshot shows a window titled "(1: itm/str/week-Final) Final Level Worksheet". It contains a table with the following data:

Location	Product	3/1/2002	3/8/2002	3/15/2002	3/22/2002	3/29/2002
Barcelona	10000359Private Label Chicken Noodle S					
Adjusted Cumulative Interval 1: itm/str/week-Final		129.85	224.90	318.06	410.61	502.89
Adjusted Forecast 1: itm/str/week-Final		132.91	132.91	132.91	132.91	132.91
Approved Forecast 1: itm/str/week-Final		132.91	132.91	132.91	132.91	132.91
Approved System Forecast 1: itm/str/week-Final		132.91	132.91	132.91	132.91	132.91
Forecast Cumulative Interval 1: itm/str/week-Final		129.85	224.90	318.06	410.61	502.89
Forecast Interval 1: itm/str/week-Final		129.85	183.63	224.90	259.69	290.35
History Data 1: itm/str/week-Final		0.00	0.00	0.00	0.00	0.00
Interim Forecast 1: itm/str/week-Final		129.85	129.85	129.85	129.85	129.85
Last Approved System Forecast 1: itm/str/week-Final		0.00	0.00	0.00	0.00	0.00
System Forecast 1: itm/str/week-Final		132.91	132.91	132.91	132.91	132.91

The following is a description of the standard measures that are contained in the Final Level Worksheet:

### Adjusted Forecast

The value in this measure defaults to the System Forecast. The user may choose to make adjustments to the System Forecast in this field. Overriding values in this field does not change the System Forecast values. If the user adjusts this value and determines that the System Forecast value should be approved, then the Adjusted Forecast must be changed back to match the System Forecast.



**Note:** Changes to the Adjusted Forecast for periods outside the forecast horizon will not be committed.

### System Forecast

Displays the quantity that the system predicts will be required for the product, location, and calendar combination. The values contained in this measure are read-only.

### Approved Forecast

This is the forecast quantity that was approved at the time of the workbook build. The values contained in this measure are read-only.

### Last Approved System Forecast

The last system forecast that was that was approved for the product/location combination the last time an approval was done. The values contained in this measure are read-only.

### Forecast Interval

Valid only at a final level, the Forecast Interval is calculated on the particular forecast region as capped standard deviation for some methods. It takes into consideration the system forecast for capping (the default capping is no less than 30% of forecast and no more than 100% of forecast). When we approve forecast we approve the corresponding Intervals and Cumulative Interval measures. To see this measure:

- Generate Intervals must be selected in the Forecast Administration Workbook
- Intervals must be selected to be viewed in the Forecast Approval wizard.

For Simple, Holt, and Winters methods more complex calculation is involved. See chapter 8 for more details.

### Forecast Cumulative Interval

Valid only at a final level, Cumulative Intervals are used in safety stock calculation used in allocation and replenishment systems. This value is a running total of the Forecast Interval and are read-only. To see this measure:

- Generate Cumulative Intervals must be selected in the Forecast Administration Workbook
- Cumulative Intervals must be selected to be viewed in the Forecast Approval wizard.

For information on the calculation of the Cumulative Interval, see chapter 8.

### Adjusted Cumulative Interval

Valid only at a final level, when the user makes changes to the Adjusted Forecast, the value of the Forecast Cumulative is recalculated in this measure. The values in this measure are read-only. To see this measure:

- Generate Cumulative Intervals must be selected in the Forecast Administration Workbook
- Cumulative Intervals must be selected to be viewed in the Forecast Approval wizard.

For information on the calculation of the Cumulative Interval, see chapter 8.

### System Baseline

A forecast generated by the system based on past sales data that contains no promotions (that is, normal demand given no causal effects). To see a generated Baseline Forecast:

- Promote must be implemented
- Generate Baseline must be selected in the Forecast Administration Workbook
- The System Baseline must be selected to be viewed in the Forecast Approval wizard.

For more information on the calculation of the System Baseline, see chapter 8.

### Approved System Forecast

A value will be populated in this measure for products/locations whose Approval Method is set to Automatic Approval or is set to Approve by Alert and the alert is not triggered. The values in this measure are read-only.

### History Data (for example, Weekly Sales or the name of your sales/data measure)

This read-only measure is the sales data used to generate the forecast. This allows the user to compare Actuals to forecasted values.

### Interim Forecast

Valid only for final levels, the Interim Forecast is the forecast generated at the final level that is used to create the profile generated in Curve. This profile will determine how the Source Forecast will be spread down to the Final Forecast. The values in this measure are read-only. To see this measure:

- Generate Interim Forecast must be selected in the Forecast Administration Workbook
- Interim Forecast must be selected to be viewed in the Forecast Approval wizard.

### Intervals and Cumulative Intervals

When a user edits the Adjusted Forecast, the cumulative intervals for all the subsequent time periods will be recalculated according to the following formula:

$$CumInt_{Adj}(t) = CumInt_{Adj}(t-1) + CAP\left[\frac{F_{Adj}(t)}{F_{Sys}(t)} \times [CumInt_{Sys}(t) - CumInt_{Sys}(t-1)]\right] \text{ Where:}$$

t: W, W+1, W+2, ..., End of forecast horizon

$CumInt_{Adj}(t)$ : Adjusted Cumulative Interval for week t

$CumInt_{Sys}(t)$ : System Cumulative Interval for week t

$F_{Sys}(t)$ : System Forecast for week t

$F_{Adj}(t)$ : Adjusted Forecast for week t

$CAP[x]$ : A capping function that limits x to  $0.3 \times F_{Adj}(t) \leq CAP[x] \leq F_{Adj}(t)$

For more information on interval calculation, see Chapter 8.

## Source Level Worksheet

The Source Level Worksheet displays the system-generated source level forecast. Final level forecast values in the Final Level Worksheet can be viewed alongside and compared with their corresponding source level forecasts.

	3/1/2002	3/8/2002	3/15/2002	3/22/2002	3/29/2002
History Data 1: itm/str/week-Final	0.00	0.00	0.00	0.00	0.00
System Forecast 3: itm/chn/week	2217.92	2217.92	2217.92	2217.92	2217.92

The following is a description of the standard measures that are contained in the Source Level Worksheet:

### History Data (for example, Weekly Sales or the name of your sales measure)

This is the sales measure used to generate the forecast. This allows the user to compare Actuals to forecasted values.

### System Baseline

The baseline quantity that the system predicts if using causal forecasting. Any causal lift effects, positive or negative, will be gauged against this baseline. To see a generated Baseline Forecast:

- Promote must be implemented
- Generate Baseline must be selected in the Forecast Administration Workbook
- The System Baseline must be selected to be viewed in the Forecast Approval wizard.

For more information on the calculation of the System Baseline, see chapter 8.

### System Forecast

The quantity that the system predicts will be required for the product, location, and calendar combination displayed.

## Approval Worksheet

The Forecast Approval Worksheet allows you to specify the manual approval policy of forecasts by product and location. This worksheet can also be used to view the approval date of forecast values, as well as the name of the user who manually approved forecast values for a given product/location combination. The default Approval Method is set in Forecast Administration Workbook and for product/location combinations that vary from the default the Forecast Maintenance Workbook can be used.



The Approval Worksheet is used to approve forecasts that require manual approval or forecasts that have been modified using the Adjust Forecast measure in the Final Level Worksheet.

The screenshot shows a window titled "(1: itm/str/week-Final) Approval Worksheet". It contains a table with the following data:

Product	Barcelona	Berlin	Boston	Catalog Store	Chicago	Dusseldorf
10000359Private Label Chicken Noodle S		+ 25%				
Approval Comment 1: itm/str/week-Final						
Approval Date 1: itm/str/week-Final	2/17/2004	2/17/2004	2/17/2004	2/17/2004	2/17/2004	2/17/2004
Approve without adjust 1: itm/str/week-Final	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Approved 1: itm/str/week-Final	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Approved By 1: itm/str/week-Final	System	adm	System	System	System	System

At the bottom, there is a "Measure" dropdown menu.

The Approval Worksheet(s) contain the following standard measures:

### Approval Comment

A comment field in which to enter notes regarding the approval of forecast values for specified product/location combinations.

### Approved Date

A read-only field showing the date that the forecasted quantity was approved. This information is necessary for Demand Forecasting to carry out any subsequent processes, such as replenishment procedures. Whenever a forecast is approved, this field is automatically updated with the current date.

### Approved

A read-only, Boolean flag. If the user edits the Adjusted Forecast, this flag is automatically activated (checked). Activating this Boolean flag approves the forecast quantity entered in the Adjusted Forecast field of the Final Level Worksheet. The adjusted forecast quantity is approved, the Approval Date measure is stamped with the current system date, and the Approved By field is stamped with the user ID.



**Note:** Any non-adjusted forecast with an Approval Method set to Automatic or is approved automatically based on an alert, will not require an Approved flag or Approved without Adjust flag to be activated.

### Approved without Adjust

A read/write, Boolean flag. For any forecast that must be manually approved, if the user accepts the System Forecast value this flag must be manually activated (checked). Activating this Boolean flag approves the forecast quantity entered in the Adjusted Forecast field of the Final Level Worksheet. The adjusted forecast quantity is approved, the Approval Date measure is stamped with the current system date, the Approved By field is stamped with the user ID, and the Approved Boolean flag is activated.



**Note:** Any non-adjusted forecast with an Approval Method set to Automatic or is approved automatically based on an alert, will not require an Approved flag or Approved without Adjust flag to be activated.

## Final or Source System Parameters Worksheet

The Final or Source Parameters Worksheets allows you to view the alpha, level and trend parameters for each fitted time series. These parameters are only available to be viewed if “Generate Parameters” or “Generate Methods” are activated in the Advanced Tab of the Forecast Administration Workbook.

Product	Location					
10000359Private Label Chicken Noodle S	Barcelona	Berlin	Boston	Catalog Store	Chicago	Dusseldorf
Forecast Picked Method 1: itm/str/week-Final	Simple	Simple	Simple	No Generatec	Simple	Simple
System Generated Alpha 1: itm/str/week-Final	0.05	0.07	0.05	0.00	0.05	0.05
System Generated Level 1: itm/str/week-Final	129.85	118.19	75.34	0.00	109.11	114.56
System Generated Trend 1: itm/str/week-Final	0.00	0.00	0.00	0.00	0.00	0.00

The Final and Source Parameters Worksheet(s) contain the following standard measures:

### Forecast Method Picked

The name of the method that was used to generate the forecast for the given product/location combination. This field is useful when combined methods are requested. Then this field displays the actual method the system picked from the combined methods. In case stand-alone methods are chosen then in general this field is the same as the method chosen in forecast administration or forecast maintenance. However if the requested method is unable to produce a good fit then the system will default to a “simpler method” and that method is displayed here. To see this measure:

- Generate Methods must be selected in the Forecast Administration Workbook
- System Generated Methods must be selected to be viewed in the Forecast Approval wizard.

### System Generated Alpha

The system-calculated alpha value (which is an internal optimization parameter which corresponds to the rate of decay of the weighting on the historical values) for the corresponding product/location combination if the chosen method is one of the following methods: Simple, Holt, Additive Winters, Multiplicative Winters, and Profile Based. To see this measure:

- Generate Parameters must be selected in the Forecast Administration Workbook
- System Generated Parameters must be selected to be viewed in the Forecast Approval wizard.

### System Generated Level

The system-calculated level (which is the constant baseline forecast) if the chosen method is one of the following methods: Simple, Holt, Additive Winters, Multiplicative Winters, and Seasonal Regression. To see this measure:

- Generate Parameters must be selected in the Forecast Administration Workbook
- System Generated Parameters must be selected to be viewed in the Forecast Approval wizard.

### System Generated Trend

The system-calculated trend (which is the rate of change of the baseline forecast with time) if the chosen method is one of the following methods: Holt, Additive Winters, Multiplicative Winters, and Seasonal Regression. To see this measure:

- Generate Parameters must be selected in the Forecast Administration Workbook
- System Generated Parameters must be selected to be viewed in the Forecast Approval wizard.

## Approving Forecasts through Alerts (Exception Management)

Retek Demand Forecasting provides the user with ability to manually approve every single product/location forecast value. However, due to the extremely large volume of product/location forecast values that will be generated each forecast cycle, RPAS also provides additional functionality that enhances a user's ability to evaluate and approve a forecast.

When configuring a RDF solution, specific alert measures may be defined and included in the system. In effect, alert measures act as watchdogs and report product/location forecast values that exceed expected thresholds. If a specific product/location forecast value exceeds a threshold, the alert measure is flagged as “on” and visible to the user as a check mark in the appropriate product/location intersection on the interface.

The complexities of retail operations can result in the need to define many alerts; each designed to watch for a specific scenario that would require a user's evaluation of a forecast value. For example:

- Alert 1: Forecast Value for a specific product/location has increased more than 30% since last week's system forecast.
- Alert 2: Forecast Value for a specific product/location is zero although there is sales activity on the same product/location.
- Alert 3: Forecast Value is x% higher than Last Years Sales.
- Alert 4: A Forecast Value was generated for a product/location combination where no sales prior sales history exists.

For more information on how these measures are defined and registered as Alert measures, refer to the RPAS Configuration Tools User Guide.

Any time the nightly batch process is run a specific Alert Finder utility is run. This utility analyzes the forecast results, and flags any values that meet the criteria of the alert measures. These “alert hits” are summed up and available for view in the Alert Manager.

### The Alert Manager

The Alert Manager provides a view of the alert hits that exist on the domain. When a user opens up RDF, if alert hits exist then the Alert Manager should open automatically. At any time however, a user can select View < Alert Manager to open the Alert Manager window. The Alert Manager provides the following information:

#### Alert Name

A descriptive label for the alert.

### Priority

The alert priority (High, Medium, or Low).

### Date

The date upon which the alert was identified; that is, the date the exception was detected in the data and an alert sent to the RDF user.

### Count

The number of hits, or instances, associated with the alert. In this list, the Count indicates the number of alerts that have been raised globally in the domain.

### Status

Specifies the status of the alert (New, Reviewed, or Resolved).

- New: Indicates that the alert is new since the last login to RDF.
- Reviewed: Indicates that a user has opened the alert workbook containing the alert.
- Resolved: Indicates that a user has selected the alert and clicked the Resolve Alert button.

### Resolve Alert button

This button is enabled when an alert is selected. It sets the status of an alert to Resolved.

For resolved alerts, the button label changes to Unresolve Alert. Clicking the button when a resolved alert is selected changes that alert's status back to Reviewed.

### Insert Alert button

Allows for selecting an alert and inserting it into an open workbook. This action permits multiple alerts to be present in a workbook.

### New Workbook button

Enabled when an alert is selected. Clicking this button builds a new alert workbook; that is, a workbook containing the items associated with the alert.

## Evaluating and Resolving Alerts in a Workbook.

The Alert Manager is used as a tool of the overall forecasting approval process. Once you have a workbook open that has an alert measure(s) included, the user must review the forecast values against the alert measure. There are two general scenarios that may exist, depending on what intersection at which the alert is defined:

### Scenario 1: Alert is defined along two dimensions (for example, Product/Location)

1. An alert is inserted into a workbook.
2. Careful attention must be paid to how the workbook window is displayed vs. how the alert measure is defined. For example: If an alert is defined at an item/store intersection, the workbook window must be arranged to only show an item/store intersection (Product rolled down to Item, Location rolled down to store, Calendar has no dimension visible). If the alert measure is displayed as cells filled with #####, then the window is not displayed at the appropriate intersection.

3. If the alert measure is defined at only two dimensions (Product/Location) then two worksheets will need to be used to evaluate the alert hits. The first worksheet window will display just the product /location intersection with the alert button visible. The second worksheet window (a copy of the first worksheet window – see instructions below) will display the actual forecast data along the alert intersection (product/location) but also have time dimension included. Both of these windows can be viewed simultaneously and the alerts will let the user know where to review the forecast values.
  - Creating a Copy of an open Worksheet Window
    - a. Close all windows except the window that has the inserted alert measure to be evaluated.
    - b. Select Window < New Window from the menu bar.
    - c. Enter a name for the new window (for example, Alert Window 2, etc.)
    - d. Select Window < Tile Horizontal from the menu bar. This should provide a view to both windows simultaneously.
4. Once a user has completed the evaluation of an alert, the user can select the alert in the Alert Manager and then press the Resolve Alert button. This will change the status of the alert to “resolved” and the user is free to move on the next alert.

### **Scenario 2: Alert is defined along three dimensions (for example, Product/ Location/ Calendar)**

1. An alert is inserted into a workbook.
2. Careful attention must be paid to how the workbook window is displayed vs. how the alert measure is defined. For example: If an alert is defined at an item/store/week intersection, the workbook window must be arranged to only show an item/store/week intersection (Product rolled down to Item, Location rolled down to store, Calendar rolled down to week.) If the alert measure is displayed as cells filled with #####, then the window is not displayed at the appropriate intersection.
3. Since the alert is defined at an item/store/week intersection, the user does not need to create a second worksheet window. The user can simply scroll from one alert hit the next, and evaluate the forecast value.
4. Once a user has completed the evaluation of an alert, the user can select the alert in the Alert Manager and then press the Resolve Alert button. This will change the status of the alert to “resolved” and the user is free to move on the next alert.

Each alert in the Alert Manager should be resolved prior to the next nightly batch run. This will reset the alert hit count to zero, and return a fresh hit count after the batch run. If an alert is not in a resolved status prior to the next nightly batch run, then any new alert hits will be added to previous number.

### **User-Defined Formatting Exceptions**

In addition to system defined alert measures, users can also leverage the RPAS Format functions to create user-specific exception alerts. For example, a user can format a workbook to show any value that is greater than 1000 to be displayed in bold red. This would make it easier for a user to scroll through forecast values, only stopping at the values in red for further evaluation.

The assumption is made that a user will understand their business, and be able to create simple formatting exceptions that will further enhance their ability to see the forecast values that need further evaluation prior to approval.

Steps to create a formatting exception:

1. Click on the Format button from the toolbar.
2. Click on Exceptions from the Formatting dialogue box.
3. Highlight the appropriate measure.
4. Enter a value for the low exception and the high exception.
5. Click on the various font/color buttons to designate how these values should be displayed.
6. Once formatting is complete, make sure to save your formatting changes by clicking Format< Save Format< User/Template/Group

See the RPAS User's Guide or online help for more information on using RPAS formatting functionality.

# Chapter 5 – Forecast Analysis Tools

## Overview

Retek Demand Forecasting provides the user with a number of tools that may be used for additional forecast analysis. The Predict Workbook template group provides the workbooks necessary to complete these tasks.

### Workbooks and Wizards

The forecasting workbooks and tools are covered in this chapter include:

- Interactive Forecast Workbook
- Forecast Scorecard Workbook

## Interactive Forecasting Workbook

The Interactive Forecasting Workbook is a forecast simulation tool that allows the user to make changes to forecast parameters and see the results, without having to wait for the batch run. In this workbook, the user can edit various forecast parameters including sales history and forecast method. A new forecast is produced based on the changed parameters. In addition to forecasts, the Interactive Forecasting Workbook can also generate fit in historical region, system picked model, and cumulative interval.

To access Interactive Forecasting, perform the following steps:

1. Select New from the File menu.
2. Select the Predict tab to display a list of workbook templates for statistical forecasting. Highlight Interactive Forecasting and click OK.
3. Select the forecast level.
4. Enter the default forecasting starting date.
5. Select the forecast output; that is, decide whether interval, cumulative interval, and system-picked model should be output.
6. Select the specific time periods to be included in the workbook. Click Next.
7. Select the products to be included in the workbook. Click Next.
8. Select the locations to be included in the workbook. Click Next.
9. Select extra measures (if available) to be included in the forecasting workbook. Click Finish.

Once the wizard is completed, the forecast is generated based on the user selections in the wizard and the Default Forecast Method set for the specified forecast level in the Forecast Administration Workbook.

After the forecast generation is complete, the Interactive Forecasting Workbook is displayed.

(itm/chn/w) Interactive Forecasting Worksheet											
Product	Location	Calendar									
10000010Leather Loafer - Black 6 B	Bricks & Mortar										
		3/29/2002	4/5/2002	4/12/2002	4/19/2002	4/26/2002	5/3/2002	5/10/2002	5/17/2002	5/24/2002	5/31/2002
History Data 1: itm/str/week-Final		56.00	55.00	55.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Forecast Cumulative Interval 3: itm/chn/week		0.00	318.89	974.15	2019.60	3514.15	5498.45	8108.09	11310.21	15521.70	20571.01
System Forecast 3: itm/chn/week		0.00	59.52	60.34	62.23	64.43	66.40	69.52	71.29	76.48	78.95
Forecast Interval 3: itm/chn/week		0.00	318.89	655.27	1045.45	1494.55	1984.30	2609.64	3202.12	4211.50	5049.30
Measure											

(itm/chn/w) Forecast Parameter Worksheet											
Location		Measure									
Bricks & Mortar											
		Forecast Method 3: itm/ch Forecast Picked Method 3 History Start Date 1: itm/st Forecast Start Date 1: itm Forecast End Date 1: itm									
10000010Leather Loafer - Black 6 B	Seasonal				10/16/1998		4/1/2002		6/1/2002		
10000011Leather Loafer - Black 6.5 B	AutoES				10/16/1998		1/1/2002		3/26/2002		
10000012Leather Loafer - Black 7 B	AutoES				10/16/1998		1/1/2002		3/26/2002		
10000013Leather Loafer - Black 7.5 B	AutoES				10/16/1998		1/1/2002		3/26/2002		
10000014Leather Loafer - Black 8 B	AutoES				10/16/1998		1/1/2002		3/26/2002		
10000025Leather Loafer - Brown 9 B	AutoES				10/16/1998		1/1/2002		3/26/2002		
10000036Leather Lace-up - Brown 9 D	AutoES			AutoES	10/16/1998		1/1/2002		3/26/2002		
10000102Cargo Jeans - Antique 10	AutoES			Simple	10/16/1998		1/1/2002		3/26/2002		
10000120Utica Square Lux 200 Sets	AutoES			AutoES	10/16/1998		1/1/2002		3/26/2002		
10000302Tormek Whetstone Grinder	AutoES			Simple	10/16/1998		1/1/2002		3/26/2002		
Product											

The workbook contains two worksheets:

- Forecasting Parameter Worksheet
- Interactive Forecasting Worksheet

### Forecasting Parameter Worksheet

The Forecasting Parameter Worksheet is based on the intersection of the Product and Location dimensions.

The Forecasting Parameter Worksheet contains the following measures. Of these measures, all measures but System picked model are editable. Changes can be made to the editable parameters, that is, Sales History, Forecast Method, History Start Date, and Forecast Start Date to re-generate a forecast of the time series.

#### Forecast Method

A drop-down list from which you can select the method used to generate the forecast. The workbook defaults to the method selected in the Forecast Administration Workbook for the specified level. A summary of methods is provided in the overview of chapter 2, and chapter 8 covers each method in detail.



**Forecast Picked Method**

This is the method that was used to generate the forecast for the given product/location combination. This field is useful when combined methods are requested (for example ES methods). Then this field displays the actual method the system picked from the combined methods. In case stand-alone methods are chosen then in general this field is the same as the method chosen in Forecast Administration or Forecast Maintenance. However if the requested method is unable to produce a good fit then the system will default to a “simpler method” and that method is displayed here. This measure is available if System Picked Method is selected in the Interactive Forecasting wizard.

**History Start Date**

The starting date for historical sales data. For example, if your system start date is January 1, 2003, but you only want to use historical sales data from the beginning of 1999, then you need to set your History Start Date to January 1, 1999. Only history after this date is used for generating the forecast. The default is the system start date unless otherwise specified. If sales data is collected weekly or monthly, Retek Demand Forecasting generates forecasts only using data from sales periods after the one containing the history start date.

It is also important to note that the system ignores leading zeros that begin at the history start date. For example, if your history start date is January 1, 1999 and an item/location does not have sales history until February 1, 1999, the system will consider the starting point in that item/location’s history to be the first data point where there is a non-zero sales value.

**Forecast Start Date**

The starting date of the forecast. The default is the system date unless otherwise specified.

**Forecast End Date**

The ending date of the forecast.

**Interactive Forecasting Worksheet**

The Interactive Forecasting Worksheet is based on the intersection of the Product, Location, and Time dimensions.

The Interactive Forecasting Worksheet contains the following measures: Sales History, System Cumulative Intervals, System Forecast, and System Intervals. Of these measures, only Sales History is editable; all other measures are read-only.

**Historical Data**

Your historical sales data. This field is editable so you can change out-of-character sales if needed. For example, if your battery sales went up during a major power outage, you can lower the sales data back to a more normal level so the unusually high sales will adversely affect your forecast. However these changes are for simulation purposes only and cannot be committed.

**Forecast Cumulative Interval**

The cumulative standard deviation of the fit error over the history. Cumulative Intervals are a running total of Intervals. This measure is available only for Final Level Forecasts and if Cumulative Interval is selected in the Interactive Forecasting wizard. For more information on how Cumulative Intervals are calculated, see Chapter 8.

### System Forecast

The quantity that the system predicts will be required for the product, location, and calendar combination displayed.

### Forecast Interval

The system generated confidence interval, which requires the standard deviation of the fit error over the forecast history. For many forecasting methods they are calculated as standard deviation but for Simple, Holt, and Winters the calculation is more complex. (See Chapter 8 for more details.) Intervals are not exported. Also, Intervals are capped. This measure is available only for Final Level Forecasts and if Confidence Intervals is selected in the Interactive Forecasting wizard.

## Forecast Scorecard Workbook

This section describes the purpose and content of the Forecast Scorecard and the steps required in order to create and access this workbook. This section also discusses the two types of worksheets contained in the Forecast Scorecard Workbook, as well as the definitions of parameters that exist in each. Evaluating forecast accuracy through the use of error statistics is discussed, as is the process of comparing historical forecasts to actual sales data.

The purpose of the Forecast Scorecard is to monitor the accuracy of both system-generated forecasts and approved final forecasts. Once a forecast has been generated and actual point-of-sale data is received for the forecasted period, statistical information can be reviewed to help you analyze the accuracy of forecasting models and methods.

### Forecast Scorecard wizard

The Forecast Scorecard template consists of a wizard and two worksheets.

Based on your selections in the wizard, the Forecast Scorecard provides statistical information and comparison data that allow you to monitor the accuracy of system-generated forecasts and final approved forecasts.

- The Final Error Measure Worksheet displays statistical information, such as mean error and root mean squared error, that reflects the accuracy of the forecast.
- The Final Actuals vs. Forecasts Worksheet displays forecast results and actual point-of-sale values for specified product/location/calendar combinations.

To access Forecast Scorecard, select Open from the File menu to bypass the Forecast Scorecard Wizard and open an existing Forecast Scorecard, or perform the following steps:

1. Select New from the File menu.
2. Select the Predict tab to display a list of workbook templates for statistical forecasting. Highlight Forecast Scorecard and click OK.
3. The Forecast Scorecard wizard opens and prompts you to select the final forecast level that you want to evaluate. Make a selection and click Next.

4. Select the generation date of the forecast you want to evaluate. Click the radio button corresponding to your selection and click Next.



**Note:** You can only choose from forecasts that are stored on the system. If the user elects to store few forecasts on the domain (as defined in Forecast Administration) the user should remember to access the Forecast Scorecard regularly, and if necessary, export the results of the scorecard for use in an external program such as Excel.

5. Check the boxes corresponding to the error statistics that you want calculated for the forecast data. Click Next.
6. Select the specific products whose forecasts and actual sales data should be viewed. Click Next.
7. Select the locations whose forecasts and actual sales data should be viewed. Click Next.
8. Select the time periods whose forecasts and actual sales data should be viewed.
9. Click the Finish button to display the workbook.

### Error Measure Worksheet

The Final Error Measure Worksheet displays statistical information that reflects the accuracy of the forecast. You may need to evaluate a variety of such statistics to verify and compare forecast accuracy.

Given the situation, different levels of forecast accuracy can be useful. For example, in a situation with noisy data and no forecast previously available, then a 200% error can be considered excellent and useful. In another situation with smooth data, if an old method of forecasting provided forecasts with a 10% error, then a new method of forecasting with a 20% error would not be considered useful.

Different levels of forecasting accuracy are obtained at different levels of product aggregation. Item level forecasts with a 200% error can roll up into division-level forecasts with a 10% error. Therefore, the error measures are most useful when comparing different methods of forecasting or when looking at a particular model's accuracy over time. Accurate forecasts should lead to a reduction in inventory holding costs, or to an increase in customer service levels; forecast errors should be converted into dollars saved.



**Note:** All error statistics are calculated over the first period in the forecast to the last period in the forecast for which forecast data is available.

The following is a description of the measures that can be included in the Final Error Measure Worksheet: The error statistics will be shown for each forecast you chose to include in the workbook (such as System Forecast, Final Forecast, etc.).

#### History Data for Forecast Window

The sum of all actual sales from the first period in the forecast to the last period in the forecast for which point-of-sale data is available.

#### Averaged System Forecast Over Horizon

The sum of all forecasted sales from the first period in the forecast to the last period in the forecast for which forecast data is available.

**System Forecast Mean Error**

The error of a forecast observation is the difference between the forecasted value and the actual POS value. The Mean Error statistic is a measure of the average error over time, calculated by summing the errors for all observations, then by dividing by the number of observations to obtain the average. It measures forecast accuracy by calculating the error in units. Because a positive error in one period can cancel out a negative error in another period, this measure is useful when you are interested in how well the forecast predicts over the forecast horizon rather than on a period-to-period basis. Mean error is, however, useful as a measure of forecast bias; a negative mean error suggests that, overall, the forecasting model overstates the forecast, while a positive mean error indicates forecasts that are generally too low.

$$\frac{1}{\# \text{ of observations}} \sum_{i=1}^{\# \text{ of observations}} (Actual_i - Forecast_i)$$

**System Forecast Mean Absolute Error**

The absolute error of a forecast observation is the absolute value of the difference between the forecasted value and the actual POS value. The Mean Absolute Error statistic is a measure of the average absolute error, calculated by summing the absolute errors for all observations, then by dividing by the number of observations to obtain the average. Mean Absolute Error gives you a better indication of how the forecast performed period by period, because the absolute value function ensures that negative errors in one period are not canceled out by positive errors in another. Mean Absolute Error is most useful for comparing two forecast methods for the same series.

$$\frac{1}{\# \text{ of observations}} \sum_{i=1}^{\# \text{ of observations}} |Actual_i - Forecast_i|$$

**System Forecast Root Mean Squared Error**

The square root of the Mean Squared Error. The Root Mean Squared Error is one of the most commonly used measures of forecast accuracy because of its similarity to the basic statistical concept of a standard deviation. It evaluates the magnitude of errors in a forecast on a period-by-period basis, and is best used to compare alternative forecasting models for a given series.

$$\sqrt{\frac{\sum_{i=1}^{\# \text{ of observations}} (Actual_i - Forecast_i)^2}{\# \text{ of observations}}}$$

**System Forecast Mean Absolute Percentage Error**

The percentage error of a forecast observation is the difference between the actual POS value and the forecasted value, divided by the actual POS value. The result of this calculation expresses the forecast error as a percentage of the actual value. The Mean Absolute Percentage Error statistic measures forecast accuracy by taking the average of the sum of the absolute values of the percentage error calculations across all observations. This method is useful when comparing the accuracy of forecasts for different volume products (it normalizes error by volume).

$$\frac{100}{\# \text{ of observations}} \sum_{i=1}^{\# \text{ of observations}} \frac{|Actual_i - Forecast_i|}{Actual_i}$$

### System Forecast Percentage Absolute Error

The absolute error of a forecast observation is the absolute value of the difference between the forecasted value and the actual POS value. The Percentage Absolute Error statistic measures forecast accuracy by calculating the total absolute error as a percentage of the total actual POS. It is calculated by summing the absolute errors for all observations, dividing this value by the absolute value of the sum of all Actuals, and dividing the result by the number of observations in the series. Finally, multiply the total by 100 to obtain a percentage result.

$$\frac{100}{\# \text{ of observations}} \frac{\sum_{i=1}^{\# \text{ of observations}} |Actual_i - Forecast_i|}{\sum_{i=1}^{\# \text{ of observations}} |Actual_i|}$$

### Actuals vs. Forecasts Worksheet

This worksheet displays forecast results and actual point-of-sale values for each product, location, and time period specified in the Forecast Scorecard Wizard. This worksheet allows you to compare the results of both system-generated forecasts and final approved forecasts to actual sales quantities.

The Actuals vs. Forecasts Worksheet may contain the following measures:

#### Actuals – System Forecast

Displays the difference between the actual sales quantities and the approved forecast values for each product, location, and calendar combination displayed. Negative values indicate that the final forecast exceeded actual sales.

#### History Data

Displays the actual point-of-sale quantities for the product, location, and calendar combinations displayed.

#### System Forecast

Displays the system-generated forecast quantity for the product, location, and calendar combination displayed. Note that the [Forecast Date] portion of this measure's label will be replaced in your worksheet with the date of the forecast you are evaluating.



# Chapter 6 - Promote (Promotional Forecasting)

## Overview

Promote is an optional add-on automated predictive solution that allows you to incorporate the effects of promotional and causal events, such as radio advertisements and holiday occurrences, into your time-series forecasts. The promotional forecasting process uses both past sales data and promotional information to forecast future demand.

This chapter provides an introduction to promotional forecasting and explains how it differs from the traditional statistical forecasting methodology. It discusses the advantages and limitations of both statistical and promotional forecasting models, and outlines the use of Retek's Causal method of forecasting demand. It describes terminology used in the context of promotional forecasting, and concludes with detailed descriptions of the workbook templates contained in the Promote Workbook Template Group.

## Workbooks and Wizards

The forecasting workbooks covered in this chapter include:

- Promotion Effectiveness
- Promotion Maintenance
- Promotion Planner

## What is Promotional Forecasting?

Traditional statistical forecasting methods provide significant benefits to the process of forecasting consumer demand, because they are good at predicting level, trend, and seasonality based on sales history. The limitation of traditional statistical methods is that they forecast with less accuracy when there are special events that cause significant deviations in selling patterns.

For example, the Easter holiday, for which companies often run promotions, occurs on a different date each year. Traditional statistical forecast methods can identify seasonality in sales history, but this seasonality is based on periodic similarities in the sales pattern. Since Easter occurs on different dates from year to year (that is, its period of recurrence is not regular), manual intervention is required to predict change in demand using the traditional statistical forecasting method. Events like this are called promotion events. Promotion events, such as advertisements, irregularly occurring holidays, competitor information, free gift with purchase offers, etc., are events that drive businesses from the normal selling cycle. The goal of a promotional forecasting system is to improve time series forecasting by:

- Providing the forecasting system with visibility as to when certain promotion events were active in the past (for example, identifying which weeks of a given year were affected by an Easter promotion).
- Automatically determining the statistical effect, if any, of these events.
- Incorporating significant effects into the future forecasts for time periods also associated with the observed promotion event.

The Promote module combines the automation of statistical time series forecasting with the improved accuracy found in customized causal forecasting. Promote uses both past sales data and promotional information (for example, advertisements, holidays) to forecast future demand. In order to understand the underlying rationale for the promotional forecasting process, it is important to understand the advantages and limitations of its underlying components.

### **Comparison between promotional and statistical forecasting**

Statistical time series forecasting uses past demand to predict future demand. The most basic component of the time series forecast is the level of sales. This is usually determined by looking at demand in the recent past. Often there also exists an underlying trend that can be detected within sales history. This is usually determined by looking at the change in demand in the recent past. A third factor influencing retail demand is seasonality. A forecasting algorithm trying to determine the effects of seasonality can only look for periodic similarities in the sales pattern. For example, December sales from previous years can be used to adjust the forecast for December only because December occurs regularly every 12 months. At every step the time series approach is limited to using historical demand to predict future demand, without regard to the underlying causes that are driving demand in the first place.

Promotional events, however, can create problems in estimating level, trend, and seasonality. Certain events, such as irregularly occurring holidays, newspaper/radio advertisements, free gift with purchase offers, and special discounts can cause significant deviations from the selling pattern.

Promotional forecasting, unlike statistical forecasting, attempts to predict future demand by identifying the factors that influenced spikes and lulls in demand in the past. Once these factors are known, the magnitude and direction of their effect can be evaluated. Their presence can then be incorporated into forecasting models for use during times when the causal factors are again expected to be present.

### **Developing promotional forecast methods**

This section describes how custom promotional forecast models have been developed in the past, leading to the discovery of several consistent findings. These findings have been incorporated into Retek's development of the Promote forecasting module.

Promotional forecasting uses promotional factors to predict future demand. The first step is to determine all of the pertinent information affecting sales and transform this information into variables that the system understands. Seasonality, for instance, can be represented by a single seasonal continuous variable, such as the number of daylight hours or average daily temperature.

Alternatively, it can be represented by 12 different indicator variables representing each of the months. An indicator variable consists only of 0's and 1's, a 1 indicating that the event is "on". For example, a monthly indicator variable for January would consist of a 1 during the first month of the year and 0's for the remaining months.



Once a list of variables is determined, the model needs to represent the promotion events in terms of their influence on overall demand. For example, if a set of promotional variables has a multiplicative promotional effect on demand, a log transformation may be needed to improve the model. After a suitable model is developed, it must be implemented using multivariate linear regression or neural network architecture, with custom code handling the data loading and variable transformations. The final custom model may be quite accurate over the data set on which it was developed. However, this model may not be general enough to be used universally across all data sets, thus requiring the development of multiple custom models to cover a client's entire domain. This has been found to be very time consuming and costly.

The process of developing custom promotional models has, however, brought to light a number of consistent patterns:

- Level, trend, and seasonality are universal components of almost any forecast.
- Including a time-series forecast as an input variable often improves promotional models.
- Indicator variables are robust in that they can represent both additive and multiplicative effects.

These findings have led Retek to develop a novel approach to promotional forecasting that combines the automation and generalization of time series forecasting with the improved (albeit data set specific) accuracy met through customized causal forecasting.

### **Retek's approach to promotional forecasting**

Retek's approach to promotional forecasting is somewhat unusual. Retek combines time series forecast methods with causal forecast methods, resulting in a new forecast method supported by the Promote module. Promote uses the AutoES method of forecast generation to determine a baseline time series forecast, and then uses indicator variables to represent promotional events of interest. By giving the forecasting routine visibility as to when certain events occurred in the past, the system can correlate changes in the sales demand with these events and determine each promotional event's effect on sales. Then whenever these events occur in the future, the promotional effects can be incorporated into the forecast.

The Promote module has been developed to produce generalized promotional models automatically, with little human intervention. Combined with the system's ability to allow you to develop your own data loading routines, Promote provides a cost-effective means for producing forecasts using promotional information.

More detailed information on promotional forecasting methods is in Chapter 8.

### **Promotional forecasting terminology and workflow**

Promote is designed to produce sales forecasts using both past sales history and event on/off information, both of which you provide. Using the sales data, the system first determines a seasonal time series model to describe the purchasing behavior of consumers. Differences between the seasonal model and the actual sales are then correlated with known events. Those events that are found to have a statistically significant impact on sales are then included in a promotional forecast model as promotion events. For each promotion event, its promotion effect on sales is determined. The final promotional model consists of the seasonal model, promotion event on/off information, and each promotion event's resulting effect on sales. By combining these three, a final promotional forecast is computed.

### Examples of promotion events

The following are examples of promotional variables that could be created and the manner in which their associated on/off event status is specified:

Example 1: Christmas Day applies to all products/locations. The Christmas promotional variable will therefore have only one dimension – Day. Because Christmas Day falls on the 359th day of each non-leap year, the Day359 variable will be set to TRUE for every such year (all other days will be set to FALSE).

Example 2: A television advertisement is run locally in the New York/New Jersey area for the four weeks at the beginning of the spring fashion season. The TVAD promotional variable will have two associated dimensions – State and Week. Week13, Week14, Week15, and Week16 will be set to TRUE only for states NY and NJ (all other states/weeks will be set to FALSE). Since no product dimension exists, the TV ad is assumed to have an effect on all products.

Example 3: A holiday promotion is run involving all sporting goods items for the two weeks prior to Father's Day. The Father's Day promotional variable has two associated dimensions – item and Week. For this year, Week23 and Week24 will be set to TRUE only for individual items related to sporting goods items (all other weeks and all other items will be set to FALSE). Since no location dimension exists, the Father's Day promotion is assumed to apply to all stores.

After promotional variables have been loaded into Retek Demand Forecasting, you can use the Promotion Planner workbook to view, edit, and update associated values without having to reload new data.

### Promote Workbooks and wizards

The Promote Workbooks and wizards allow you to manage the promotion events used in the system's promotional forecasting processes, and view/edit the system's analysis of the effects of these events on demand. The Promote Workbook templates include:

- Promotion Planner - Allows you to specify when certain promotional events were active in the past, and when they will be active in the future.
- Promotion Maintenance– Allows you to review the system-calculated promotional lift effects, edit these effects and determine how changes will be factored into the promotional model.
- Promotion Effectiveness – Our promotional what-ifing workbook. Allows the user to analyze the performance of previous promotions and simulate future promotions by editing when promotional events will be active for an item/location, and by modifying the promotion lift effects.

## Promotion Planner Workbook Template

In order to correlate deviations from the seasonal forecast with the occurrence of historic promotion events, the system needs visibility as to when these events were active. The system must also be informed of dates on which the status of upcoming promotion events will again be “on,” so the anticipated promotion effects can be built into the forecasting model.

The Promotion Planner Workbook allows you to indicate to the system when certain events were active in the past, and when they will be active in the future. All promotional events should be represented as accurately as possible so the modeling routine can more precisely detect correlations between event occurrences and changes in sales values.

The Promotion Planner Workbook consists of as many worksheets as are necessary to represent all unique dimensional intersections associated with the promotion events contained in the workbook. A separate worksheet is constructed for each of the required intersections. For example, promotion events such as Advertisement and Gift with Purchase may be loaded at the [Item/Store/Week] intersection, while an event such as Christmas is loaded at the [Day] level.

In this setup, the Advertisement and Gift with Purchase promotions would appear on one worksheet, and Christmas would appear on another. Whenever a hierarchy is missing from an intersection specification, as in the case of the Christmas promotional event, the event is assumed to apply to all positions in that hierarchy. Thus, Christmas is assumed to apply to all products and all locations, but only to the Day-level calendar position(s) specified in the Promotion Planner Worksheet.

### **Promotion Planner wizard**

The Promotion Planner wizard steps you through the process of creating a new Promotion Planner Workbook from a template. To access the Promotion Planner, select Open from the File menu to bypass the wizard and open an existing Promotion Planner Workbook, or perform the following steps:

1. Select New from the File menu.
2. On the Promote tab, select Promotion Planner and click OK.
3. The Promotion Planner wizard opens and prompts you to select the promotion events whose on/off status you wish to specify or edit. Click Next.
4. Select the locations that need to have promotions planned. Click Next.
5. Select the products that need to have promotions planned. Click Next.
6. Select the dates that need to have promotions planned. Click Next.
7. Click Finish to build the workbook.

## Promotion Planner Workbook and Worksheet

The Promotion Planner Workbook allows you to view and edit the on/off information associated with each configured promotional event. This workbook provides an interface in which you can specify the time periods (and possibly products and/or locations) for which certain promotional variables are active.

The screenshot shows a software window titled "[Item][Store][week] Worksheet". It contains a table with columns for dates, "Circular", and "In-Store Display". The "Circular" column has values of 1.00 or 0.00, and the "In-Store Display" column has values of 1.00 or 0.00. The dates range from 11/2/2001 to 2/15/2002. A "Calendar" button is visible at the bottom left.

Product	Location	Measure
10000360Private Label Cream of Mushroom	Barcelona	
	Circular	In-Store Display
11/2/2001	1.00	0.00
11/9/2001	0.00	0.00
11/16/2001	0.00	1.00
11/23/2001	0.00	1.00
11/30/2001	0.00	1.00
12/7/2001	0.00	1.00
12/14/2001	1.00	0.00
12/21/2001	1.00	0.00
12/28/2001	1.00	0.00
1/4/2002	1.00	0.00
1/11/2002	0.00	1.00
1/18/2002	0.00	1.00
1/25/2002	0.00	1.00
2/1/2002	1.00	0.00
2/8/2002	1.00	0.00
2/15/2002	1.00	0.00

A measure exists for each calendar/promotion event measure intersection. If the number “1” appears in the measure for a given cell, then the associated promotion event’s status is “on” (or 100% of the lift effect applies) for that calendar period. If “0” is entered in the measure, then the event’s status is “off.”

Place “1’s” as required to most accurately describe each product/location/calendar combination’s event status. Among the ways Causal variables can be implemented includes: price, % contribution of the lift effect, or discount %. Your Retek Consultant can best determine the most accurate set up of causal variables based upon your promotional data.

When you have made your changes, commit the workbook by selecting a Commit option from the File menu.

## Promotion Maintenance Workbook Template

The Promotion Maintenance workbook provides a view to the system-calculated and adjusted lift effects. You can edit effects at any product/location intersection and determine how these changes will be factored into the promotional models. The Promotion Maintenance Workbook contains one worksheet. There may be multiple versions of this worksheet, defined at various causal levels.

### Promotion Maintenance Wizard

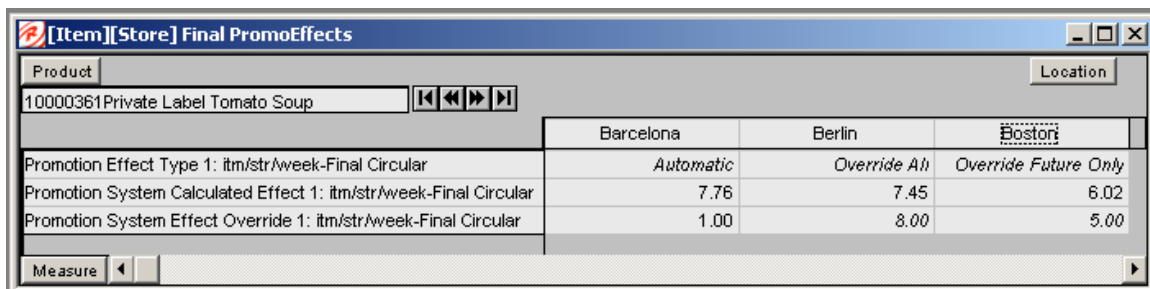
The Promotion Maintenance wizard steps you through the process of creating a new Promotion Maintenance Workbook from a template. To access the Promotion Maintenance Workbook Template, perform the following steps:

1. Select New from the File menu.
2. On the Promote tab, select Promotion Maintenance and click OK.
3. Select the promotion events to analyze. Click Next.
4. Select the causal level for analysis. Click Next.
5. Select the locations to analyze. Click Next.
6. Select the products to analyze. Click Next.
7. Click Finish.

### Promotion Maintenance Workbook and Worksheets

#### Final PromoEffects Worksheet

The Final PromoEffects Worksheet allows you to view and modify the system-calculated effects of a given promotion.



Product	Barcelona	Berlin	Boston
10000361 Private Label Tomato Soup			
Promotion Effect Type 1: itm/str/week-Final Circular	Automatic	Override All	Override Future Only
Promotion System Calculated Effect 1: itm/str/week-Final Circular	7.76	7.45	6.02
Promotion System Effect Override 1: itm/str/week-Final Circular	1.00	8.00	5.00

#### Promotion Effect

The system-calculated lift effect.

#### Promotion Effect Override

The user-specified lift effect. This user-entered effect is active if used in conjunction with the “Override All” and “Override Future Only” Promotion Effect Types.

### Promotion Effect Type (Causal Variable Type)

Causal variable types define how causal variables are treated in the causal model fitting process (which includes a call to the lower level regression engine) and the forecast generation process where the model is used to extend the forecast over the forecast horizon. Following are the drop-down list options:

#### Automatic

The inclusion of the causal variable is decided by regression. If the causal variable is found to be significant on the training set it is included in the model, otherwise it is rejected. Automatic is the system default Promotion Effect Type.

#### Forced In

The causal variable is forced in to the model, thus regression is not given a choice to reject even if the effect is considered insignificant by regression. As a result we will always return an effect, even if it has a negative impact to the demand forecast.

#### Disabled

The variable is excluded from the model, \hence no effect will be returned either.

#### Override All

This type allows the user to specify a causal effect that will be used during the fitting and forecasting process. This is a directive that is recognized only by the causal engine and not by the lower level regression engine. For causal variables specified as Override All, the user also specifies the corresponding causal effect in the Promotion Effect Override. The causal engine then de-causalizes the training data using the user-specified effect. The variable then is internally set Disabled to calculate the fit. During forecast generation the user-specified effect is used to determine the causal forecast. Therefore, the user must change the Promotion Effect Type when this user-specified effect is no longer to be used.

#### Override Future Only

This type allows the user to specify a causal effect that will be used only during forecasting process and not during the fitting process. This is also a directive that is recognized only by the causal engine and not by the lower level regression engine. For causal variables specified as Override Future, the user also specifies the corresponding causal effect in the Promotion Effect Override. The causal engine then internally sets the causal variable to Automatic to calculate the fit. The calculated effect is not however written back to the effects array (so as to not overwrite the user specified effect). During forecast generation the calculated effect is ignored and instead the user-specified effect is used to produce a causal forecast. Therefore, the user must change the Promotion Effect Type when this user-specified effect is no longer to be used.

### **Override From Higher Level**

Used in conjunction with the Causal Higher Intersection set in the Forecast Administration Workbook, this promotion type allows the system to use an average value of causal effects computed from product/location combination in the same group (the intersection level specified in the Causal Higher Intersection during system setup) for product/location combinations on whose sales history alone a causal effect is unable to be computed for that causal variable. The way the system handles this is by having the effects array filled in with higher-level effects for those variable specified as “Override Higher Level” and which did not have an effect returned in the previous run. The effect array is passed to the causal engine. If the engine succeeds in computing a significant effect it writes back the system computed effect and uses it for generating a forecast. Otherwise it uses the effect passed in (which as mentioned is the average effect among product stores belonging to the same group) for generating the forecast.

### **Automatic Boolean**

If the promotion variable will always be set to 0.00 or 1.00 (meaning inactive or active respectively), this type will produce the same results as the Automatic type described above, however Automatic Boolean will improve the performance (speed) of the forecasting engine during the batch run of the forecast.

## **Promotion Effectiveness Workbook Template**

The Promotion Effectiveness Workbook Template is a historical and future view to the effects of a planned promotion.

This workbook has two worksheets:

- View of promotion effects
- Visibility to Actuals, forecasts, baselines and promotion variable/event information

In this workbook a user views the promotional forecast. There is also the ability to analyze the effects on the forecast if a promotion does or does not occur. This analysis is performed by turning a promotional event or attribute on or off for dates in the future plans, and/or by modifying the Promotion Simulated Effect. This workbook is intended for simulation and analysis purposes only. There is no Commit functionality.

### **Promotion Effectiveness Wizard**

The Promotion Effectiveness wizard steps you through the process of creating a new Promotion Effectiveness Workbook from a template. To access the Promotion Effectiveness Workbook Template, perform the following steps:

1. Select New from the File menu.
2. On the Promote tab, select Promotion Effectiveness and click OK.
3. Select the promotion events to analyze. Click Next.
4. Select the forecast level for analysis. Click Next.
5. Select the dates to analyze. Click Next.
6. Select the locations to analyze. Click Next.
7. Select the products to analyze. Click Next.
8. If available, you may select any additional measures that to be included in the workbook.

9. Click Finish.

## Promotion Effectiveness Workbook and Worksheets

### Promotion Effectiveness Worksheets

The Promotion Effectiveness worksheets are built at the intersection of the available causal variables. For example, if all of the causal variables are defined at a item/store/week level, then only one worksheet would be built. However, if causal variables have been included in the workbook that are defined at different intersections (for example, item/store/week, item/store, item/class/week, etc.), then multiple worksheets will be created.

[Item][Store] Worksheet				
Product				Location
10000361Private Label Tomato Soup				
	Barcelona	Berlin	Boston	
Promotion Approved Effect 1: itm/str/week-Final Circular	8.50	1.00	1.00	
Promotion Simulated Effect 1: itm/str/week-Final Circular	8.50	1.00	1.00	
Promotion System Calculated Effect 1: itm/str/week-Final Circular	7.52	6.37	6.41	
Promotion System Effect Override 1: itm/str/week-Final Circular	8.50	1.00	1.00	
Measure				

[Item][Store][week] Worksheet									
Product	Location								
10000361Private Label Tomato Soup	Barcelona								
		12/28/2001	1/4/2002	1/11/2002	1/18/2002	1/25/2002	2/1/2002	2/8/2002	2/15/2002
Circular		1.00	1.00	0.00	0.00	0.00	1.00	1.00	1.00
Approved Forecast 1: itm/str/week-Final		2421.71	2139.87	1154.76	908.57	1298.50	2113.68	2227.09	2336.70
Approved Promotional Peak 1: itm/str/week-Final		2930.66	2472.06	922.97	702.75	1009.20	2330.02	2481.46	2631.01
Promotion Future Baseline 1: itm/str/week-Final		-508.95	-332.19	231.78	205.82	289.30	-216.34	-254.36	-294.31
Promotion Future Forecast 1: itm/str/week-Final		-4326.12	-2823.63	231.78	205.82	289.30	-1838.90	-2162.10	-2501.64
Promotion Historical Baseline 1: itm/str/week-Final		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Promotion Historical Forecast 1: itm/str/week-Final		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Weekly Sales		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Measure									

The Promotion Effectiveness Worksheets contain the following measures:

#### Approved Forecast

Read-only measure. This is the latest forecast quantity that was approved for the product/location combination.

#### Approved Promotional Peak

Read-only measure. The unit-lift over the Baseline Forecast, calculated during the forecast generation:

- Promotional events that are active in the Promotional Planner Workbook
- Promotion Effects calculated by the system or overridden by the user in the Promotion Maintenance Workbook

The process of approving any time series with a promotional peak approves both the forecast and the associated promotional peak. Approval can be automatic or manual. (See the Forecast Approval Workbook for more details.)



### Promotion Future Baseline

Read-only measure. Calculated as the Approved Forecast minus (–) Approved Promotional Peaks. User-changes to the editable measures in the Promotion Effects workbook do not affect this value.

### Promotion Future Forecast

Read-only measure. This is the Promotion Future Baseline with Promotion Effects applied. Calculated as the Promotion Future Baseline multiplied by the Changing the Promotion Effect Override or Promotion Variables will change this result.

### Promotion Historical Baseline

Read-only measure. Calculated if the promotion is not turned on. This is Actuals with the Retek Standard Median filter applied.

### Promotion Historical Forecast

Read-only measure. If a promotion is active, the Promotion Historical Forecast equal is the Historical Baseline multiplied by the Promotion System Effect Override.

### Promotion Approved Effect

A read-only measure. This is the approved promotion lift effect used in the generation of the current Approved Forecast in RDF. This value is originally viewed in the Promotion Maintenance workbook and can be modified there as well.

### Promotion Simulated Effect

A read/write measure that can be edited by the user to recalculate the promotional measures.

### Promotion System Calculated Effect

A read-only measure. This is the promotion lift effect calculated by the system during the forecast generation process. This value is originally viewed in the Promotion Maintenance workbook.

### Promotion System Effect Override:

A read-only measure. This is the user-adjusted promotion lift effect set in the Promotion Maintenance workbook. The Promotion System Effect Override will equal the Promotion System Calculated Effect if there were no adjustments made to the effect in the Promotion Maintenance Workbook.



**Note:** Changes to the Promotion Effects Workbook cannot be committed back to the master database, however this workbook is useful for:

- Reporting on the performance of past promotions
- Simulating the effects of future promotions to support more accurate promotional modeling

## Procedures in Promotional Forecasting

The following outlines the standard procedures performed in order to set up the system to run a promotional forecast (more detailed steps follow in the next section):

- Set up the system to run a promotional forecast
  - Set forecast parameters in the Forecast Administration Workbook
  - Set forecast parameters in the Forecast Maintenance Workbook
  - Set promotions to be active in the Promotion Planner Workbook
  - Run the batch forecast
- View and Edit Causal Forecast results
  - Analyze forecasts in the Forecast Approval Workbook
  - Analyze and edit causal effects in the Promotion Maintenance Workbook
- Promotion Simulation (what-ifying) and Analysis

### Set up the system to run a promotional forecast

Follow this procedure to set up your system to run a promotional forecast.

1. On the Predict tab, select and build a Forecast Administration Workbook
  - a. In the Forecast Administration Workbook: Advance Parameter Worksheet, select Generate Baseline.
  - b. Optional: Set the Default Forecast Method to “Causal” for the desired level if the level is to be use only for Promotional Forecasting.
  - c. Optional: Set the Causal Higher Intersection for the desired level if the Override from Higher Level promotion type will be used.
  - d. Optional for use with Daily Causal Forecasting: Set the values for the following parameters:
    - Causal Aggregation Profile
    - Causal Calculation Intersection
    - Causal Calculation Intersection Periodicity
  - e. Commit your changes to the master database by selecting Commit Now from the File menu.
2. On the Predict tab, select and build a Forecast Maintenance Workbook
  - a. Set the Forecast Method Override to “Causal” for any items/locations at the desired levels that will utilize Promotional Forecasting.
  - b. Commit your changes to the master database by selecting Commit Now from the File menu.
3. On the Predict tab, select and build a Promotion Planner Workbook
  - a. Set causal variables for items and locations historically in that the selected promotions are active.

- b. Commit your changes to the master database by selecting Commit Now from the File menu.
4. On the Predict tab, select Run Batch
  - a. Generate a Forecast

### **View and Edit Causal Forecast Results**

Follow this procedure to view a forecast that includes promotion effects:

1. On the Predict tab, select and build a Forecast Approval Workbook and include System Baseline in your workbook.
  - a. In the Final Level Worksheet review the System Baseline and the System Forecast. The System Baseline is predicted demand given no causal effects. The System Forecast is the sum of the System Baseline and the Promotional Peak calculated during the forecast generation process based on the causal data and settings.

Follow this procedure to view and edit Promotion System-Calculated Effects:

1. On the Promote tab, select and build a Promotion Maintenance Workbook
  - a. In the PromoEffects Worksheet review the Promotion System-Calculated Effect.
  - b. If the Promotion System Calculated Effect is to be modeled using a method other than Automatic, edit the Promotion Effect Type.
  - c. If the user chooses to adjust the system-calculated effect, adjustments can be made to the Promotion System Effect Override. The user must also set the Promotion Effect Type to Override All or Override Future Only.
2. On the Predict tab, select Run Batch
  - a. Generate a Forecast.

### **Promotion Simulation (“What-If?”) and Analysis**

Follow this procedure to perform analysis on past promotions and simulate the effects of historic or future promotions:

1. On the Promote tab, select and build a Promotion Effectiveness Workbook
2. In the PromoEffects Worksheet review the Promotion System-Calculated Effect and edit the Promotion Simulated Effect, then select Calculate to recalculate the following:
  - Promotion Future Baseline
  - Promotion Future Forecast
  - Promotion Historical Baseline
  - Promotion Historical Forecast
3. On the Promotional Forecasting Worksheet, review and modify the causal variable information, then select Calculate to recalculate the following:
  - Promotion Future Baseline
  - Promotion Future Forecast
  - Promotion Historical Baseline

- Promotion Historical Forecast



**Note:** Changes to the Promotion Effects Workbook cannot be committed back to the master database, however this workbook is useful for:

- Reporting on the performance of past promotions
- Simulating the effects of future promotions to support more accurate promotional modeling

# Chapter 7 – Profile Generation using Curve

## Overview

Curve is an optional automated predictive solution that can generate ratio arrays from historical data at user-specified intersections. The profiles generated by Curve can be used for various purposes; for example, to convert the organization-level assortment plans into base-level weekly sales forecasts, and to generate seasonal forecasts, daily forecasts, or new product forecasts using lifecycle profiles.

Curve meets the need of operational systems (such as Retek Demand Forecasting (Demand Forecasting) and the Retek Merchandising System (RMS)) to have sales predictions at a more detailed level than those provided by corresponding planning programs. The planning process attempts to establish the correct balance between different products in order to maximize sales opportunities in the available sales space. The planning process is supported by the generation of an assortment plan, which provides details of your anticipated sales volumes and stock requirements at aggregated levels. However, operational systems like Retek Demand Forecasting and RMS require data to be at the lowest level of execution (that is, item/store/week or item/store/day), because these systems are responsible for ensuring that the right quantity of each product is in the right store at the right time.

To use Curve with Retek's Enterprise software (interface with the Merchandising system), custom work may be required. For information about performing this custom work, contact your Retek representative.

## Workbooks and Wizards

The workbooks and tools are covered in this chapter include:

- Profile Administration
- Profile Approval
- Profile Maintenance
- Run Batch Profile

## Profile Management Terminology and Workflow

This section outlines the basic functionality of the Curve module and defines terminology used in the context of generating profile-based forecasts. The profile management process is discussed, as are the workbook templates used to perform profile management functions.

### Profiles (spreading ratios)

Profiles are generated using historical data and phase definitions based on the system configuration. Typical profiles include but are not limited to store participation, size distribution, and time profiles. The aggregated (source) and destination (final) levels of the forecast spreading (transformation) uniquely describe each profile. Since a profile is used to spread the source level plan down to the final forecast level, a naive way of calculating a profile is to obtain the ratio of sales at the destination level to the sales at the source level. However, in most situations the sales at the final forecast level are sparse, noisy, or do not exist (new product or new store). Instead of generating the profiles at the destination level, the sales can be aggregated, and profiles can be obtained at higher levels. The aggregated level at which profile is generated is referred to as the profile source level. Profiles can be calculated at multiple source levels.

A separate profile is calculated for each hierarchy. Several profiles are used to spread the forecast into the final level. The user can generate daily profiles to be used for daily forecasting; seasonal profiles to be used in generating a seasonal forecast, or new product forecasting can be done using lifecycle profiles. In order to improve the usability of the system, Curve has the capability of processing several profiles at the same time.

### Steps in profile generation

For each profile / processing plan, you need to perform the following steps:

1. Set the parameters for profile building, using the Profile Administration and Profile Maintenance Workbooks.
2. Generate and auto-approve the profile(s), using the Run Batch Profile Workbook.
3. Adjust and approve the profile(s), using the Profile Approval Workbook.
4. Set the parameters for forecasting, using the Forecast Administration and Forecast Maintenance Workbooks, and/or spreading policies.
5. Run forecast generation.

The first three steps correspond to the profile generation, while the last two steps are specific to profile-related forecasting. The forecasting process should be set to using the profiles in specific ways, such as profile spread, seasonal indices, daily forecasting.

Also it is important to note that in most cases profiling and forecasting parameters are already set, and you can skip step 1 and step 4. A probable business scenario is that several traders will generate and approve profiles for the products that they are interested in. When this task is accomplished, a batch job will be started to run profile/forecast generation. This chapter addresses only the first three steps related to profile generation.

## Profile generation techniques

This section describes the algorithms behind the profile generation process. Each profile typically acts on one dimension. A concept that is closely associated with each profile is the unit-of-measure, which defines the symbolic ratio of the destination level to the source level. We provide an example with three profiles. The first one is a time profile. The unit-of-measure for the time profile is week/phase. The two other profiles that are considered in the example are size distribution and store participation. Size distribution determines how much each size is sold in a given option. For a fashion item, option-size typically defines a item. Therefore, size distribution is the profile to explode an option level plan into a item level plan. Store participation, on the other hand, is the contribution of a store to the chain sales. The units of measure for these two profiles are item/option and store/chain, respectively.

### Building system profiles based on the historic level

Two techniques are developed for profile generation. The first profile generation technique is built on the assumption that historical information, which is relevant to the planned products, exists and future sales will follow the past sales patterns. Under these assumptions, a profile can be calculated as the ratio of sales at the destination level to the sales at the aggregated level. In the case of a continuity line, this is likely to be true. For a new seasonal product this may not be the case, but in many instances similar style, subclass, or class history will provide an accurate baseline to build the profiles against. This baseline is referred to as the source level. Note that, while generating the profiles at the source level, the unit-of-measure should be considered. Most profiles will be built based on historic data. Since the system allows the user to override the profiles, the technique has the unique feature of combining the trader's expertise and computer intelligence without heavily depending on extensive human interaction.

### Overriding profiles by adjusting the source measure

Profile generation requires a metric containing historical data as input. In some cases the data is used as it is. At other times, however, it is necessary to make adjustments using overrides to correct seasonal and causal effects. A source measure is constructed from an input data metric and one or more override measures. Overrides might be used, for example, to compensate the effect of Easter changing in time each year. Another situation that might require overrides is non-recurrent causal events such as Euro 96. Multiple overrides are particularly useful for improving accuracy and provide better visualization of the effects of independent events. Source measures and adjustment techniques are determined during implementation. Note that an alternative to sales overrides is to edit the profiles directly.

## **Defining the training window for historical data**

Another feature of Curve is that only the part of the historical data that is relevant to the profile generation process is utilized for the calculations. This task is accomplished by specifying the start and end dates of the historic data that will be used for profile generation, that is, by specifying a training window. The user has the flexibility of defining default training windows for each profile. In general, a one-year long training window is appropriate for store participation. On the other hand, training window for size-distribution should be set such that the effects of the stock-out periods are minimized. The user can also use system-generated training windows that are based on the start and end dates of the current phase. It is recommended to use the system-generated windows for the time profile. As an example, for calculating the time profile for a Spring-Summer phase plan, the training window should be set such that only the data from the last year's Spring-Summer phase is used during the profile generation process. Since the start and end dates, that is, the phase definition, of the current phase is already loaded into the system, a simple yet effective rule to generate the training window is to subtract one year from the current phase definitions dates. The user also has the ability to modify the training window definitions using the Profile Maintenance Workbook. If the user does not specify the training window method, the system sets it by default to "use default training window".

## **Aggregating historical data**

Because a profile is often used in forecasting to spread the source level plan into the destination level, a naive way of calculating a profile is to obtain the ratio of sales at the destination (final) level to the historic sales at the aggregated level. Considering the store participation example, this is equivalent to dividing the item-store sales by item-chain sales. In most situations, however, the sales at the final level are sparse, noisy, or do not exist (new product or new store). Instead of generating the profiles at the destination level, the sales can be aggregated, and profiles can be obtained at higher levels as long as the unit-of-measure is appropriate.

The store profile, for example, can be calculated as the ratio of subclass-store level sales to the subclass-chain level sales. The unit-of-measure of this ratio is still store/chain, as desired. The aggregated level at which profile is generated is referred to as the source level. Multiple source levels can be calculated and used during the explosion stage. The source level for the above example is subclass-store. Note that the time dimension does not exist. This implicitly means that sales are aggregated across the training window, and the store participation is assumed to be constant throughout the phase.

To demonstrate the process, consider the following scenario. A trader is trying to determine the store participation for shirts. The shirts are planned to be sold in four colors (black, navy, white, and blue) in the upcoming phase, which is four weeks long. The color "black" is newly introduced and the color "navy" was only sold in Lenox store previously. The sales history for the equivalent four-week training window last year for the four options and corresponding style is given below.



**Lenox Store Sales**

	Week 1	Week 2	Week 3	Week 4	Phase
Black Shirt	0	0	0	0	0
Navy Shirt	1	0	1	0	2
White Shirt	2	1	1	2	6
Blue Shirt	0	0	1	0	1
Shirts	3	1	3	2	9

**Cumberland Store Sales**

	Week 1	Week 2	Week 3	Week 4	Phase
Black Shirt	0	0	0	0	0
Navy Shirt	0	0	0	0	0
White Shirt	1	1	1	0	3
Blue Shirt	1	0	0	2	3
Shirts	2	1	1	2	6

The ratios obtained at the option-store and style-store levels are provided below.

**Store Ratios**

	Lenox	Cumberland
Black Shirt	NA	NA
Navy Shirt	100%	0%
White Shirt	67%	33%
Blue Shirt	25%	75%
Shirts	60%	40%

If the trader calculates the store participation ratios at the option-store level, then she cannot obtain any ratios for black shirts since no history exists for this color. Moreover, the ratios for navy shirts will be biased since this color hasn't been sold in Cumberland store before. An alternative is to calculate the ratios at aggregated levels such as style-store. The trader can also use multiple source levels (for example, style-store for black, navy and blue shirts, and option-store for white shirts). The motivation is to obtain more accurate ratios for stable products such as "white shirts" while using ratios obtained at higher levels for new or low-volume products. The trader can choose an appropriate source level for each product during the approval process.

## Unreliable data, thresholds, and threshold exceptions

In certain situations, data may still be sparse even after aggregation. Sparse data generally causes unreliable ratios. Consider the following hypothetical situation:

### Total Sales

	Store 1	Store 2	Store 3	Chain
<b>Subclass A</b>	1	1	1	3
<b>Subclass B</b>	100	100	100	300
<b>Subclass C</b>	100	200	100	400

### Ratios

	Store 1	Store 2	Store 3
<b>Subclass A</b>	0.33	0.33	0.33
<b>Subclass B</b>	0.33	0.33	0.33
<b>Subclass C</b>	0.25	0.50	0.25

The ratios for the subclass B and C are reliable and minor fluctuations in sales history will not significantly effect the ratios. On the other hand, the store participation ratios for the products belonging to subclass A can drastically change if the sales for the second store were two units instead of one. In fact, it is not clear if the subclass A behaves as subclass B or subclass C. Curve automatically generates a threshold exception for unreliable ratios when the sales are sparse at the source level. The generation rule is simple, if the dividend of the ratio is smaller than a threshold, then all ratios using this dividend is marked as exception. The user provides the threshold through the administration workbook. Since the user can view these exceptions during the approval stage, the exception mechanism can be viewed as a decision support system.

### Loading default ratios

As previously stated, Retek provides an alternative approach to profile generation: loading default ratios. This option should be utilized if significant mismatches between historic and current sales patterns are anticipated. The profiles can be loaded at any level. The loading level is analogous to the source level from the system perspective.

### Approving the generated profiles

The profile generation includes an auto-approval process, in which the system profiles are spread down and combined at the final level, and copied to the approved final profiles through an approval mask that is set up in the profile administration and maintenance workbooks

Up to this point we have discussed the algorithms involved with profile generation. The next step is running the Profile Approval Workbook. Profile approval involves viewing and editing the final level profiles, and choosing an appropriate source level for each product. The process will be described later in this documentation.

Once the profiles are approved, the system will run a series of algorithms so that these profiles can be utilized in the forecasting stage. In particular, the profiles at the source level are copied down to the final level. To demonstrate the process, consider the following example. Assume that the following size distribution for skirts is given at the “style-size”-chain level

#### Size profile for Skirts

Skirts-2	Skirts-4	Skirts-6	Skirts-8	Skirts-S	Skirts-M	Skirts-L	Skirts-XL	Skirts-32	Skirts-34
0.05	0.1	0.1	0.05	0.1	0.2	0.2	0.1	0.05	0.05

Let’s assume that three colors are available for skirts: blue, black, and red. These three options use the same size distribution profile during the forecasting stage. However, it is possible that not all sizes are available for each option. As an example, assume that blue is sold in sizes [2,4,6,8], black is sold in sizes [S, M, L, XL] and red is sold in sizes [32, 34]. The size distribution at the style-size level cannot be directly used at the option level. Instead, the ratios of the available sizes should be modified for correct forecast results. There are two rules for modification. First, the profile ratios should still add up to one at the option level. Second, the relative ratios of two different sizes should be preserved. The normalized ratios are as follows.

#### Size profile for blue skirts

Blue Skirt-2	Blue Skirt-4	Blue Skirt-6	Blue Skirt-8
1/6	1/3	1/3	1/6

#### Size profile for black skirts

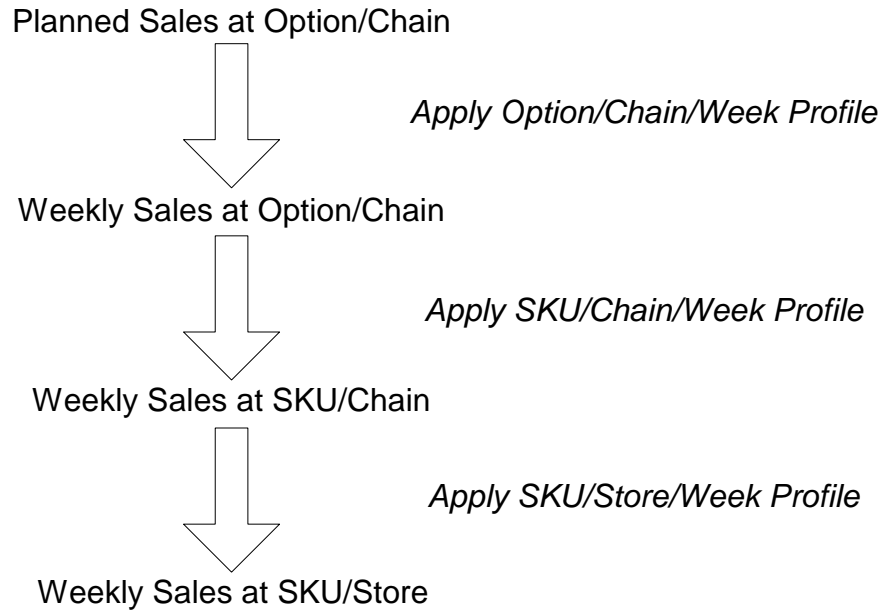
Black Skirt-S	Black Skirt-M	Black Skirt-L	Black Skirt-XL
1/6	1/3	1/3	1/6

#### Size profile for red skirts

Red Skirt-32	Red Skirt-34
1/2	1/2

Similar normalization is required, if certain stores are known to not participate in certain options.

After approving the profiles, you can start the forecasting stage. Curve is algorithmically similar to spreading source level forecast into the final level. Forecast spreading via Curve is typically accomplished in a series of steps as illustrated in the figure. The planned sales level is typically the default generation level. It is at this level that sales plans are loaded. The item/Store/Week level in this example is the final forecast level. The two intervening levels do no more than describing the transformation path from the assortment plan level (option/chain) to the item/store/week level.



### **Transforming an assortment plan to an operational sales plan**

Profiles are mostly used for spreading, including daily profiles (spreading from week to day) and lifecycle (spreading a plan to the week level). Besides spreading, Curve generated Seasonal profiles are used by the forecasting engine for generating profile-based forecasts. The Curve module should be configured for generating Seasonal profiles at the forecast level intersection or higher. The forecasting part is handled by Predict and its setup and use are described in the Predict documents.

## Profile Administration Workbook

The Profile Administration Workbook allows you to set default parameters for profile generation, the first step in profile generation. These parameters are typically set during system implementation, and are configured based on your business practices and needs. This configuration can be updated if you need to change certain parameters over time. However, it is not practical to change the configuration on a regular basis. The Profile Administration Workbook gives you the flexibility to change profiling parameters as the need arises to improve both forecasting accuracy and computational efficiency.

### Profile Administration Wizard

The Profile Administration wizard steps you through the process of creating a Profile Administration Workbook from the template. This workbook allows you to set default parameters for profile generation.

The Profile Administration wizard requires you to select the final profile that you wish to edit. These profiles are determined during the system implementation/configuration. When you have selected a final profile, click the Finish button to open the Profile Administration Workbook. When the Profile Administration Workbook is created, a single worksheet (Default Profile Worksheet) will exist for the final profile and its associated source profiles.

For profiles that are dynamically generated to support Source Level Forecasting in RDF, default values for the parameters in the Default Profile Worksheet are automatically populated during the implementation. Maintenance may be required to these profiles for the following parameters:

- Default Phase Start
- Default Phase End
- Default Training Window End
- Default Training Window Start
- System Training Window Length

## Default Profile Worksheet

The Default Profile Worksheet allows you to specify default values for parameters affecting profile generation.

	11 - week->day - Final	12 - week->day
Data Source		dpos
Default Approval Method	Approve Use System	Approve Use System
Default Phase End	12/16/2004	12/16/2004
Default Phase Start	12/27/1997	12/27/1997
Default Training Window End	12/16/2004	12/16/2004
Default Training Window Start	12/27/1997	12/27/1997
Final Level Profiles	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Normal Value	1.00	1.00
Profile Agg Intersection	itemstr_	itemstr_
Profile Approval Intersection	itemstr_	itemstr_
Profile Intersection	dow_itemstr_	dow_itemstr_
Profile Maintenance Intersection	dow_itemstr_	dow_itemstr_
Profile Type	PGTY03	PGTY03
Renormalize	<input type="checkbox"/>	<input type="checkbox"/>
Source Level Profiles	11	11
System Training Window Length	10	10
Threshold	0.00	0.00
Training Window Method	Default And Override	Default And Override

The following is a description of the measures contained on the Default Profile Worksheet:

### Data Source

A read-only measure that specifies the data to be used for profile generation. This measure is set during configuration and is only set for source profiles.

### Default Approval Method

The default approval strategy for each profile. Choices are “Approve Use System” and “Don’t Approve”.

### Default Phase End

Displays the default phase end day. Change the value in this field by clicking the pop-up calendar. If phase definitions are not available, the default phase end date will be used. Also, when calculating time profiles, default dates are used for intermediate computations. For computational efficiency, use the most common phase definition as the default value.

### Default Phase Start

The default phase begin day. Change the value in this field by clicking the pop-up calendar. If phase definitions are not available, the default phase start date will be used. Also, when calculating time profiles, default dates are used for intermediate computations. For computational efficiency, use the most common phase definition as the default value.

### Default Training Window End

Displays the default training window end date. Change the value in this field by clicking the pop-up calendar. The default date will be used only if the training window method is Default and Overrides.

### Default Training Window Start

The default training window start date. Change the value in this field by clicking the pop-up calendar. The default date will be used only if the training window method is Default and Overrides.

### Final Level Profiles

A read-only, Boolean measure indicating a final profile.

### Normal Value

If the profile is aggregated to the Aggregation Intersection this will be the value in all the cells (or zero outside of the phase window.) This is usually 1.00 (100%) but occasionally you would want to override this value.

### Profile Agg Intersection

A read-only measure set in the Configuration Tools. The intersection at which the profile will sum to 1.00 (100%), this value may be override in Normal Value.

### Profile Approval Intersection

A read-only measure set in the Configuration Tools. The intersection at which the profile is approved. Approval Intersection should be above or equal to the Aggregation Intersection.

### Profile Intersection

A read-only measure set in the Configuration Tools. The initial intersection to which the profile will spread down.

### Profile Maintenance Intersection

A read-only measure set in the Configuration Tools. This is the intersection at which the profile can be edited in the Profile Approval Worksheet. In most situations the maintenance intersection is equal to the stored intersection. There are some scenarios (such as Product Type profiles) where this is not true.

### Profile Type

A read-only measure set in the Configuration Tools. The type is used to determine the profile algorithm and validation required by the profile level. See the Curve 10.5 User's Guide for more information on each type.

### Renormalize

Renormalize is a Boolean measure. When set to TRUE, it will automatically renormalize the calculated profile result at the corresponding final level. Normally the renormalization is not necessary. For example, if you have a source profile at week of season and its final profile is at day of season, you would need to renormalize the final level because going from week to day will do replication. Now at day level the profile will sum up to greater than 1 for a season (since it was a week to day it will probably sum up to seven). The renormalize will force the final profile to sum to 1.

### Source Level Profiles

A read-only measure set in the Configuration Tools. Specifies the Final Profile that has been assigned to a Source Profile. All Final Profiles have their own profile number in this measure.

### System Training Window Length

A write-able measure that specifies the number of weeks of the most recent data to use when the Training Window Method is set to “Use Training Window”. The System Training Window Length defaults to 10 weeks.

### Threshold

The default historic threshold, or level at which historic sales are considered too sparse to generate reliable profiles. If the aggregated data, used as a dividend in ratio calculations, is not greater than this threshold, an exception will be generated. Exceptions are displayed in the Profile Approval Workbook.

### Training Window Method

Displays the default method used to obtain training window. The options are:

- **Default & Overrides:** Uses the default dates as set in the Training Window Begin and Training Window End measures.
- **Phase Definitions & Overrides:** Calculates the training window dates based on the phase definitions.
- **Last 10 & Overrides:** Uses the last ten periods of data to define the training window.

All methods can be overridden if you enter specific training window values for a subset of products in the Profile Maintenance Workbook.



## Profile Maintenance Workbook

After setting default parameters for profile generation in the Profile Administration Workbook, the next step in profile generation is to select any subset of items for which the training window values should differ from the defaults. This step is necessary in those situations where it is not efficient to use the same parameters for all products. The act of selecting item subsets is known as ranging. Ranging is performed through the standard two-tree item selection screen in the Profile Maintenance Wizard.

### Profile Maintenance Wizard

As in Profile Administration, the first Profile Maintenance wizard screen prompts you to select a final profile level.

To create a Profile Maintenance Workbook, perform the following steps:

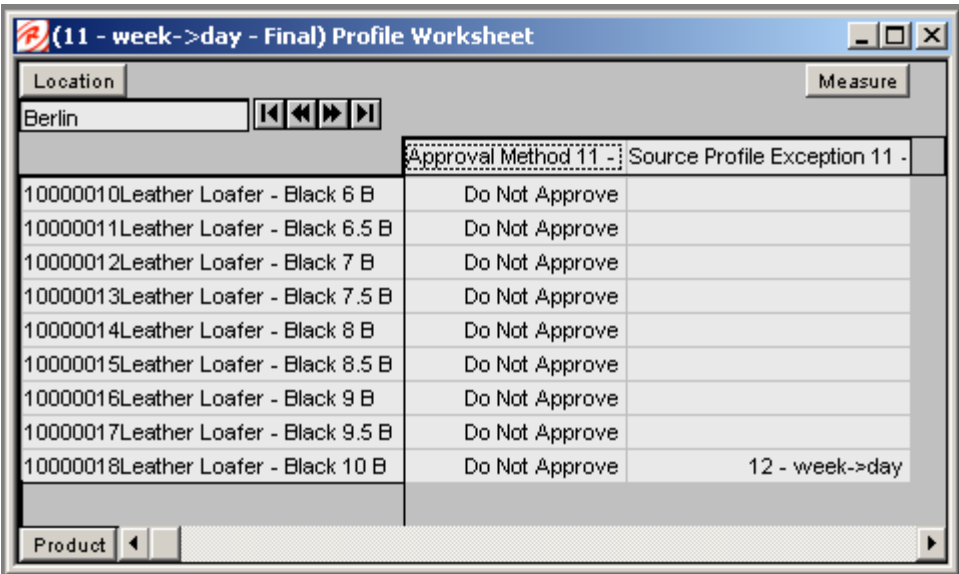
1. Select New from the File menu.
2. Select the Curve tab to display a list of workbook templates for Profiling. Highlight Profile Maintenance and click OK.
3. The Forecast Maintenance Wizard opens and prompts you to select the level of the final profile. Make the appropriate selection and click Next.
4. Select the locations to include in the workbook. Click Next.
5. Select the products to include in the workbook. Click Next.
6. Select the time periods to include in the workbook. Click Next.
7. An additional wizard screen will prompt you to select any additional measures (that is, measures not standard in the Profile Maintenance Workbook) that you would like included. The measure options available in this screen are set in the RPAS Security Administration Workbook / Workbook Template Measure Rights Worksheet. Make the appropriate selections (if any) and click the Finish button to display the workbook.

When the Profile Maintenance Workbook is created, a separate worksheet will exist for each profile generation level associated with the selected processing plan.

Profile Maintenance Workbook

The Profile Maintenance Workbook allows you modify the default values for some parameters set in the Profile Administration Workbook. The Profile Maintenance Workbook allows you to edit the Training Windows, Approval Methods, and Source Levels for intersections that vary from the default settings for the profile.

The Final Profile Worksheet



The following is a description of the measures contained in the Final Profile Worksheet:

Approval Method

The approval method for this intersection of the profile. Choices are Approve and Don't Approve. If this intersection is using the default value set in the Profile Administration Workbook, there will be no value in this measure.

Source Profile Exception

The source level for this intersection of the profile. You can choose a source level using a pick list. A list of possible source levels is determined at the implementation for each final profile level. If this intersection is using the default value set in the Profile Administration Workbook, there will be no value in this measure.

## The Source Profile Worksheet

		System Training Window Begin 12	System Training Window End 12
10000010	Leather Loafer - Black 6 B	2/1/2001	
10000011	Leather Loafer - Black 6.5 B	2/1/2001	
10000012	Leather Loafer - Black 7 B	2/1/2001	
10000013	Leather Loafer - Black 7.5 B	2/1/2001	
10000014	Leather Loafer - Black 8 B	2/1/2001	
10000015	Leather Loafer - Black 8.5 B	2/1/2001	
10000016	Leather Loafer - Black 9 B	2/1/2001	
10000017	Leather Loafer - Black 9.5 B	2/1/2001	
10000018	Leather Loafer - Black 10 B	2/1/2001	

### System Training Window Begin

Displays the override training window start date. Change the value in this field by clicking the pop-up calendar. This value overrides any default training window or phase begin dates set in Profile Administration.

### System Training Window End

Displays the override training window end date. Change the value in this field by clicking the pop-up calendar. This value overrides any default training window or phase end dates set in Profile Administration.

## Run Batch Profile

The Run Batch Profile template consists of a wizard that steps you through the process of manually executing a profile calculation batch job.

A single-select wizard allows you to select the processing plan for which the profiles will be calculated. Your batch job will create a database to hold the profiles, and then will calculate the profiles and exceptions for the levels specified in the processing plan. Both the profiles and exceptions will be created at the proper source levels. Curve allows you to calculate values at multiple source levels for each item profiled. An auto-approval process is run after the source level profiles have been generated. The process consists of spreading the source level profiles to the final level, and then combining them according to the source level selections made in the Profile Administration and Profile Maintenance Workbooks. The final level profiles are approved with the approval methods selected in the Profile Administration and Profile Maintenance Workbooks.



**Note:** Before you start a Run Batch Profile process, make sure that no other users are logged onto the Retek Demand Forecasting system. Other users cannot access the system until after the batch run has finished.

## Profile Approval Workbook

The profiles generated at the historic levels must be viewed, analyzed, revised, and approved using the Profile Approval Workbook. In the approval process, you select the appropriate source level for each product/location combination. After you make any necessary changes to the profiles and commit the workbook, the profiles are normalized to preserve the appropriate ratios. At this time, Curve automatically spreads the source level profiles to the final level and combines them. After you commit your changes, you can refresh the data in your workbook to display the newly generated final level profiles.

Use the Profile Approval Workbook to view, analyze, revise, and approve the profiles generated at the historic levels. This workbook contains three types of worksheets:

- Final Profile Worksheet
- Source Profile Worksheet
- Profile Approval Worksheet

### Profile Approval Wizard

The Profile Approval wizard steps you through the process of creating a new Profile Approval Workbook.

The Profile Approval wizard first prompts you to select the final profile to be approved. When the Profile Approval Workbook is created, a separate worksheet will exist for each profile generation level associated with the selected final profile. The next step is to select the subset of items to appear in the workbook. You will then be prompted to select from the location and calendar hierarchy.

An additional wizard screen will prompt you to select any additional measures (that is, measures not standard in the Profile Approval Workbook) that you would like included. The measure options available in this screen are set in the RPAS Security Administration Workbook / Workbook Template Measure Rights Worksheet. Make the appropriate selections (if any) and click the Finish button to display the workbook.

When you have made your selections, click the Finish button to build the workbook.

## Final Profile Worksheet

Through this worksheet, you can view the system calculated final profile and make adjustments to this profile. Following is an example Final Profile Worksheet for a store participation profile.

Final Source Approval				
(01 - chn->str-Final) Profile Worksheet				
Product	Location	Measure		
10000010Leather Loafer - Black 6 B	Barcelona			
	Adjusted Profile 01 - chn->str-Final	Approved Profile 01 - chn->str-Final	System Profile 01 - chn->str-Final	
11/23/2001	0.25	0.25	0.05	
11/30/2001	0.05	0.05	0.05	
12/7/2001	0.05	0.05	0.05	
12/14/2001	0.05	0.05	0.05	
12/21/2001	0.05	0.05	0.05	
12/28/2001	0.05	0.05	0.05	
1/4/2002	0.05	0.05	0.05	
1/11/2002	0.05	0.05	0.05	
1/18/2002	0.05	0.05	0.05	
1/25/2002	0.05	0.05	0.05	
2/1/2002	0.05	0.05	0.05	
2/8/2002	0.05	0.05	0.05	
2/15/2002	0.05	0.05	0.05	
Calendar				

The following measures are contained in the Final Profile Worksheet:

### Adjusted Profile

This is the user-adjusted profile. If the user wants to make adjustments to the final profile, it is required that the Final Profile worksheet be aggregated to the Aggregation Intersection and lock the cells before making adjustments at the final profile level. An easy way to determine the Aggregation Intersection is to match the intersection on the Approval worksheet. For example in our GA configuration, the profile intersection for Profile 01 is Item/Store/Week. The Aggregation Intersection (as shown on the Approval worksheet) is Item/Chain/Week. On the Final worksheet, aggregate the stores to chain and lock the cells. Locking the cells at the Aggregation Intersection allows for cells to normalize to 100% or 1.00 when adjustments are made at the Profile Intersection. See the following example:

**(01 - chn->str-Final) Profile Worksheet**

Product: 10000010Leather Loafer - Black 6 B Location: Bricks & Mortar Measure

	Adjusted Profile 01 - chn->str-Final	Approved Profile 01 - chn->str-Final	System Profile 01 - chn->str-Final
1/4/2002	1.00	1.00	1.00
1/11/2002	1.00	1.00	1.00
1/18/2002	1.00	1.00	1.00
1/25/2002	1.00	1.00	1.00
2/1/2002	1.00	1.00	1.00
2/8/2002	1.00	1.00	1.00
2/15/2002	1.00	1.00	1.00

Calendar

Context Menu:

- Cut
- Copy
- Copy to Clipboard
- Paste from Clipboard
- Grid...
- Lock Cell

After the cells have been locked, add the store dimension back into your roll-up and edits can be made at this level.

### Approved Profile

Displays the approved profiles. Approved final profiles only appear for product/location combinations whose approval method was set to Approve Use System on the Profile Approval Worksheet. If changes are made to the Adjusted Profile, the values in this measure will update once the intersection that was adjusted is Manually Approved on the Profile Approval worksheet.

### System Profile

A read-only measure that displays the system-generated profiles calculated at the final profile's profile intersection for each product/location combination displayed.

### Source Profile Worksheet

The Source Profile Worksheet displays the profiles generated at the source level for all product/location combinations selected to appear in the workbook. This worksheet displays the source system profiles, that is, the profiles that are calculated by the system, and the threshold exceptions detected during the profile generation process, indicating values that may be unreliable due to sparse historic data conditions.

A separate Source Level Worksheet exists for each historic level at which profiles can be generated. You can view and compare the profiles generated at the different levels in order to select the one that should be used to determine data for the final profile.

Final Source Approval

(02 - chn->str) Source Profile Worksheet

Product Location Measure

10000010Leather Loafer - Black 6 B Barcelona

	System Profile 02 - chn->str	Threshold Exception 02 - chn->str
11/23/2001	0.05	<input type="checkbox"/>
11/30/2001	0.05	<input type="checkbox"/>
12/7/2001	0.05	<input type="checkbox"/>
12/14/2001	0.05	<input type="checkbox"/>
12/21/2001	0.05	<input type="checkbox"/>
12/28/2001	0.05	<input type="checkbox"/>
1/4/2002	0.05	<input type="checkbox"/>
1/11/2002	0.05	<input type="checkbox"/>
1/18/2002	0.05	<input type="checkbox"/>
1/25/2002	0.05	<input type="checkbox"/>
2/1/2002	0.05	<input type="checkbox"/>
2/8/2002	0.05	<input type="checkbox"/>
2/15/2002	0.05	<input type="checkbox"/>

Calendar

The following measures are contained in the Source Level worksheet:

#### System Profile

A read-only measure that displays the system-generated profiles calculated at the source profile's profile intersection for each product/location combination displayed.

#### Threshold Exception

A checkbox measure that warns you when the system has detected a profile value that may be considered unreliable due to sparse historic data. A threshold for profile calculations is set in the Profile Administration Workbook. When source measure values at the historic level fall below this threshold, a threshold exception is generated.

## Profile Approval Worksheet

The Profile Approval Worksheet allows you to review and approve final profiles. The following is an example Profile Approval Worksheet for the store profile.

Final Source Approval				
(01 - chn->str-Final) Profile Approval Worksheet				
Product	Location	Measure		
10000010Leather Loafer - Black 6 B	Bricks & Mortar			
	Approved By 01 - chn->str-Final	Approved Date 01 - chn->str-Final	Manually Approve 01 - chn->str-Final	Source Profile Exception 01 - chn->str-Final
11/23/2001	adm	2/23/2004	<input checked="" type="checkbox"/>	
11/30/2001	System	2/18/2004	<input type="checkbox"/>	
12/7/2001	System	2/18/2004	<input type="checkbox"/>	
12/14/2001	System	2/18/2004	<input type="checkbox"/>	
12/21/2001	System	2/18/2004	<input type="checkbox"/>	
12/28/2001	System	2/18/2004	<input type="checkbox"/>	
1/4/2002	System	2/18/2004	<input type="checkbox"/>	
1/11/2002	System	2/18/2004	<input type="checkbox"/>	
1/18/2002	System	2/18/2004	<input type="checkbox"/>	
1/25/2002	System	2/18/2004	<input type="checkbox"/>	
2/1/2002	System	2/18/2004	<input type="checkbox"/>	
2/8/2002	System	2/18/2004	<input type="checkbox"/>	
2/15/2002	System	2/18/2004	<input type="checkbox"/>	
Calendar				

The Profile Approval Worksheet contains the following measures.

### Approved By

This measure displays who approved the profile for a given product/location combination. For all profile intersections with an Approval Method set to Approve Use System, the Approved By measure will contain "System".

### Approval Date

Displays the date on which a profile was approved whether it is automatically approved by the system or manually approved by the user.

### Manually Approve

A Boolean measure that must be activated (checked) for all profile intersections that are set to "Do not approve" or for intersections in which the user makes changes to the "Adjusted Profile" on the Final Profile worksheet.

### Source Profile Exception

This is the source profile that should be used if it varies from the global default set for this intersection of the profile. This measure will display any Source Profile Exceptions set in the Profile Maintenance Workbook. The user may also change the source level by choosing from the pick list. A list of possible source levels is determined at the implementation for each final profile level. If this intersection is using the default source profile set in the Profile Administration Workbook, there will be no value in this measure.



## Procedures in Profile Generation

The following is a list of standard procedures performed when conducting source level forecasting using profiles dynamically generated in Curve:

- Set default parameters for a profile
- Override parameter settings for products, locations or time periods that vary from the defaults
- Manually request a generated profile
- Approve a profile
- Set Retek Demand Forecasting to use a profile created by Curve

### Set default parameters for a profile

Use this procedure to set the default parameters for profile generation. Typically, values for these parameters are set during system installation and need not be modified on a regular basis.

1. To open an existing Profile Administration Workbook, select Open from the File menu, select a workbook, click OK, and go to step 5. Or to open a new workbook, select New from the File menu.
2. Click the Curve tab.
3. Select Profile Administration and click OK.
4. Select the final profile to be used to create the workbook. Click Finish.
5. A worksheet is created for the final profile selected and its associated source profiles. Review each measure and set its contents or value as needed. For descriptions of all measures, see “Profile Administration Workbook”.
6. Commit any changes that you make to the master database by selecting Commit Now from the File menu. If desired, you may also save your workbook by selecting Save from the File menu.
7. To close the workbook, select Close from the File menu.

### Override parameter settings for products, locations or time periods that vary from the defaults

Use this procedure to change the Training Windows, Approval Methods, and Source Levels for intersections that vary from the default settings for the profile.

1. To open an existing Profile Maintenance Workbook, select Open from the File menu, select a workbook, click OK, and go to step 7. Or to open a new workbook, select New from the File menu.
2. Click the Curve tab.
3. Select Profile Maintenance and click OK.
4. Click on a radio button to select the final profile that will be used to build the workbook. Click Next.
5. Select the locations to include in the workbook. Click Next.
6. Select the products to include in the workbook. Click Next.

7. Select the time periods to include in the workbook. Click Next.
  - An additional wizard screen will prompt you to select any additional measures (that is, measures not standard in the Profile Maintenance Workbook) that you would like included.
8. Make any necessary changes at the appropriate intersections to the following measures:
  - Training Window Start
  - Training Window End
  - Approval Method
  - Source Profile Exception
  - See the previous section on the Profile Maintenance Workbook for more information on these measures.
9. Commit any changes that you make to the master database by selecting Commit Now from the File menu. If desired, you may also save your workbook by selecting Save from the File menu.
10. To close the workbook, select Close from the File menu.

### Manually request a generated profile

Use this procedure to manually generate a set of Curve profiles, before the next scheduled automatic batch process.




**Note:** Before performing this procedure, make sure there are no other users logged onto Retek Demand Forecasting. No other user can access Retek Demand Forecasting until the profile generation process is finished.

1. From the File menu, select New.
2. Click the Curve tab.
3. Select Run Batch Profile and click OK.
4. Click on a radio button to select the final profile to use for profile generation and click Finish.

### Approve a profile

Use this procedure to view, analyze, revise, and approve the profiles generated at the final profile level. In the approval process, you select the appropriate level for each product/location combination and commit the approved profile values to the master database.

1. To open an existing Profile Approval Workbook, select Open from the File menu, select a workbook, click OK, and go to step 10. Or to open a new workbook, select New from the File menu.
2. Click the Curve tab.
3. Select Profile Approval and click OK. The Profile Approval wizard first prompts you to select the final profile to be approved.
4. Select the subset of items to appear in the workbook.
5. Select the subset of locations to appear in the workbook.

6. Select the subset of time periods to appear in the workbook.  
 An additional wizard screen will prompt you to select any additional measures (that is, measures not standard in the Profile Approval Workbook) that you would like included.
7. Click the Finish button to build the workbook.
8. Open the Final Profile Worksheet and view the system calculated final profile and make adjustments to this profile. Remember to aggregate your hierarchies to the Aggregated Intersection and lock these cells before making adjustments at the lower level.
9. Open the Source Profile Worksheet and review the system-generated profiles and the threshold exceptions for each source profile associated to the final profile.
10. Open the Profile Approval Worksheet to approve the profiles.
11. For any intersection, if you want to change the source profile to be used for the final profile, click the Source Profile Exception field (drop-down list) and select the appropriate source profile.
12. If you want to leave a comment about any item, type your comments in the Approval Comment field.
13. If the default approval method in the Profile Administration Workbook is set to Approve Use System, each Approval By field will already display “System”, and each Approval Date will display the proper date the system. If the default approval method in the Profile Administration Workbook is set to Don’t Approve, each Approval Method field will display “Don’t Approve.” The Approved By and Approval Date measures will be unfilled.
14. To manually approve the profile value for an item, activate (check) the Manual Approval flag. Your user ID will automatically display in the Approved By field and today’s date will display in the Approval Date field.
15. From the File menu, select Commit Now to commit the approved profile values.
16. To close the workbook, select Close from the File menu.

### **Set Retek Demand Forecasting to use a profile created by Curve**

Use this procedure to set up your Retek Demand Forecasting system to perform forecast spreading from source forecast levels down to final forecast levels or to support profile-based forecasting.

1. To open an existing Forecast Administration Workbook, select Open from the File menu, select a workbook, click OK, and go to step 5. Or to open a new workbook, select New from the File menu.
2. Click the Predict tab.
3. Select Forecast Administration and click OK.

4. Set up forecast parameters as indicated in the previous section on Forecast Administration Workbook. The following parameters in the Forecast Administration Workbook may require values to support forecasting using profiles generated by Curve:
  - **Default Forecast Method:** If using the Profile-Based forecast method at either a Final or Source Level, the measure name(s) for the profile(s) must be entered in the Seasonal Profile. If using the Causal forecast method at the day level, the measure name(s) for the profile(s) must be entered in the Causal Aggregation Profile and Causal Spread Profile.
  - **Seasonal Profile:** Used in conjunction with the Profile-Based forecasting method, this is the measure name of the seasonal profile that will be used to generate the forecast at either the source or final level.
  - **Spreading Profile:** Used for Source Level Forecasting, the value of this measure indicates the profile level that will be used to determine how the source level forecast is spread down to the final level. No value is needed to be entered at the final level. For dynamically generated profiles, this value is the number associated with the final profile level (for example 01)—note that profiles 1 through 9 have a zero (0) preceding them in Curve—this is different than the forecasting level numbers. For profiles that must be approved, this is the measure associated with the final profile level. This measure is “apvp”+level (for example: apvp1). A Spreading Profile can include multiple profiles separated by commas (for example: 09,apvp11). These types of profiles are multiplied by each other to determine the final level results.
  - **Causal Aggregation Profile:** Used only for Daily Causal Forecasting. The measure name of the profile used to aggregate promotions defined at “day” up to the “week”.
  - **Causal Spread Profile:** Used only for Daily Causal Forecasting. The measure name of the profile used to spread the causal baseline forecast from the Causal Calculation Intersection to the Final Level.
5. Commit the changes to the master database by selecting Commit Now from the File menu. If desired, you may also save your workbook by selecting Save from the File menu.
6. To close the workbook, select Close from the File menu.

# Chapter 8 – Retek Demand Forecasting Methods

This chapter discusses the forecasting methods used in Retek Demand Forecasting in detail.

## Forecasting techniques used in RDF

Retek Demand Forecasting uses a variety of predictive techniques to generate forecasts of demand. The technical methods used are driven by the goal to provide the most accurate forecasts possible in an automatic and efficient manner. These methods have been analyzed, optimized, and refined over years of research on retail specific data.

The primary techniques RDF uses include:

- Exponential smoothing
- Regression analysis
- Bayesian analysis
- Prediction intervals
- Automatic method selection
- Source level forecasting
- Promotional forecasting

### Exponential smoothing

Exponential smoothing models fit basic features of the demand pattern such as level, trend, and seasonality, and project these into the future. These models provide computational benefits and have been chosen for their ability to handle different types of time series, including short and/or noisy series that are characteristic of retail sales. They are "smoothing" models because they use weighted averages on historic data. They are "exponential smoothing" models because the weighting used decays at an exponential rate. That is, more recent data is weighted more heavily than the past.

### Regression analysis

Regression analysis is another standard technique used in prediction. Regression uses a least-squares estimator to fit a model of predictor variables to another set of target variables. Seasonal Regression is a Retek specific extension of this procedure for use in seasonal models with between one and two years of history. Causal Forecasting uses stepwise regression to determine which causal variables are significant.

### Bayesian analysis

Bayesian analysis considers a priori information as a starting point in development of a prediction. Bayesian forecasting, as developed by Retek, uses a sales plan as the starting point that is adjusted based on observed data. This method fills a gap in standard time series forecasting when new, short lifecycle, or products with significant lifecycles are being forecast.

For more information on Bayesian forecasting, see page 117.

### Prediction intervals

Prediction from these various models gives the estimated mean outcome. By using standard statistical distributional assumptions, RDF develops measures of uncertainty associated with forecast point estimates from these models. While this is of key concern for various optimization applications of the forecast, the technical details are beyond the scope of this document. For further details on prediction interval calculations, see Char&Yatfield, International Journal of Forecasting, March 1992.

### Automatic method selection

Providing multiple forecasting methods is only valuable if the appropriate model can be selected in an accurate and efficient manner. In order to make this feasible in a retail environment Retek has developed a number of different Meta-Methods that can automatically select the best method among a number of competing models. Automatic Exponential Smoothing (AutoES) is an example of one such method that clients can select. The final selection between the competing models is made according to a performance criterion that involves a tradeoff between the model's fit over the historic data and its complexity (a description of the competing models used within AutoES is described in section two of this document). In academia this discipline is known as Information Theory and is used in the combination and selection of various competing models.

### Source level forecasting

Sometimes it is difficult to capture seasonality, trend, or causal effects on the final level (item/Store) due to scarcity of the data. Also, time series are often too noisy at that level. To overcome these issues RDF utilizes source level forecasting. In source level forecasting, data is aggregated first to a higher level across the product or location hierarchy (or both). Then the forecast is generated and proportionally spread down to the final level. We have experimentally proven that source level forecasting technique very often improves the accuracy on the final level.

### Promotional forecasting

In some instances, especially in retail, pure time series techniques are inadequate for forecasting demand. Instead of using only historic demand patterns to forecast future demand, additional causal or promotional factors are used to better explain past performance. With the help of a promotional calendar, an indication of when promotions will be run in the future, these promotional forecasting techniques can better predict demand in the future.

For more information on promotional forecasting methods, see page 120.

## Time series (statistical) forecasting methods

This section describes those techniques within RDF that generate forecasts directly from only a single time series. Generally the time series provided is past sales history for a given item/Store that is used to predict what future demand might be. In actual practice these algorithms have been and can be used to forecast a myriad of different data streams at any product/location level (shipment data at item/warehouse, financial data at dept./chain, etc.).

The following topics present fundamentals of the Retek Demand Forecasting statistical forecasting processes. Included is a discussion of the importance of confidence intervals and confidence limits, the time series methods used to generate forecasts, and how the best forecasting method is selected from a list of candidate models.

A wide variety of statistical forecasting techniques are available, ranging from very simple to very sophisticated. All of these methods attempt to best capture the statistical probability distribution discussed above, and they do this by fitting quantitative models to statistical patterns from historical data. Put simply, the better the history of the variable being forecasted, the stronger these statistical patterns will be. Increased forecast accuracy depends on the strength of these patterns in relation to background irregularities.

Retek Demand Forecasting is able to use several time series methods to produce forecasts. Time series methods extrapolate features from the past (in this case, past sales data) to the future. The time series methods that the system offers include:

- Auto Exponential Smoothing Forecasting (AutoES)
- Seasonal Exponential Smoothing Forecasting (SeasonalES)
- Simple Moving Average
- Simple Exponential Smoothing
- Croston's Method
- Holt Exponential Smoothing
- Multiplicative Winters Exponential Smoothing
- Additive Winters Exponential Smoothing
- Seasonal Regression
- Bayesian Information Criterion

### **Why use statistical forecasting?**

The purpose of statistical forecasting is to make the process of predicting future events both objective and quantitative. Statistical forecasting utilizes information from the past (such as sales data) to predict what will happen in the future. Forecast accuracy depends on the degree to which a mathematical model can detect and extract statistical patterns from historic data. The most common statistical methodologies used are univariate. This means that they are based solely on the history of one variable, such as sales. Each forecast observation reflects a future value of the sole input variable. Statistical forecasting processes are relatively easy to implement, and the better the historical data, the better the resulting forecasts.

Businesses benefit greatly from the use of systematic statistical forecasting techniques that aim to accurately predict product demand, enabling these businesses to maintain sufficient product inventory levels. When inventory levels are optimized, lost sales due to product stock-outs are greatly reduced, as are the costs incurred by overstocking.

### **Exponential Smoothing (ES) forecasting methods**

The primary process by which RDF automatically fits an exponential smoothing model to a time series is called Automatic Exponential Smoothing (AutoES). When AutoES forecasting is chosen in RDF, a collection of candidate models is initially considered. The models in the candidate list include

- Simple (One Parameter) Exponential Smoothing
- Croston's Method (Intermittent ES)
- Holt (Two Parameter) Exponential Smoothing (Trend ES)

- Winters (Three Parameter) Exponential Smoothing (Seasonal ES)
- Seasonal Regression

These models include level information, level and trend information, and level, trend and seasonality information, respectively. The optimal smoothing parameters for each model form are determined automatically (that is, greater smoothing will be applied to noisier data). The final selection between the resulting models is made according to a performance criterion that involves a tradeoff between the model's fit over the historic data and its complexity.

The amount of available historic information can affect the complexity of the model that can be fit. For example, fitting a seasonal model would not be appropriate without a complete year of historic data. In fact, one prefers to see each "season" occur multiple times. For a particular series, even if the amount of available history allows one to fit a complex model (that is, one with seasonal components), the resulting model is not necessarily superior to a simpler model. If a simpler model (for example, a model with only a level component, or level and trend components) fits "as well" as a seasonal model, then the AutoES forecasting process will find the simpler model to be preferable. In such a case, the simpler model captures the basic features supported by the data without over fitting and therefore will generally project better forecasts.

### Definitions of equation notation used in this section

The following notation is used in equations throughout this section.

$Y_t$  - Observed value at time  $t$ .

$h$  - Number of periods ahead for which to forecast.

$L_t$  - Smoothed level component at end of time  $t$ .

$T_t$  - Smoothed trend component at end of time  $t$ .

$S_t$  - Smoothed seasonal index component at end of time  $t$ .

$\alpha$  - Smoothing parameter for level of series.

$\gamma$  - Smoothing parameter for trend.

$\delta$  - Smoothing parameter for seasonal indexes.

$\phi$  - Damped trend constant.

$p$  - Number of periods per year.

$\hat{Y}_t(h)$  - Forecast for time  $t+h$  from base  $t$ .

$\tilde{S}_{t+h}$  - Most recent seasonal index for time  $t+h$

### Components of exponential smoothing

Several features of the data can be incorporated into exponential smoothing models using the following structural components:

The level ( $L_t$ ) of the series estimates the non-seasonal, slowly changing process of the time series. This data feature represents a flat value for the data when noise, trend and seasonality effects are excluded from the data.



The trend ( $T_t$ ) of a series reflects the rate of change of the series from one point to another. RDF uses a damping factor with its trend component to curtail exaggerated effects over long forecast horizons.

Smoothed seasonal indexes ( $S_t$ ) estimate periodic patterns in the demand data. Using these estimated values, a model can extrapolate the seasonal features of a series. A seasonal index can be derived as an additive or multiplicative feature of the data.

For a particular time series, a more complex model might consider seasonality and/or trend. For all models, a form of the level of the series is used.

## Average

A simple moving average forecast involves taking the average of the past  $n$  time periods and using that average as the forecast for all future time periods (where  $n$  is the length of fitting period). Simple moving average forecasts are frequently used in the system because they make few assumptions about the historical time series, they can be generated with little historical data, and because they are very fast to generate. Typically, moving average forecasts are generated at the final forecast level (for example, item/Store) and their results used to spread more sophisticated higher-level forecasts (for example, those generated with exponential smoothing).

A Simple Moving Average model assumes that historical data is too short or noisy to consider seasonal effects or local trend, and is based on the level of the series. Since this model does not use a smoothing parameter to place added weight on more recent historic values, a Simple Moving Average model is not actually in the exponential smoothing family. However, it is an adequate model to use when low-level (final forecast) ratios are needed for RDF's spreading of high-level (aggregate) forecasts. That is, when aggregate forecasts can be calculated for long and less noisy aggregate time series, Simple Moving Average models provide an adequate (and computationally quick) forecast to determine the ratios needed for RDF spreading. User input in overriding the automatic training horizon further enhances the simple robustness of this model for base-level data.

Overall, a forecast is evaluated as:

$$\hat{Y}_t(h) = \frac{1}{n} \sum_{k=0}^{n-1} Y_{t-k}$$

## Confidence intervals constraining in Average:

The confidence interval is capped using the following rule:

if  $\text{interval}(0) = \text{stdev}(\text{frst error}) < 0.3 \cdot \text{level}$ , then  $\text{interval}(i) = 0.3 \cdot \text{level} \cdot \sqrt{(i+1)}$

$$\text{cuminterval}(i) = \sqrt{\text{cuminterval}(i-1)^2 + \text{interval}(i)^2}$$

if  $\text{interval}(0) = \text{stdev}(\text{frst error}) > \text{level}$ , then  $\text{interval}(i) = \text{level} \cdot \sqrt{(i+1)}$

$$\text{cuminterval}(i) = \sqrt{\text{cuminterval}(i-1)^2 + \text{interval}(i)^2}$$

Otherwise,  $\text{interval}(i) = \text{interval}(0) \cdot \sqrt{(i+1)}$

$$\text{cuminterval}(i) = \sqrt{\text{cuminterval}(i-1)^2 + \text{interval}(i)^2}$$

## Simple exponential smoothing

Simple Exponential Smoothing does not consider seasonality or trend features in the demand data (if they exist). It is the simplest model of the exponential smoothing family, yet still adequate for many types of RDF demand data. Forecasts for short horizons can be estimated with Simple Exponential Smoothing when less than a year of historic demand data is available and acts-like associations are not assigned in RDF.

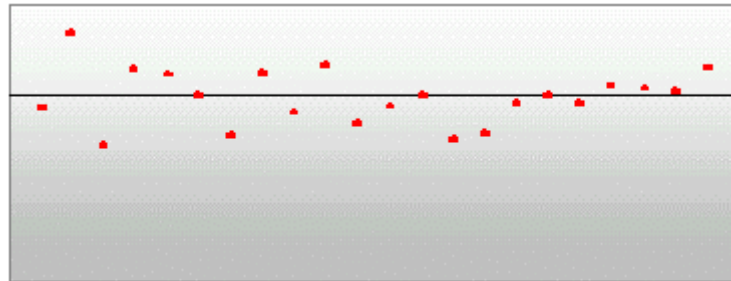
In its recursive form, the Simple Exponential Smoothing equation is:

$$L_t = \alpha Y_t + (1 - \alpha) L_{t-1}$$

A forecast point estimate is evaluated as:

$$\hat{Y}_t(h) = L_t$$

The following figure is an example of a forecast whose data seems to be un-trended and un-seasonal; note the flat appearance of the forecast.



**Simple exponential smoothing**

### Confidence intervals constraining in SimpleES:

The confidence interval is capped using the following rule:

if  $\text{interval}(0) = \text{stdev}(\text{frst error}) < 0.3 \cdot \text{level}$ , then  $\text{interval}(i) = 0.3 \cdot \text{level} \cdot \sqrt{(i+1)}$

$$\text{cuminterval}(i) = \sqrt{\text{cuminterval}(i-1)^2 + \text{interval}(i)^2}$$

if  $\text{interval}(0) = \text{stdev}(\text{frst error}) > \text{level}$ , then  $\text{interval}(i) = \text{level} \cdot \sqrt{(i+1)}$

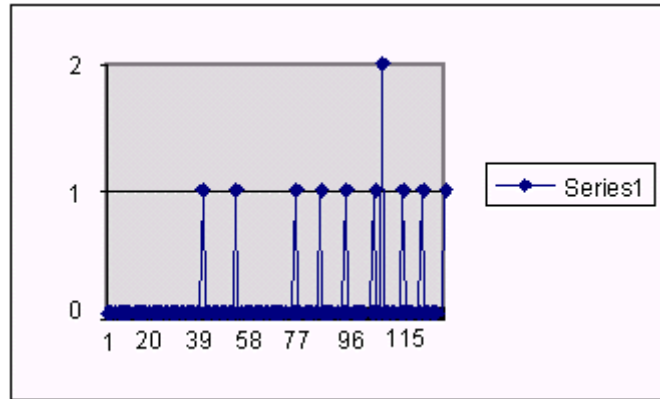
$$\text{cuminterval}(i) = \sqrt{\text{cuminterval}(i-1)^2 + \text{interval}(i)^2}$$

Otherwise, the intervals and cumints are extended in horizon using the ES formula for intervals from SimpleES (1)

### Croston's method

Croston's method is used when the input series contains a large number of zero data points (that is, intermittent demand data). The method involves splitting the original time series into two new series: (i) magnitude series and (ii) frequency series. The magnitude series contains all the non-zero data points, while the frequency series consists of the time intervals between consecutive non-zero data points. A Simple Exponential Smoothing model is then applied to each of these newly created series to forecast a magnitude level as well as a frequency level. The ratio of the magnitude estimate over the frequency estimate is the forecast level reported for the original series.

The following figure shows a sales history of data where the demand for a given period is often zero.



Croston's method

### Simple/Intermittent Exponential Smoothing

This method is a combination of the Simple ES and Croston's (Intermittent ES) methods. The Simple ES model is applied to the time series unless a large number of zero data points are present, in which case the Croston's model is applied.

### Holt exponential smoothing

Holt exponential smoothing treats data as linearly trended but non-seasonal. The Holt model provides forecast point estimates by combining an estimated trend (for the forecast horizon - h) and the smoothed level at the end of the series. RDF uses a damped Holt model that decays the trend component so that it disappears over the first few weeks. This improves forecasts created using Holt over longer forecast horizons.

Overall, a forecast is evaluated as:

$$\hat{Y}_t(h) = L_t + \left[ \sum_{i=1}^h \phi^i \right] T_t$$

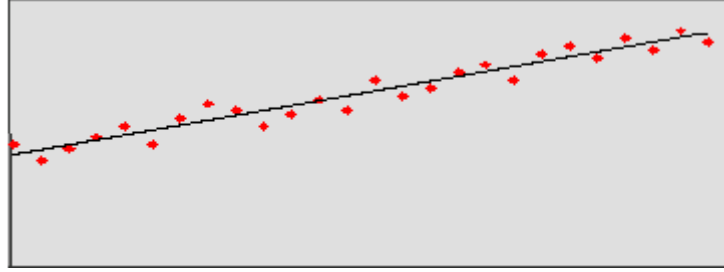
where the Level at the end of the series (time t) is:

$$L_t = \alpha Y_t + (1 - \alpha)(L_{t-1} + T_{t-1}), \text{ and}$$

the Trend at the end of the series (time t) is:

$$T_t = \gamma (L_t - L_{t-1}) + (1 - \gamma) T_{t-1}$$

When this forecasting method is selected, the forecasts are seen as trending either up or down, as in the following example:



**Holt exponential smoothing**

### Multiplicative Winters exponential smoothing

Winters exponential smoothing treats data as both trended and seasonal.

From sufficient data, RDF extracts seasonal indexes that are assumed to have multiplicative effects on the de-seasonalized series. Note that the component describing the de-seasonalized values (which is multiplied by the seasonal index  $\hat{S}_t(h)$ ) is just the Holt model described above. In this case, three parameters are used to control smoothing of the components of level, trend and seasonality.

Overall, a forecast point estimate is evaluated as:

$$\hat{Y}_t(h) = \left( L_t + \left[ \sum_{i=1}^h \varphi^i \right] T_t \right) \hat{S}_t(h),$$

where the Level at the end of the series (time t) is:

$$L_t = \alpha \frac{Y_t}{S_{t-p}} + (1 - \alpha)(L_{t-1} + T_{t-1}), \text{ and}$$

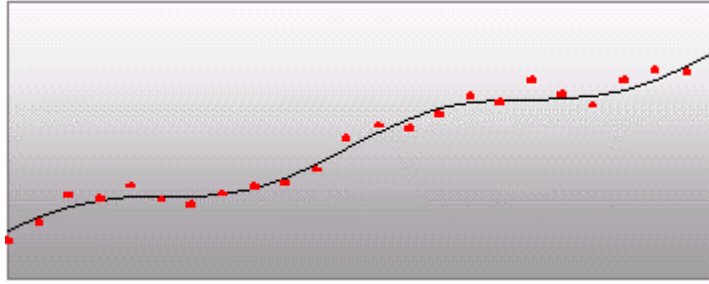
the Trend at the end of the series (time t) is:

$$T_t = \gamma(L_t - L_{t-1}) + (1 - \gamma)T_{t-1}, \text{ and}$$

the Seasonal Index for the time series (applied to the forecast horizon) is:

$$S_t = \delta \frac{Y_t}{L_t} + (1 - \delta)S_{t-p}$$

When this forecasting method is selected, the forecasts tend to look “squiggly, as shown in the following figure:



**Multiplicative Winters exponential smoothing**

### Additive Winters exponential smoothing

Additive Winters is similar to Multiplicative Winters, but the de-seasonalized values are adjusted by adding the seasonal index (for the forecast horizon). Three parameters are evaluated to control the smoothing of components of level, trend and seasonality.

Overall, a forecast point is evaluated as:

$$\hat{Y}_t(h) = L_t + \left[ \sum_{i=1}^h \varphi^i \right] T_t + \hat{S}_t(h)$$

where the Level at the end of the series (time t) is:

$$L_t = \alpha(Y_t - S_{t-p}) + (1 - \alpha)(L_{t-1} + T_{t-1}), \text{ and}$$

the Trend at the end of the series (time t) is:

$$T_t = \gamma(L_t - L_{t-1}) + (1 - \gamma)T_{t-1}, \text{ and}$$

the Seasonal Index for the time series (applied to the forecast horizon) is:

$$S_t = \delta(Y_t - L_t) + (1 - \delta)S_{t-p}$$

### Confidence intervals constraining in HoltES, AWinters, MWinters:

The confidence interval is capped using the following rule:

$$\text{if } \text{interval}(0) < 0.3 * \text{forecast}(i), \text{ then } \text{interval}(i) = 0.3 \cdot \text{forecast}(i) \cdot \sqrt{(i+1)}$$

$$\text{cuminterval}(i) = \sqrt{\text{cuminterval}(i-1)^2 + \text{interval}(i)^2}$$

$$\text{if } \text{interval}(0) > \text{forecast}(i), \text{ then } \text{interval}(i) = \text{forecast}(i) \cdot \sqrt{(i+1)}$$

$\text{cuminterval}(i) = \sqrt{\text{cuminterval}(i-1)^2 + \text{interval}(i)^2}$  from the first constrained interval until the end of the forecast horizon

Otherwise, the intervals and cumints are extended in horizon using the interval ES formulas (i, ii, iii)

## Seasonal Exponential Smoothing (SeasonalES)

In certain instances, it is known that seasonal models will generally outperform non-seasonal models in forecast accuracy. When this is true (generally used for known seasonal items or for forecasts with a long horizon), it is advantageous to prevent AutoES from selecting from the Simple/Holt/Croston's methods. Choosing SeasonalES does just this. In instances where there exists too little data to create a seasonal forecast (less than 52 weeks of history), the SeasonalES method will cascade to select between Simple/Holt/Croston. In all other instances, a seasonal model (Winter's or Seasonal Regression) will be chosen. See the following section for more information on Seasonal Regression.

### Confidence intervals constraining in Seasonal method:

The confidence interval is constrained using the following rule:

if  $\text{interval}(0) = \text{stdev}(\text{first error}) < 0.3 \cdot \text{forecast}(i)$ , then  $\text{interval}(i) = 0.3 \cdot \text{forecast}(i) \cdot \sqrt{(i+1)}$

if  $\text{interval}(0) > \text{forecast}(i)$ , then  $\text{interval}(i) = \text{forecast}(i) \cdot \sqrt{(i+1)}$

Otherwise,  $\text{interval}(i) = \text{interval}(0) \cdot \sqrt{(i+1)}$

$\text{cuminterval}(i) = \sqrt{\text{cuminterval}(i-1)^2 + \text{interval}(i)^2}$

## Seasonal Regression

A common benchmark in seasonal forecasting methods is sales last year. A sales last year forecast is based entirely on sales from the same time period of last year. Forecasting using only sales last year involves simple calculations and often outperforms other more sophisticated seasonal forecasting models. This method performs best when dealing with highly seasonal sales data with a relatively short sales history.

The seasonal models used in earlier releases of Retek Demand Forecasting (Additive and Multiplicative Winters) were designed to determine seasonality. However, they were not designed to work with sales histories of shorter than two years. Because sales histories of longer than two years are often difficult to obtain, many retail environments need a seasonal forecast that can accommodate sales data histories of between one and two years. In addition, the Additive and Multiplicative Winters models search for short-term trends and have difficulties with trends occurring inside the seasonal indices themselves. The current Retek Demand Forecasting Seasonal Regression forecasting model is designed to address these needs.

The Seasonal Regression Model uses simple linear regression with last year's data as the predictor variable and this year's sales as the target variable. The system determines the multiplicative and additive weights that best fit the data on hand. When optimizing the Seasonal Regression Model, the sales last year forecast is inherently considered, and will automatically be used if it is the model that best fits the data. If there have been significant shifts in the level of sales from one year to the next, the model will learn that shift and appropriately weight last year's data (keeping the same shape from last year, but adjusting its scale).

As with other seasonal models, you can forecast demand for products with insufficient sales histories using this method if:

- You paste in fake history as needed, providing a seasonal profile for the previous year.

- You also forecast for a source level (with the same seasonality profile as the forecasted item and with more than one year of history), using seasonal regression and spread these forecast results down to the member products.

The Seasonal Regression Model is included in the AutoES family of forecasting models, and is thus a candidate model that will be selected if it best fits the data.

More formally, for a series  $\vec{x}$  of length  $N$ , define  $x(j)$  as the value of  $\vec{x}$  at time  $j$ ,  $1 \leq j \leq N$ , and let  $p$  be the length of the seasonal cycle in series  $\vec{x}$ ,  $1 \leq p \leq N$ , which is assumed to be known apriori. The forecast for the series at time  $l + h$  is represented by  $\hat{x}_l(h)$  where  $l$ ,  $1 \leq l \leq N$ , is the location in the series at which forecasting begins and  $h$  is the position in the forecast window. Using this terminology the forecast is defined as:

$$\hat{x}_l(h) \equiv A \cdot x(l + h - p) + B,$$

where  $A$  and  $B$  are the constants calculated by linear regression.

Plotting the series where one axis is the value of the series at time  $t$  (that is,  $x(t)$ ) and the other axis is the value of the series at time  $t - p$  (that is,  $x(t - p)$ ) yields a scatter plot. As can be determined by visual inspection the series plotted against itself shifted by a single cycle falls along a rough line. It is this line that is captured by the linear regression where  $A$  is the slope of the line and  $B$  is the point of intersection.

Thus, this method captures the trend of a series through the slope of the regression line while the series shifted by a cycle provides its seasonal profile. Using this method the resulting forecast for the original series is calculated. The regression method provides a much better forecast of the series than was possible with the other exponential smoothing algorithms.

Based on the assumptions of the model that this method is trying to describe, versus the noisy data it is likely to receive, several exceptions to this regression technique are caught and corrected. First, since it is logically impossible to receive a negative value for the slope (such a value suggesting an inverse seasonality) any time a negative slope is detected the regression is rerun with the intercept fixed to zero. This guarantees that a positive slope will be calculated and thus a more logical forecast will be given.

The second noise-driven concession is to check the slope to determine if it is either too slight or too great. If this is the case, then the method rejects itself out of hand and allows one of the other competing methods to provide the forecast.

Thus, the full forecasting algorithm is:

1. For the series  $\vec{x}$  of length  $N$  with seasonality occurring with cycle length  $p$  form the pairs  $X = (x(1), x(1 + p)), \dots, (x(N - p), x(N))$ .
2. Perform regression on the pairs in  $X$  to retrieve the slope,  $A$ , and the intercept,  $B$ , using the equation above.
3. Check the slope of the regression. If the slope is negative then rerun the regression on  $X$  fixing the intercept to zero.
4. Check the slope of the regression to determine if it is in the accepted range. If not this method fails to produce a forecast.

5. Build the forecast for the horizon of length  $l$  as

$$\hat{x}_N(h) = A \cdot x(N - p + h) + B, \quad 1 \leq h \leq l.$$

### **Bayesian Information Criterion (BIC)**

Within AutoES, the model that minimizes the Bayesian Information Criterion (BIC) is selected as the final model. The BIC criterion attempts to balance model complexity with goodness-of-fit over the historical data. The BIC criterion rewards a model for goodness-of-fit and penalizes a model for its complexity. The complexity penalty is necessary to avoid over fitting.

There are various equivalent versions of the Bayesian Information Criterion, but RDF minimizes the following:

$$BIC = s \cdot n^{k/2n}$$

where  $n$  is the number of periods in the available data history,  $k$  is the number of parameters to be estimated in the model (a measure of model complexity), and  $s$  is the root mean squared error computed with one-step-ahead forecast errors resulting from the fitted model (a measure of goodness-of-fit). Note that since each member of the model candidate list is actually a family of models, an optimization routine to select optimal smoothing parameters is required to minimize  $s$  for each model form (that is, to select the best model).

Within RDF, a few modifications to the standard selection criteria have been made. These include reducing the number of parameters the Winter's model is penalized by discounting seasonal indices that have little impact on the forecast (multiplicative indices close to 1, additive indices close to 0). These changes tend to favor the seasonal models to a slightly higher degree that improves the forecasts on retail data, especially for longer forecast horizons.

### **AutoES Flowchart**

The following outlines the processing routine the system runs through to evaluate each time series set to forecast using the AutoES method. See Chapter 2: Forecast Administration/Advance Settings for more information on adjusting the parameters used to qualify a time series for Croston's, Holt or Winters methods:

Step 1: Filter all leading zeros in the input data that is within the training window. Go to Step 2.

Step 2: Does the time series contain the minimum data points to qualify to forecast using the Croston's method? If yes, generate the forecast and statistics using the Croston's method, and move on to the next time series. If no, move on to Step 3.

Step 3: Does the time series contain enough relevant data to generate a forecast? If yes, generate a forecast and statistics using the Simple ES method and move on to Step 4. If no, do not forecast, then go to the next time series.

Step 4: Does the time series contain the minimum data points to qualify to forecast using the Holt method? If yes, generate a forecast and statistics using the Holt method and move on to Step 5. If no, move on to Step 5.

Step 5: Does the time series contain more than 52 weeks of input data? If yes, generate a forecast and statistics using the Seasonal Regression method and move on to Step 6. If no, move on to Step 9.

Step 6: Does the time series contain the minimum data points to qualify to forecast using Winters methods? If yes, move on to Step 7. If no, move on to Step 9.

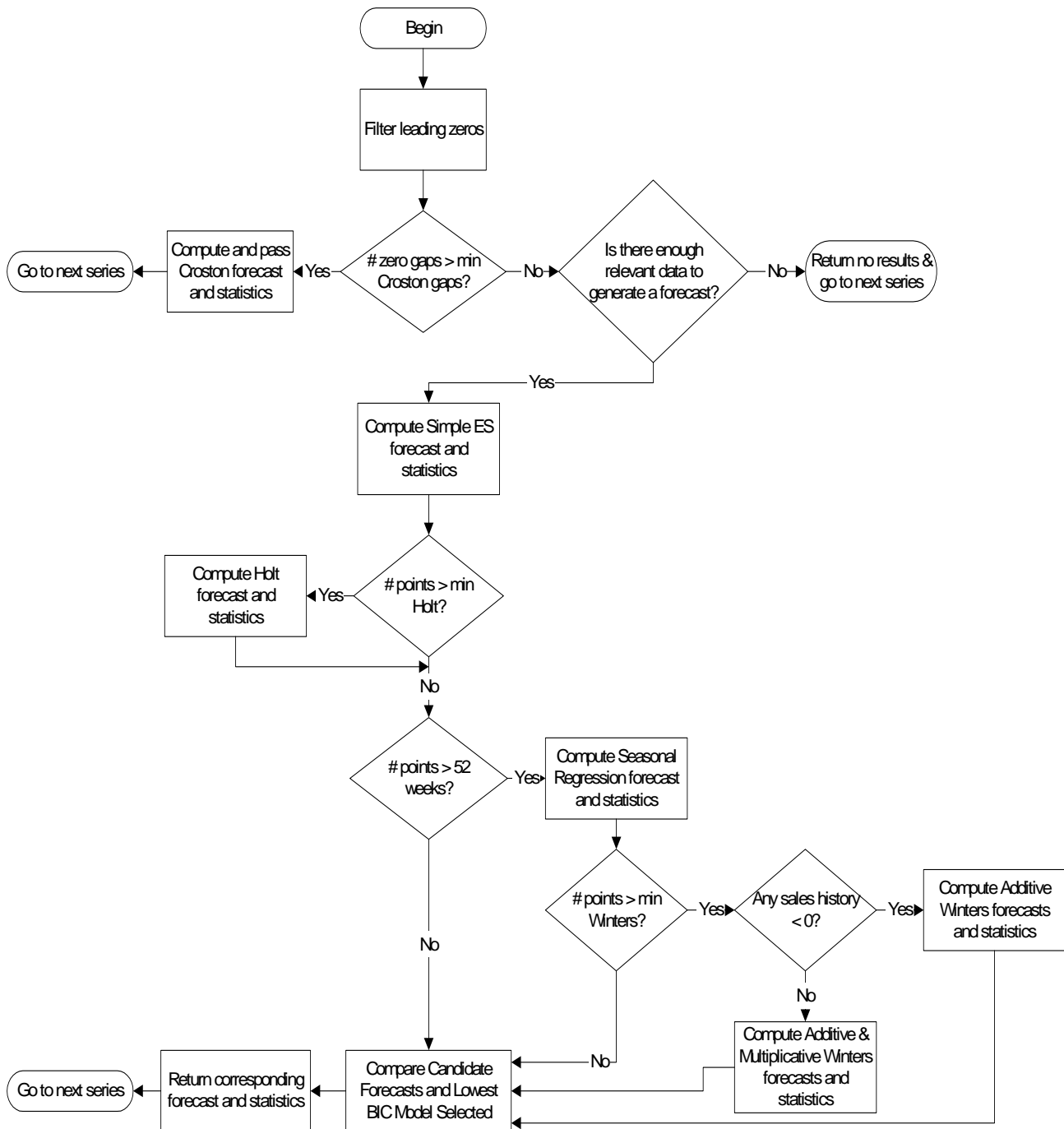


Step 7: Does the time series contain any data point with sales equal qualify to forecast using Additive Winters method? If yes, generate the forecast and statistics using the Additive Winters method, and move on to Step 9. If no, move on to Step 8.

Step 8: Does the time series qualify to forecast using the Multiplicative Winters method? If yes, generate the forecast and statistics using both the Additive Winters and Multiplicative Winters methods, and move on to Step 9.

Step 9: Compare all candidate forecasts using BIC Criterion.

Step 10: Return the corresponding forecast and statistics for the system-selected forecast method, and move on to the next time series.



### **Automatic forecast level selection (Auto-Select)**

This section describes how the automatic forecast level selection (Auto-Select) could help improve the accuracy of your forecasts.

In the system, one of the key elements to producing accurate forecasts is using the system's ability to aggregate and spread sales data and forecasts across the product and location hierarchies. Low selling or relatively new products can use aggregated data from similar products/locations at a higher level in the hierarchy, generate forecasts using this data, and then spread these higher level forecasts back down to provide more accurate forecasts. The difficulty comes in deciding which products/locations will benefit from this technique, and from what level in the hierarchy these source level forecasts should be spread.

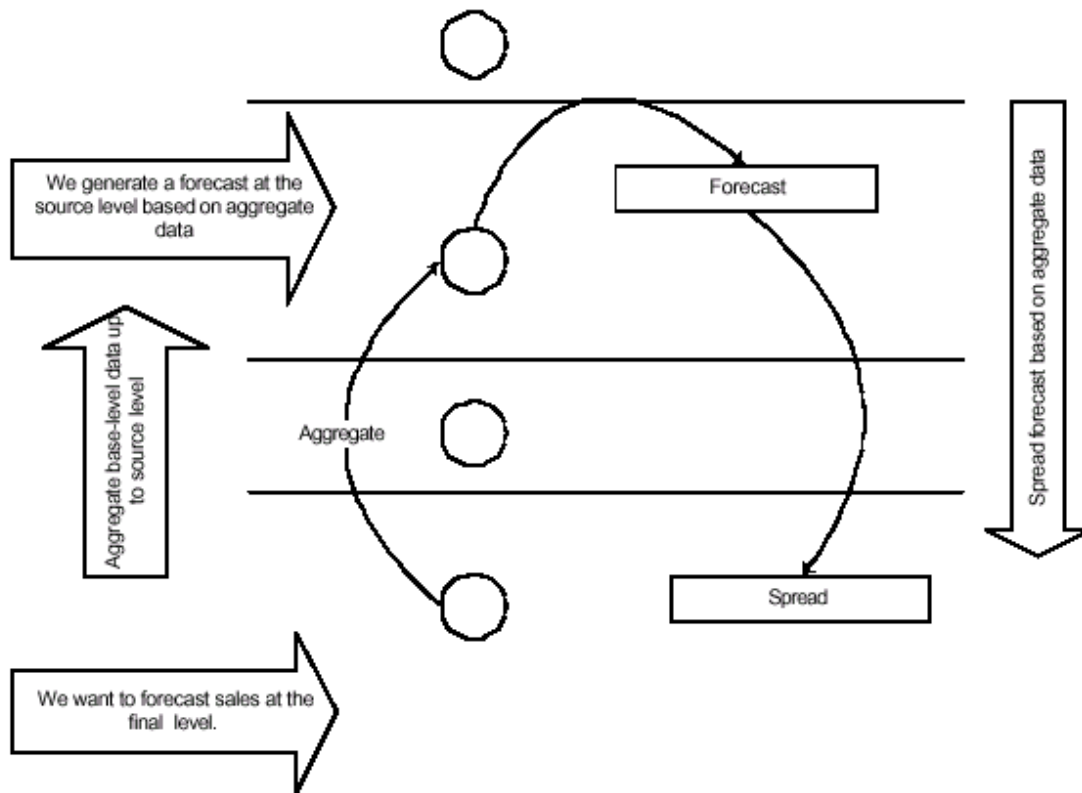
The Automatic Forecast Level Selection feature of the system automates the selection of best aggregation level (forecast source level) for each product/location combination. While providing invaluable information regarding the best aggregate level for source forecasts, the Automatic Forecast Level Selection process may be very CPU intensive. To solve this problem, the task of selecting best aggregation levels for product/location combinations is decomposed and processed piecemeal during times when the computer would normally be idle. Identifying the best aggregation levels for sets of products and locations can be divided into a number of sub-problems:

- Forecasting
- Determining the best source level forecast
- Status and Scheduling

### **The forecast level selection process**

The automatic source generation level selection subsystem selects the best source generation level for each product/location in a given final forecast level. In order to determine the best level, a final forecast is generated for each product/location using each candidate source generation level. As illustrated in the figure below, a final forecast is generated by 1) aggregating up from the base level to the source level, 2) generating a source level forecast, and 3) spreading the source-level forecast down to the final level.

For example, assume base-level sales data is at the ITEM/STORE level, the final forecast level is at the ITEM/STORE level, and the candidate source generation level is at the STYLE/STORE level. Then, base-level sales data is aggregated from the ITEM/STORE level up to the STYLE/STORE level. A STYLE/STORE forecast is generated, and the forecast data is then spread back down to the ITEM/STORE level. This forecast represents the final forecast.



**Final forecast generation flow chart**

### Determining the best source level forecast

The selection of the best level is based on a train-test approach. In this process, historical data is used to generate a forecast for a test period for which actual sales data already exists. The forecast, generated over the train period, can be compared to the actual sales figures in the test period to calculate the percent absolute error (PAE) between the two.

A final-level forecast is generated for each product/location combination using each potential source generation level. Each time a source level forecast is generated, a PAE is calculated for that level. If that PAE is better than the current best PAE (corresponding to the current best source generation level), then the source generation level that generated that better PAE becomes the new best level.

### Status & scheduling

Identifying the best aggregation level for a given set of products and locations may take a significant amount of time (that is, an amount of time that is greater than the duration of the computer's shortest idle period). This task, however, can be partitioned; that is, the problem of selecting the best aggregation levels can be decomposed into smaller sub problems to be solved piecemeal during times when the computer would normally be idle.

For each product/location combination at the final forecast level, the problem consists of 1) generating forecasts at each unique aggregation level and 2) using the train-test approach to evaluate the percent absolute error statistics for each. One or more of these subtasks will be performed during each period that the computer is idle. The best aggregation status keeps track of which sub problems have been performed and which sub problems remain. In this way, when the best aggregation procedure is run, the procedure knows what the next sub problem is.

Best aggregation level procedures are run during idle computer periods. The scheduling of the Automatic Forecast Level Selection process must be integrated with the schedules of other machine processes. In general, you should select a schedule so that source generation level selection does not conflict with other activities. The following is an example of a typical schedule for the Automatic Forecast Level Selection process: Monday through Thursday, the selection process starts at midnight and runs for 8 hours; on Friday and Saturday, the process is allowed to run for 20 hours; Sunday is reserved for generating forecasts.

### Using the system-selected forecast level

You have the option of accepting the system-generated source level selection or manually selecting a different source level to be used. The value for the source forecast level can be manipulated in the Final Level Worksheet of the Forecast Maintenance Workbook. For each product/location combination, the best source forecast level identified by Retek Demand Forecasting will appear in the Suggested Generation Level measure on this worksheet. You can enable the use of this level by placing a checkmark in the Use Suggested Generation Level measure for that product/location. The absence of a checkmark in this measure causes the system to select the source level chosen in the Generation Level measure, which you can specify using a drop-down list.

## Profile-based forecasting

The Profile-based forecasting method generates a forecast based on a seasonal profile. The profile may be loaded, manually entered, or generated by Curve. It can also be copied from another profile and adjusted.

### Forecast method

The Profile-based forecasting method proceeds as follows:

1. The historical data and the profile are loaded.
2. The data are de-seasonalized using the profile and then fed to Simple method.
3. The alpha is capped by 0.5
4. The Simple forecast is then re-seasonalized using the profiles.

### Confidence intervals constraining in Profile Based method:

In Profile Based method, the intervals are taken from the baseline SimpleES forecast. However, the Profile Based forecasts are obtained by multiplying the baseline forecasts with the profiles, thus a new interval constraining is required after the multiplication. The confidence interval is constrained using the following rule:

if  $\text{interval}(0) = \text{stdev}(\text{first error}) < 0.3 * \text{forecast}(i)$  ( = Simple forecast \* profile), then  $\text{interval}(i) = 0.3 \cdot \text{forecast}(i) \cdot \sqrt{(i+1)}$

if  $\text{interval}(0) > \text{forecast}(i)$ , then  $\text{interval}(i) = \text{forecast}(i) \cdot \sqrt{(i+1)}$

Otherwise,  $\text{interval}(i) = \text{interval}(0) \cdot \sqrt{(i+1)}$

$\text{cuminterval}(i) = \sqrt{\text{cuminterval}(i-1)^2 + \text{interval}(i)^2}$

### Profile based method and new items

The Profile-based forecasting method can be successfully used to forecast new items. In order to do that we need to have a profile (which can be copied from a item that shares the same seasonality), and a number that specifies the de-seasonalized demand (DD value). The forecast is calculated using the DD value multiplied by the profile. The confidence interval is set to 1/3 of the DD value.

If the DD value is used to forecast, the history (if exists) of the product is ignored. Once we have enough history (number of data points exceed a global parameter), the forecast stops using the DD value and it defaults to the “normal” Profile Based method.

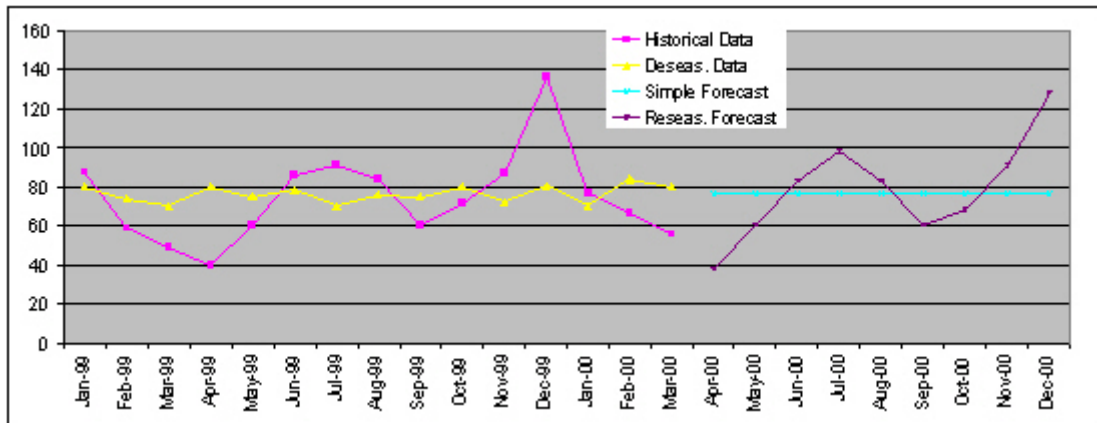
## Example

Consider a product, sunglasses, with monthly data from January 1999 through March 2000.

In grid form, the profile-based forecast for this product is:

Profile	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Historical Data	88	59	49	40	60	88	91	84	60	72	87	137	77	67	98									
Desreas. Data	80	73.75	70	80	75	78.18	70	78.36	75	80	72.5	80.59	70	80.75	80									
Simple Forecast																78.9	78.9	78.9	78.9	78.9	78.9	78.9	78.9	78.9
Reseas. Forecast																37.88	60.8	80.33	98.48	80.33	60.8	68.18	90.91	128.8

Here is the same forecast displayed in chart form:



## Bayesian forecasting

The Bayesian Forecasting method is based on combining historic sales data with sales plan data. It is especially effective for new products with little or no historic sales data.

Your sales plan can incorporate expert knowledge in two ways, shape and scale. Shape is the selling profile or lifecycle that can be derived from a sales plan. For example, the shape for certain fashion items might show sales ramping up quickly for the first four weeks and then trailing off to nothing over the next eight weeks. The scale, or magnitude, of a sales plan is the total quantity expected to be sold over the plan's duration.

Bayesian Forecasting assumes that the shape that sales will take is known, but the scale is uncertain. In Bayesian Forecasting, when no sales history is available, the sales forecast figures are equal to the sales plan figures (at this point, there is no reason to mistrust the sales plan). As point of sale data becomes available, the forecast is adjusted and the scale becomes a weighted average between the initial plan's scale and the scale reflected by known sales history. Confidence in the sales plan is controlled by the amount of sales data on hand and a Bayesian sensitivity constant (which you can set between zero and one).

Unlike standard time series forecasting, which requires only sales history to produce a forecast, Bayesian Forecasting requires a sales plan and sales history (if available). Because of this difference, Bayesian Forecasting is not included in AutoES. You must select it manually as a forecasting method, in Forecast Administration or Forecast Maintenance.

Obtaining accurate short life-cycle product forecasts is very difficult, and standard statistical time series forecasting models frequently do not offer an adequate solution for many retailers. Major problems in automatically developing these forecasts include:

- The lack of substantial sales history for a product (which especially makes obtaining seasonal forecasts very difficult),
- The difficulty of automatically matching a new product to a previous product or profile
- The inability to include planners' intuition (for example, the overall sales level of the product, how quickly the product will take off, how the product's sales will be affected by planned promotions) into a forecasting model.

Using a Bayesian approach, a short life-cycle forecasting algorithm has been developed that begins with a product's seasonal sales plan (that is developed externally to the system by the planner). As sales information arrives during the first few days or weeks of the season, the model generates a forecast by merging the information contained in the sales plan with the information contained in the initial sales data. These forecast updates can be critical to a company's success and can be used to increase or cancel vendor orders.

As forecasting consultants and software providers, Retek assists clients in obtaining "good" forecasts for future demands for their products based upon historical sales data and available causal information. Depending upon the information available, Retek's software supports various forms of exponential smoothing and regression based forecasting. Frequently, however, clients already have some expectations of future demands in the form of sales plans. Depending upon the quality of their plans, they can provide very useful information to a forecasting algorithm (especially when only limited historical sales data is available). A forecasting algorithm has been developed that merges a customers sales plans with any available historical sales in a Bayesian fashion (that is, it uses new information to update or revise an existing set of probabilities).

### Sales plans vs. historic data

In most retail situations, clients are interested in obtaining good product forecasts automatically with little or no human intervention. For stable products with years of historic sales data our time series approaches (Simple, Holt, Winters, Regression based Causal, etc.) produce adequate results. The problem arises when attempting to forecast products with little or no history. In such instances expert knowledge is required, generally in the form of sales plans. Given that both sales plans and time series forecasts are available, an obvious question exists: When should the transition from sales plan to time series forecasting occur? Suppose that in answer to that question (in a particular scenario) we have determined that thirteen weeks of history is the transition point. Does that mean that at 12 weeks the time series results are irrelevant and that at 14 weeks the sales plan has no value? Our intuition tells us that instead of there existing a hard-edge boundary, there is actually a steady continuum where the benefits from the sales plan decrease as we gather more historic sales data. This was the motivation for developing an approach that would combine the two forecasts in a reasonable manner.

### Bayesian algorithm

The forecasting algorithm is provided only to give the technical reader insight into exactly how actual sales are combined with a plan to produce a forecast. What is important for all users to understand is that the algorithm is dependent on a sensitivity parameter that can be set by the client. A higher sensitivity setting will make the forecasting process increasingly reactive to actual sales. This parameter should be set based on the business goals of each individual client.

Let:



$N$  be the number of periods in the current season (and  $N = \infty$  for staple products),

$M$  be the current period,

$p(j)$  be the sales plan for periods  $j = 1, \dots, N$ ,

$x(j)$  be the achieved sales for period  $j = 1, \dots, M$ , and

$\alpha$  be a constant between 0.0 and 1.0 (This parameter influences the balance between model sensitivity and robustness, that is, how responsive the model is to new sales data).

Additionally, define

$P' \equiv \sum_{j=1}^M p(j)$  as the sum of the sales plan up to the current period,

$P'' \equiv \sum_{j=1}^N p(j)$  as the sum of the sales plan over the entire season, and

$X' \equiv \sum_{j=1}^M x(j)$  as the sum of the achieved sales up to the current period.

Finally, compute the forecasts as

$$\hat{x}(j) \equiv p(j) \left( \frac{X'}{P'} \right) \left( \frac{P'}{P''} \right)^{\alpha} + p(j) \left( 1 - \left( \frac{P'}{P''} \right)^{\alpha} \right) \text{ for periods } j = M+1, \dots, N.$$

The motivation for this forecast is relatively clear. The forecast is a convex combination of a scaled version of the sales plan,  $p(j) \left( \frac{X'}{P'} \right)$ , and the original sales plan itself. The scaled version

of the sales plan is scaled based upon the ratio of the achieved historical sales to the historical sales plan (for example, if we had sold twice what we had planned to sell in the past, then the scaled plan would be twice the original plan). Thus, if we had no confidence in the magnitude of the original sales plan (but we still believed in its time profile or shape), then the scaled plan would probably be a good forecast on its own. On the other hand, if we really still believe in our plan and we don't believe that the recent past performance is indicative of future performance, then it would make sense to stick with the original sales plan as our forecast.

In our forecasting algorithm, the weights assigned to the scaled and original plans represent the confidence in the respective portions. As  $\left( \frac{P'}{P''} \right)$  becomes larger (that is, the portion of the plan that we can compare to historical sales increases), we tend to have more confidence in the scaled plan. For example, if  $\left( \frac{P'}{P''} \right) = 0.01$ , then we really don't have much information upon which to base the scaled plan.

On the other hand, for example, as the quantity approaches 0.5 (that is, the season is half way over), then we really should start seriously considering why the plan was incorrect and we may have greater belief in the scaled plan. Additionally, the  $\alpha$  parameter is used to tweak the sensitivity of the forecasting method. As  $\alpha$  increases the forecast will tend to stick closer to the original plan, and for small values of  $\alpha$  the forecast will move rapidly towards the scaled plan as historical sales data becomes available. Clients should use their own data and judgement to determine an appropriate  $\alpha$  for their particular business problem at hand.

### Guidelines

Bayesian forecasting is primarily designed for use with new product/location positions. The following guidelines should be followed:

1. No more than one plan should exist for a given product/location position. If multiple plans are to be set up for different time periods, the domain should be set up with different forecasting levels for each time period of interest.
2. Any time period with non-zero Actuals for a given product/location position should have a corresponding plan component (otherwise the system will assume a plan exists and equals zero and will act accordingly).
3. Any non-zero Actuals not within the time period of interest should be overridden to zero.

### Causal (promotional) forecasting method

Causal, or promotional, forecasting requires three input streams:

- Time Series Data
- Historical Promotional Calendar
- Future Promotional Calendar

Promote decomposes the problem of promotional forecasting into two sub-tasks: estimating the effect promotions have on demand and forecasting baseline (that is no promotions) demand.

To accomplish the first task a stepwise regression sub-routine is used. This routine will take a time series and a collection of promotional variables and determine which variables are most relevant and what effect those relevant variables have on the series. Thus, the output from the algorithm is a selection of promotional variables and the effects of those variables on the series. In the second step the time series is de-causalized using the promo effects. Then, AutoES is used to calculate the baseline demand. Once we know the effects and we have the baseline demand we can generate a promotional forecast by applying the effects wherever the promotion is active in the future.

It should be noted that just because promotional forecasting is selected it doesn't necessarily imply that a "promotional" forecast will result. In some instances no promotional variables will be found to be statistically significant. In these cases the forecast ends up equivalent to a standard time series forecasts. (If users wish to force in certain promotional variables into the model this can be managed through forecasting maintenance parameters.)

Retek's experience in promotional forecasting has led us to believe that there are a few requirements that are necessary to successfully forecast retail promotions:

- Baseline forecasts need to consider seasonality; otherwise "normal" seasonal demand will be attributed to promotional effects.
- Promotional Effects need to be able to be analyzed at higher levels in the retail product and location hierarchies. This produces cleaner signals and alleviates issues involved in forecasting new items and new Stores and issues involving data sparsity.

- Users need to be aware that the forecasting models cannot tell the difference between causal effects and correlated effects. What this means is that users should be wary of promotional effects attributed to an event that occurs at the same time every year. The system cannot distinguish between the promotional effect and the normal seasonality of the product. The same can be said for any two events that always occur at the same time (the combined effect will most likely be attributed to one or the other event).

Following is a description of the causal, or promotional forecasting, including the following topics:

- A description of the causal forecasting algorithm process
- The array interface between the Acumate environment and the AliAutoES binary
- Causal forecasting at the daily level
- Final considerations about causal forecasting

### **The causal forecasting algorithm**

For purposes of understanding the algorithm, a promotional variable is defined as a causal event that is only active for certain series at certain points in time. It is assumed that these events are entered into the system independently of the forecasting algorithm and that a vehicle exists for determining which promotional variable are relevant to a particular series.

The core of the causal forecasting algorithm uses a stepwise regression sub-routine. This routine takes a time series and a collection of promotional variables, and determines which variables are most relevant and what effect those relevant variables have on the series. Thus, the output from the algorithm is a selection of promotional variables and the effects of those variables on the series.

Causal variable types define how causal variables are treated in the causal model fitting process (which includes a call to the lower level regression engine) and the forecast generation process where the model is used to extend the forecast over the forecast horizon. See chapter 6 for information on each of the causal variable types:

- Automatic
- Force In The Model
- Disabled
- Override All
- Override Future
- Override Higher Level

### **Types of causal models**

Two different types of causal models are possible. The first type is an additive model in which each effect is considered to add a constant amount to the sales of the product. The second type of model is the multiplicative model in which the system determines a baseline value that is multiplied by each effect to get the final forecast value.

## Causal forecasting algorithm process

The causal forecasting algorithm itself lies in the AutoES binary code, and executes in the following manner.

1. The binary reads the history of the time series.
2. The binary reads the type of each promotional variable into the system.
3. The binary reads in all the promotional variables that apply to the series.
4. The binary creates the internal promotional variable to allow the modeling of trend.
5. Promotional variables, internal promotional variables, promotional variable types, and the series itself are passed to the stepwise regression routine with the historic data serving as the dependent variables. Stepwise regression is run for both the additive and multiplicative models [Note: for the multiplicative model the logarithm of the historic data is used].
6. If the regression finds no significant promotional variables for either the additive or the multiplicative models then the casual method is considered to have failed to fit. In this case, the standard time series methods are used to generate a forecast and we skip to step 15.
7. The fit region is calculated for both models (additive and multiplicative). The fit at time  $t$ ,  $\text{fit}(t)$ , is defined in terms of  $\beta_0$ , the intercept of the regression,  $\beta_i$ , the effect corresponding to promotional variable  $i$ , and  $p_i(t)$ , is the value of promo variable  $i$ , in time  $t$  as:  
$$\text{fit}(t) = \beta_0 + \sum \beta_i * p_i(t) \quad \text{for the additive model}$$
$$\text{fit}(t) = \beta_0 * \prod \beta_i^{p_i(t)} \quad \text{for the multiplicative model}$$
8. The RMSE is determined across the two fit regions and the winning model is the one that produces the least RMSE.
9. The Time Series is de-causalized in the fit region of the history, by removing the causal effects (that is subtracting the additive causal effects, respectively dividing by the multiplicative causal effects for the product/location/time positions where the corresponding promo variables are “on”)
10. A seasonal model is fitted to the de-causalized series. The seasonal model is the winner of a competition between Seasonal ES, Additive Winters and Multiplicative Winters. The RMSE is determined across the fit region on the de-causalized series and the winning model is the one that produces the least RMSE.
11. The winning seasonal model is then used to determine the seasonal forecast by applying the  $\text{fit}(t)$  function across the forecast horizon. This forecast is also exported as the baseline forecast (that is forecast without any causal influences).
12. The forecast is obtained by re-causalizing the seasonal forecast. This is done by adding back the additive causal effects, respectively multiplying by the multiplicative causal effects for the product/location/time positions where the corresponding promo variables are “on” in the forecast region.
13. The binary writes the winning promotional variables effects back to the database.
14. The selected model is recorded in the database.
15. The binary records the forecast and the baseline in the database.

### Confidence intervals constraining in Causal:

The confidence interval is capped using the following rule:

if  $\text{interval}(0) = \text{stdev}(\text{first error}) < 0.3 \cdot \text{forecast}(i)$ , then  $\text{interval}(i) = 0.3 \cdot \text{forecast}(i) \cdot \sqrt{(i+1)}$

if  $\text{interval}(0) > \text{forecast}(i)$ , then  $\text{interval}(i) = \text{forecast}(i) \cdot \sqrt{(i+1)}$

Otherwise,  $\text{interval}(i) = \text{interval}(0) \cdot \sqrt{(i+1)}$

$\text{cuminterval}(i) = \sqrt{\text{cuminterval}(i-1)^2 + \text{interval}(i)^2}$

Besides the interval constraining, in Causal.cpp the interval calculation was changed. Specifically, to the extension formula:

$\text{interval}(i)^2 = \text{mse} \cdot (i+1)$

### Causal forecasting array interface description

The promotional variables are stored in the database named promo. In the database named pmaint, the following arrays are stored:

- The promotional variables aggregated to the forecast level, along with promotional effects arrays. Both the additive and multiplicative effects are saved for promotional effectiveness assessment.
- The type arrays (arrays in which the type of each variable – see “Algorithm Description” - is stored for each product/location intersection at the forecast level).
- The list of variables to be considered in the stepwise regression.

The promotional variables (located in the promo database) are aggregated at the forecast level and saved in pmaint by the forecasting wrapper, fbatch.wrapautoes.

For causal forecasting the path to the database “pmaint” is passed as input to the AliAutoES binary. From pmaint the binary reads the promotion list and the promotional variables, and writes back the additive and multiplicative causal effects and intercept in the right arrays.

Forecast and baseline forecast are stored in separate databases.

### Causal forecasting at the daily level

The causal forecasting at the daily level is calculated by spreading the weekly causal forecast down to day. The spreading utilizes causal daily profiles thus obtaining a causal forecast at the day granularity.

The daily casual forecast process executes in the following manner.

1. Preprocess the day level promotional variables by multiplication with daily profiles. Aggregate the preprocessed continuous day level promotional variables to the week level.
2. Calculate the causal forecast at the weekly level. Set promotional effects if desired. Use the RDF causal engine to generate the forecast.
3. Calculate the multiplicative promotional effects at the item/store level for every promo variable. The effects can be either
  - Manually preset (See step 1.)

- Calculated. When calculating the causal forecast, the calculated causal effects are written back to the database. If the effects are calculated at higher level than item/store, the effects will be replicated down to item/store – reasonable assumption since the effects are multiplicative. If source level forecasting is used and causal method is used both at the source level and at the final level then the effects from the final level will be used.
- 4. Daily profiles are calculated, using the Curve module. Since we use as much history as possible and we average it over seven days we assume these profiles are de-causalized. The de-causalized daily profiles capture the day of week effect and should be quite stable.
- 5. Causal effects are applied to the daily profiles. We multiply the profiles by the causal effects. Then, we have to renormalize the profiles.

### Example:

For every item/store combination, calculate a normal week-to-day profile based on historic data (note that this profile is already computed for spreading the weekly forecasts to the day level). Suppose for a certain product, the profile is as follows:

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Week
10%	10%	10%	10%	20%	30%	10%	100%

Suppose that in the past, the promotion was held on Wednesday, Thursday, and Friday of week w6:

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
		P	P	P		

Then the continuous weekly indicator for this promotion in w6 should be set to 0.4, which is the sum of the weights of Wednesday, Thursday, and Friday

Now assume that the same promotion will be held in a future week, say w36, but only on Thursday:

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
			P			

Then the continuous weekly indicator for w36 should be set to 0.1, which is the weight of Thursday only.

The approach to use the continuous promotion indicators to generate an accurate causal forecast at the day level is as follows:

- Calculate the weekly multiplicative effect for the promotion using the standard causal forecasting system with continuous indicators.
- Calculate the forecast for w36 using the standard causal forecasting system with continuous indicators. Note that with the multiplicative model and continuous promotional variables the multiplicative factor for a promotional event is obtained by raising the multiplicative effect to the power of the promotional variable. Let's say this multiplicative factor for w32 was calculated to be 2 (the promotion doubles the regular sales).

- Update the week-to-day profile of w36 so that the weight of Thursday is doubled (the multiplicative factor is 2):

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Week
10%	10%	10%	<b>20%</b>	20%	30%	10%	<b>110%</b>

- Normalize the profile for w36:

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Week
9%	9%	9%	18%	18%	27%	9%	100%

Finally, spread the forecast of w36 using the normalized profile.

### Final considerations about causal forecasting

In Retek's approach to causal forecasting, the causal effects are obtained by fitting a stepwise linear regression model that determines which variables are most relevant and what effect those relevant variables have on the series. The data used to fit the regression is the fit history of each time series, so basically we fit a model per time series. A problem arises due to potential lack of significant data, that is, when a promotional variable is not represented in the history but is present in the forecast region. In that case, the effect for that variable would not be computed at all, thus affecting the accuracy of the forecast. There are a few solutions that make use of the effects from other similar time series. One solution would be to do source level causal forecasting and then spread down to the final level. This would be equivalent to using the effects at the source level for time series that have no causal variable instances in the history. However, this has a serious conceptual drawback: by aggregating the promotional variables at the source level, we would force the effects on the other time series in the same aggregation class that otherwise would not have the causal variables on at the same time. An alternate solution is whenever a causal effect cannot be computed because of lack of significant data an averaged effect from another time-series in the same aggregation class is going to be used instead – see Override Higher Level type.





# Glossary



**Note:** With a few exceptions, this glossary contains definitions of terms specific to Retek Demand Forecasting. For further definitions of terms and concepts relating to the RPAS user interface, see the Retek Predictive Application Server online help or User Guide.

## **additive seasonal method**

Also referred to as Additive Winters Model, this model is similar to the Multiplicative Winters model, but is used when zeros are present in the data. This model adjusts the un-seasonalized values by adding the seasonal index (for the forecast horizon).

## **alert**

A notice displayed to system users that a forecasted value is above or below user-defined limits (an exception).

## **Alert Manager window**

A window that displays the alerts assigned to you. This dialog provides a list of all identified instances in which a monitored measure's values fall outside a set of defined limits. You may pick an alert from this list and have RCS automatically build a workbook containing the measure values that triggered the alert.

## **AutoES Method or Automatic Exponential Smoothing Method**

Retek Demand Forecasting fits the sales data to a variety of exponential smoothing (time series) models of forecasting, and the best model is chosen for the final forecast. The candidate methods considered by AutoES are: Simple ES, Intermittent ES, Trend ES, Multiplicative Seasonal, Additive Seasonal and Seasonal ES. The final selection between the models is made according to a performance criterion (Bayesian Information Criterion) that involves a tradeoff between the model's fit over the historic data and its complexity.

## **Bayesian Method**

Useful for short lifecycle forecasting and for new products with little or no historic sales data. The Bayesian method requires a product's known sales plan (created externally to RDF) and considers a plan's shape (the selling profile or lifecycle) and scale (magnitude of sales based on Actuals). The initial forecast is equal to the sales plan but as sales information comes in, the model generates a forecast by merging the sales plan with the sales data. The forecast is adjusted so that the sales magnitude is a weighted average between the original plan's scale and the scale reflected by known history.

## **Causal Method**

Causal is a forecasting method used for promotional forecasting and can only be selected if Promote is implemented. (See Chapter 3 for more information on Promote.) Typically, the Causal method is used at the Final Levels (that is, item/week/week). Causal uses a Stepwise Regression sub-routine to determine the promotional variables that are relevant to the time series and their lift effect on the series. AutoES utilizes the time series data and the future promotional calendar to generate future baseline forecasts. By combining the future baseline forecast and each promotion's effect on sales (lift), a final promotional forecast is computed.

## **confidence interval**

The confidence percentage value used to calculate the value of the upper confidence limit. A different confidence level can be set for every forecast level appearing in the workbook

### **confidence limit**

The upper bound of a normal probability distribution that is centered about the forecast value. It is calculated based on the Default Confidence % parameter value entered in the Forecast Administration Workbook, or on the Confidence Level value entered in the Confidence Worksheet of the Forecast Approval Workbook (if such a value has been entered to override the default).

### **Croston's model of exponential smoothing**

See Intermittent Exponential Smoothing.

### **Curve**

An optional automated predictive solution that transforms organization-level assortment plans into base-level weekly sales forecasts.

### **exception**

A forecast value that is greater than or less than a user-defined limit.

### **exponential smoothing**

A form of a weighted moving average. It weights decline in data exponentially. Most recent data weighted more heavily. Requires smoothing constant ( $\alpha$ ). Ranges from 0 to 1. Subjectively chosen.

### **final forecast level**

A low level in a hierarchy from which a forecast is generated, and at which approvals and data exports can be performed. Often, data from forecasts at a low level is insufficient to generate reliable forecasts without first aggregating the data to a higher level and then spreading the data back to the low level.

### **forecast-driven planning**

Planning that keys off of forecasts fed directly into a planning system. Connection to Retek Demand Forecasting (RDF) is built directly into the business process supported by Retek Predictive Planning through an automatic approval of a forecast that is fed directly in the planning system. This allows you to accept all or part of Sales Value forecast. Once that decision is made, the balance of business measures are planned within Retek Predictive Planning.

### **Holt's model of exponential smoothing**

See Trend Exponential Smoothing

### **interactive forecasting**

A workbook in RDF used to simulate forecast by modifying parameters such as Forecast Method and History Start Date

### **IntermittentES or Intermittent Exponential Smoothing.**

Retek Demand Forecasting fits the data to the Croston's model of exponential smoothing. This method should be used when the input series contains a large number of zero data points (that is, intermittent demand data). The original time series is split into a Magnitude and Frequency series, then the Simple ES model is applied to determine level of both series. The ratio of the magnitude estimate over the frequency estimate is the forecast level reported for the original series.

**like item or like SKU**

An item that will be used as a model to forecast a new item introduction.

**lost sales**

Periods in sales data in which there was no inventory to meet consumer demand.

**measure**

Any item of data that can be represented on a grid in worksheets.

**measure description**

The description of the measure that can be viewed in a workbook. This description may contain relationships and calculations.

**measure function**

Internal functions that can be used to simplify building calculations for a measure.

**measure identifier**

The combination of role, version, metric, and units that uniquely specifies a single measure.

**metric**

A measure definition with the role, version, and units omitted.

**Multiplicative Seasonal**

(also referred to as Multiplicative Winters Model) This model extracts seasonal indices that are assumed to have multiplicative effects on the un-seasonalized series.

**Predict**

In Retek Demand Forecasting (RDF), Predict refers to RDF's statistical forecasting capabilities.

**Preprocessing**

In Retek Demand Forecasting (RDF), Preprocessing refers to a module that processes data before forecasts are generated to adjust for situations such as lost sales and unusually high demand.

**profile**

Spreading ratios that are used in the Curve process. Typical profiles can include store participation, size distribution, and time (phase-to-week) profiles, as well as other information. Profiles are generated using historical data and phase definitions, based on your system configuration.

**Profile Based**

Retek Demand Forecasting generates a forecast based on a seasonal profile that can be created in Curve or a legacy system. Profiles can also be copied from another profile and adjusted. Using historic data and the profile, the data is de-seasonalized and then fed to the Simple ES method. The Simple forecast is then re-seasonalized using the profiles.

**Profile Spread**

Used at the final level to utilize a profile (either generated externally or with Curve) to determine the spreading ratios from the Source level forecast down to the Final level.

### **Promote**

Promote is an optional add-on automated predictive solution that allows you to incorporate the effects of promotional and causal events, such as radio advertisements and holiday occurrences, into your time series forecasts. The promotional forecasting process uses both past sales data and promotional information to forecast future demand.

#### **promotion planning**

A workbook template and simulation process used within the context of promotional forecasting. Promotion planning involves specifying whether the event status for a particular promotional variable is active (on) or inactive (off) for a specific product/location/calendar combination. When past promotional events are represented as accurately as possible, the modeling routine can more precisely detect correlation between event occurrences and changes in sales values.

#### **promotional effectiveness**

A workbook template used in the context of promotional forecasting. This workbook allows you to analyze the effects of promotions on items at both the micro and the macro level. “What if” analysis can also be performed on the results of promotional forecasts, as you can modify future and past promotional inputs, the system-estimated effects of promotions, and the promotional forecasts themselves.

#### **promotional forecasting**

Promote’s forecasting technique (also referred to as Causal forecasting) uses promotional factors and events to predict future demand. Promotion events are events such as advertisements, holidays, competitor information, and other factors that affect the normal selling cycle for a business.

#### **promotion group**

A set of products or locations that are believed to exhibit similar effects during common causal events. Promotion groups should be established to maximize the number of time series for each group (so each promotional event can be evaluated from as many different observations as possible) while ensuring that each time series is affected by causal events to the same degree.

### **Seasonal ES Method**

A combination of several Seasonal methods. This method is generally used for known seasonal items or forecasting for long horizons. This method applies the Multiplicative Seasonal model unless zeros are present in the data, in which case the Additive Winters model of exponential smoothing is used. If less than 2 years of data is available, then a Seasonal Regression model is used. If there is too little data to create a seasonal forecast (in general, less than 52 weeks), then the system will select from the Simple ES, Trend ES and Intermittent ES methods.

### **Seasonal Regression**

Seasonal Regression cannot be selected as a forecasting method, but is only a candidate model used when the Seasonal ES method is selected. This model requires a minimum of 52 weeks of history to determine seasonality. Simple Linear Regression is used to estimate the future values of the series based on a past series. The independent variable is the series history one-year or one cycle length prior to the desired forecast period, and the dependent variable is the forecast. This model assumes that the future is a linear combination of itself one period before plus a scalar constant.

**Simple/Intermittent ES Method**

A combination of the Simple ES and Intermittent ES methods. This method applies the Simple ES model unless a large number of zero data points are present, in which case the Croston's model is applied.

**SimpleES or Simple Exponential Smoothing Method**

Retek Demand Forecasting uses a simple exponential smoothing model to generate forecasts. Simple ES ignores seasonality and trend features in the demand data and is the simplest model of the exponential smoothing family. This method can be used when less than 1 year of historic demand data is available.

**simple moving average**

See Average Method

**sister store**

A store that will be used as a model to forecast a new store.

**source level forecast**

The level at which the aggregate, more robust forecast is run.

**Time series**

Set of evenly spaced numerical data obtained by observing response variable at regular time periods. This data is used to forecast based only on past values. It assumes that factors influencing past and present will continue influence in future

**training window**

The number of weeks of historical sales data to use in generating a forecast.

**Trend Exponential Smoothing or TrendES**

(Also referred to as Holt's Model.) Retek Demand Forecasting fits the data to the Holt model of exponential smoothing. The Holt model is useful when data exhibits a definite trend. This method separates out base demand from trend, then provides forecast point estimates by combining an estimated trend and the smoothed level at the end of the series.

**wizard**

A set of screens that guide you through the process of creating a new workbook or performing other actions in an application, by asking you various questions and having you select values.

**workbook**

The framework used for displaying data and user functions. Workbooks are task-specific and may contain one or more worksheets. Users define the format of their workbooks. See also workbook template, worksheet.

**workbook template**

The framework for creating a workbook. You build each new workbook from an existing workbook template, such as Pre-Season Financial Plan or Forecasting Administration. Several workbook templates are supplied with the Retek Predictive Solutions, and are available for selection when you choose File+New to create a new workbook.

### **worksheet**

A multidimensional spreadsheet used to display workbook-specific information. Worksheet data can also be displayed in chart format.

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<sup>i</sup> Chatfield, C. and M.Yar, 1990, "Prediction intervals for the Holt-Winters forecasting procedure", International Journal of Forecasting, 6, 127-137

<sup>ii</sup> Chatfield, C. and M.Yar, 1990, "The Holt-Winters forecasting procedure", Applied Statistics, 27, 264-279

<sup>iii</sup> Chatfield, C. and M.Yar, 1990, "Holt-Winters forecasting: theory and practice", The Statistician, 37, 129-140