Functional Overview

The forecasting techniques contained in the Stock Management System are designed to provide a wide variety of statistical model "fitting" to derive projected demand patterns. These are all considered in the forecast analysis of each item (unless a specific *Family* has been chosen). This means that most patterns will be detected. It should be stressed that there will always be some items or some conditions that are affected by "extrinsic" variables and do not "fit" the past trend patterns. There also may be some items with such a negligible level of demand history that no pattern exists at all (sporadic demand). Since these conditions can exist, it is recommended that the user review statistical forecasts in a strategic and exception-oriented manner to focus on the questionable statistical forecasts.

There are six (6) *Forecasting Families*. They are:

- ***MOVING AVERAGE*** (3, 6, 12 month trend)
- ***TREND AVERAGE*** (3, 6, 12 month trend)
- ***SEASONAL*** (This year = Last year with 0, 3, 6, 12 month trend)
- ***SINGLE EXPONENTIAL SMOOTHING*** ("alpha" = .08 / .25 / .50)
- ***LINEAR REGRESSION***
- ***CUSTOM EXPONENTIAL SMOOTHING*** ("alpha" = User specified)

These forecasting techniques are reviewed on the following pages.

Moving Average Family

This Family of models is identified as the #10 family. Forecast techniques here summarize the past "N" months of history and derive an "average" value for each month based on those "N" months. This "average" value then becomes the monthly forecast for the next twelve (12) months. Thus a "flat" forecast is derived. The three models in this *Family* are:

For equations used:

fi	= Monthly forecast for coming twelve (12) months
Mi	= Monthly demand history for month "I" (I = 1 to 24)
$YR2$	= Past year (i.e, M24+M23+M22+M21+M20+M19+M18+M17+M16+M15+M14+M13)
i	= Indicator of specific month used

- [MODEL #11] 3 MONTH MOVING AVERAGE

$$fi = \left[\sum M24 + M23 + M22\right] \div 3$$

- [MODEL #12] 6 MONTH MOVING AVERAGE

$$fi = \left[\sum M24 + M23 + M22 + M21 + M20 + M19\right] \div 6$$

- [MODEL #13] 12 MONTH MOVING AVERAGE

$$fi = YR2 \div 3$$

This fi value is the same monthly value for all twelve (12) forecasted months.

Trend Average Family

This *Family* of models is identified as the #20 family. Techniques here summarize the past "N" months of history and derive an "average" monthly value based on those "N" months. This "average" value is compared to an annual "average" for the twelve (12) month period. Whether higher or lower, this percentage difference becomes a "trend" to be applied to the twelve (12) month "average". This trend-factored value then becomes the monthly forecast for the next twelve (12) months. Thus a "flat" forecast reflecting a trend is derived. Three models in this *Family* are:

For equations used:

fi	= Monthly forecast for coming twelve (12) months
Mi	= Monthly demand history for month "I" (I = 1 to 24)
i	= Indicator of specific month used
$YR2$	= Total sum of previous twelve (12) months
AVG	= Average value of previous twelve (12) months [M24+M23+M22+M21+M20+M19+M18+M17+M16+M15+M14+M13] / 12

- [MODEL #21] 3 MONTH TREND AVERAGE

$$factor = \left[(M24 + M23 + M22) - (AVG \times 3)\right] \div YR2$$

$$fi = (1 + factor) \times AVG$$

- [MODEL #22] 6 MONTH TREND AVERAGE

$$factor = \left[(M24 + M23 + M22 + M21 + M20 + M19) - (AVG \times 6)\right] \div YR2$$

$$fi = (1 + factor) \times AVG$$

- [MODEL #23] 12TH MONTH TREND AVERAGE

$$factor = \left[(M24) - (AVG)\right] \div YR2$$

$$fi = (1 + factor) \times AVG$$

Seasonal Family

This *Family* of models is identified as the #30 family. These techniques retain the seasonal characteristics (if any) that may recur during the coming year. First the past "N" months of history are summarized with an "average" derived for these "N" months. This "average" value is compared to an annual "average" for the twelve (12) month period. Whether higher or lower, the percentage difference becomes a "trend" to be applied to the most recent twelve (12) monthly history values. These trend factored values then becomes the monthly forecast for each of the next twelve (12) months. Thus a "seasonal" forecast reflecting a trend is derived. The four models in this *Family* are:

For equations used:

fi = Monthly forecast for coming twelve (12) months
Mi = Monthly demand history for month "I" (I = 1 to 24)
i = Indicator of specific month used
$YR2$ = Last year (M24+M23+M22+M21+M20+M19+M18+M17+M16+M15+M14+M13)
$YR1$ = Two years ago (M24+M23+M22+M21+M20+M19+M18+M17+M16+M15+M14+M13)

The first SEASONAL model has no trend applied. Monthly values from the previous year become the monthly forecasts for the coming year.

- [MODEL #31] THIS YEAR = LAST YEAR (NO TREND)

  $fi = Mi$ ....for i = 13 to 24

The next three SEASONAL models have trends applied to them. These trends are a comparison of YEAR 2 to the same period during YEAR 1 (3, 6 or 12 month periods).

- [MODEL #32] THIS YEAR = LAST YEAR (3 MO TREND)

  $$factor = \left[\sum M24 + M23 + M22\right] \div \left[\sum M12 + M11 + M10\right]$$

  $fi = factor \times Mi$ ....for i = 13 to 24

- [MODEL #33] THIS YEAR = LAST YEAR (6 MO TREND)

  $$factor = \left[\sum M24 + M23 + M22 + M21 + M20 + M19\right] \div \left[\sum M12 + M11 + M10 + M09 + M08 + M07\right]$$

  $fi = factor \times Mi$ ....for i = 13 to 24

- [MODEL #34] THIS YEAR = LAST YEAR (12 MO TREND)

  $factor = YR2 \div YR1$

  $fi = factor \times Mi$ ....for i = 13 to 24

Single Exponential Smoothing Family

This *Family* of forecasting models derives a moving (weighted) average forecast. The weighting of the most recent month history is "alpha" which is specified for three models ("alpha" = .08 / .25 / .50). These "alpha" factors correspond to a "one month" moving average, "quarterly" moving average and a "semi-annual" moving average respectively. The higher the "alpha", the more emphasis (i.e., weight) placed on the most recent monthly history.

For equations used:

fi = Monthly forecast for coming twelve (12) months
Mi = Monthly demand history for month "I" (I = 1 to 24)
i = Indicator of specific month used
j = Indicator of specific month used
Sj = Smoothing factor as of the j th month

- [MODEL #41] SMOOTHING (ALPHA = .08)

$Si = [(Mi) \times (.08)] + [(Sj - 1) \times (.92)]$ ......for (i = 13 to 24) & (j = 1 to 12)

$fi = Sj$ ......for (i = 1 to 12) & (j = 12)

- [MODEL #42] SMOOTHING (ALPHA = .25)

$Si = [(Mi) \times (.25)] + [(Sj - 1) \times (.75)]$ ......for (i = 13 to 24) & (j = 1 to 12)

$fi = Sj$ ......for (i = 1 to 12) & (j = 12)

- [MODEL #43] SMOOTHING (ALPHA = .50)

$Si = [(Mi) \times (.50)] + [(Sj - 1) \times (.50)]$ ......for (i = 13 to 24) & (j = 1 to 12)

$fi = Sj$ ......for (i = 1 to 12) & (j = 12)

Linear Regression Family

This *Family* of forecasting models contains a single model which determines a trend (or slope) for the most recent historical data. This method identifies two statistical factors - the "intercept" and the "rate" of trend change. These values are then applied to project the starting month value (i.e., the "intercept") and the next eleven monthly values (i.e., each month times a cumulative "rate" or trend). This is a standard Linear Regression model.

For equations used:

XX = (24+23+22+21+20+19+18+17+16+15+14+13+ 12+11+10+09+08+07+06+05+04+03+02+01) / 24

YY = (M24 + M23 + M22 + M21 + M20 + M19 + M18 + M17 + M16 + M15 + M14 + M13 + M12 + M11 + M10 + M09 + M08 + M07 + M06 + M05 + M04 + M03 + M02 + M01) / 24

Mi = Monthly demand history for month "I" (I = 1 to 24)

BTOP = BTOP + (I - XX) x (for I = 1 to 24)

BBOT = BBOT + (I - XX) x (I - XX) (for I = 1 to 24)

B = BTOP / BBOT

A = YY - (B x XX)

i = Indicator of specific month used

j = Indicator of specific month used

Fj = Monthly forecast for coming twelve (12) months

- [MODEL #51] LINEAR REGRESSION

$Fj = A + (B \times i)$ ......for (i = 25 to 35) & (j = 1 to 12)

Custom Exponential Smoothing Family

This *Family* of forecasting models derives a moving (weighted) average forecast. The weighting of the most recent month's history is "alpha" which is specified for one model ("alpha" = USER SPECIFIED ALPHA). This "alpha" factor corresponds to a "user defined" moving average. The higher the "alpha" - the more emphasis (i.e., weight) is placed on the most recent monthly history.

For equations used:

fi = Monthly forecast for coming twelve (12) months
Mi = Monthly demand history for month "I" (I = 1 to 24)
i = Indicator of specific month used
j = Indicator of specific month used
Sj = Smoothing factor as of the j th month
UF = User defined "alpha" factor

- [MODEL #61] SMOOTHING (ALPHA = .08)

$Si = [(Mi) \times (UF)] + [(Sj - 1) \times (1 - UF)]$ ......for (i = 13 to 24) & (j = 1 to 12)

$fi = Sj$ ......for (i = 1 to 12) & (j = 12)