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UPS-SCS weekly forecasting tool.

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UPS-SCS WEEKLY FORECASTING TOOL

By

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UPS-SCS WEEKLY FORECASTING TOOL

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A Thesis Approved on

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ABSTRACT

This thesis develops a forecasting model to predict six different volume measures on a weekly and daily basis for UPS-Supply Chain Solutions (UPS-SCS). The volume measures are used by UPS-SCS to develop business plans, operation plans, and staffing plans.

Four different forecasting methods are used to evaluate each volume metric. Moving average, single exponential smoothing, double exponential smoothing and Winter's additive model are the four forecasting methods that are used to generate forecasts. From the statistical evaluation measures and graphs of the data, decisions of which forecasting method for each volume measure can be made. The demand pattern of the data set will influence which of the forecasting methods should be selected.

UPS-SCS currently has a weekly forecasting method but it is not complex or dynamic. Two different case studies of actual data sets showed that the UPS-SCS Weekly Forecasting tool generated 10% more accurate forecasts compared to the current method that UPS-SCS uses. Based on the two different case studies the UPS-SCS Weekly Forecasting tool generated forecasts that were 90% effective or better and the current method that UPS-SCS uses generated forecasts that were 80% effective.

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I. INTRODUCTION

A. Company Background

United Parcel Service (UPS) is the world's largest leading package delivery company and a leading global provider of logistics and transportation services. UPS reported $51.5 billion in total revenue for 2008.

UPS Supply Chain Solutions (UPS-SCS) is a third party logistics provider that is part of the overall UPS business portfolio. In 2008 UPS-SCS reported $8.9 billion in annual revenue. UPS-SCS provides transportation, freight services, logistics, distribution and consulting. They operate 1,033 facilities in more than 120 countries with more than 38 million square feet of warehouse space. The facilities include: distribution centers, bonded warehouses, container freight stations, brokerage offices and forward stocking locations. UPS-SCS has seven strategic distribution campuses that comprise the majority of the distribution space that UPS-SCS occupies. The distribution campuses are located at these locations:

- Louisville, Kentucky
- Hebron, Kentucky
- Alliance, Texas
- Mira Loma, California
- Burlington, Ontario Canada
- Roermond, The Netherlands
- Singapore

UPS-SCS focuses on three main business verticals: high-tech, healthcare and goods, both retail and consumer.

B. Project Definition

With such a large variety of customers, UPS-SCS is required to adapt to a wide range of demand patterns to fulfill customer service agreements. To successfully adapt to the demand patterns, UPS-SCS needs to accurately predict, within an expectable error rate, each client's future demands. The forecasts are an integral part to the success of UPS-SCS. These forecasts are used to proactively and strategically plan the number of needed resources, develop financial business plans and operation plans.

The purpose of this project was to develop a forecasting tool that would analyze past data, evaluate multiple forecasting methods and allow the user to select which method they preferred to use. The tool will have the ability to generate weekly and daily forecasts for a user-defined length of time. The tool will also use Microsoft Excel Solver, an optimization software, to ensure the highest possible accuracy of the forecasts.

C. Project Objectives

The objectives of the project were to:

1) Develop multiple forecasting methods that will analyze different known demand patterns.
2) Develop an automated forecasting tool using Microsoft Excel and Visual Basic that will forecast six different volume channels weekly and daily.
3) Provide a user's manual for the automated tool that will explain how to operate the tool and troubleshooting ideas.

D. Problem Description

UPS-SCS is not currently using a complex forecasting method. There are two different methods that they use to generate forecasts. The first is using simple moving averages. This is used for accounts that do not have a full year's worth of data. For accounts that do have a full year's worth of data, double exponential smoothing is used. Before the double exponential smoothing is applied, the data is multiplied by a yearly seasonality factor. By doing this the assumption is being made that the exact volume distribution from the previous year is going to be followed. This assumption is almost too large to accept. Just looking at one of the three business verticals that UPS-SCS specializes in, retail and consumer goods, the demand pattern will adjust significantly per year depending on what new products the company has released, popular trends during a season, outside influences of the economy, or even changes in the business scope. Since the majority of the accounts have been partners with UPS-SCS for less than five years, it is difficult to fully understand true seasonality and define other outlining influences for each account.

II. LITERARTURE REVIEW

With such a wide variety of accounts and an ever-changing economic situation, forecasting is essential for UPS-SCS to be a global, third-party competitor. Forecasting is an important aid to efficient and effective planning. Inventory control, financial planning, scheduling resources, acquiring additional resources, determining resource needs and product demand are a few areas that forecasting can play a key role in assisting a company.

Nahmias (2001) suggests several key characteristics of forecasts that should be kept in mind during the decision-making process:

1. *Forecasts are usually wrong.* Forecasts are predictions and not exact information. Determining acceptable error rates for forecasts is dependent on what is being forecasted.
2. *A good forecast is more than a single number*. Since forecasts are generally wrong, a good forecast will include a measure for forecast error; this is usually in the form of a range.
3. *The longer the forecast horizon, the less accurate the forecast will be*. Due to variability in the demand pattern, the smaller the forecast horizon the more likely the forecast will adjust to influences on the demand pattern. Long forecast horizons cannot plan for the unknown changes in the demand pattern that may happen.
4. *Forecasts should not be used to the exclusion of known information*. If there is known information on what will happen in the near future, the information

should be used because it may not be accounted for in the historical data. An example of this would be a company that is going to release a new product that is more technologically advanced than any of its competitors in the upcoming month. This information would cause the decision-makers to adjust the forecasts.

The purpose of forecasting is to reduce the risk in decision making. The effectiveness of a forecast relies on the selection of the forecasting model. There are several key factors that influence the type of forecasting method that should be used. Montgomery and Johnson (1976) point out eight factors that influence the forecasting method selection.

1. *Form of forecast required*: The type of forecast will very depending on what data is required by the decision makers. Generally forecasts will take one of the following forms:

   a) An estimate of the desired variable.

   b) An estimate of the characteristics of the distribution of the data

   c) An estimate of the standard deviation of forecast error

   d) A range that has a probability of actually containing the future value.

2. *Forecast horizon, period and interval*: As discussed in the above section, forecasts generally get worse with the longer forecast horizon. Depending on the forecast horizon, certain models will react better to changes in the demand pattern. For example, the moving average method only forecasts for one period in the future and then uses that for every other forecast period. This

model would not be the best for any long forecast horizon because of variability in the data.

3. *Data availability:* How much historical data - if any at all- will help determine the forecasting method.
4. *Accuracy required:* A forecast is easy to generate, but predicting a future event with a low error rate is challenging. Selecting the correct forecasting method will help improve the accuracy of the forecast.
5. *Behavior of process being forecasted (demand pattern):* Specific forecasting methods are better for different demand patterns than others. Demand patterns will be discussed in detail in section II A. Forecasting Methods.
6. *Cost of development, installation, and operation:* Assuming that each dollar spent on developing forecasts will results in a smaller reduction of risk than the previous, it eventually will not be cost effective to invest any additional money in to developing a more complex forecasting method. This is because at some point, regardless of how complex the forecasting method is, the forecast error will not reduce below a certain point and there will not be a return on the investment.
7. *Ease of operation.* Forecasting methods that are not easy to update are rarely used. There should be very little, if any, training required to update a forecasting model. If the time required is too extensive, it may be more cost beneficial to adapt a different forecasting method.
8. *Management comprehension and cooperation:* For the forecasts to be used by a company, management needs to embrace the concept and have a basic

understanding of how the forecasts were created. Without acceptance from all parties involved in the decision making process the forecasting method used will not matter because the work that was put into creating the forecasts will be useless.

A. Forecasting Methods

Forecasting methods can be broadly defined into two categories: qualitative and quantitative. Qualitative methods are subjective and involve the opinion of subject matter experts. This method is generally used when there is not a lot of historical data. There are several different ways this data can be collected. A few common examples of qualitative methods are market surveys, sales expert opinions and Delphi methods.

Quantitative methods are clearly defined mathematical forecasting techniques. Historical data is analyzed to determine the underlying trend or pattern. Casual and time series are two different types of quantitative methods. Casual methods relate two or more independent variables and establish a relationship between the variables. Time series models use only the time-ordered historical data of the variable to predict future events.

a. Causal Forecasting Methods

Causal models depend on the specific application but generally have the form

$$d_t = f(x_{t-k}) + \varepsilon_t \qquad (1)$$

where d_t = demand in period t
f = forecast function
x_t = independent variable
ε_t = error at time t
k = time lag

The demand at time *t* is some function of the independent variable at t-k, $k \geq 1$. The function could be linear, exponential or any other mathematical relationship. For complex systems more independent variables can be added. From the general form of the model, a limitation of casual methods is obvious: the independent variable must be known at the time the forecast is made. If it is not known the method will not work. Some common examples of areas that casual methods are applied and the variables that could be used are listed in Table 1.

Table 1. Casual Forecasting Examples (Hillier and Lieberman, 2001)

Types of Forecasting	Possible Dependent Variable	Possible Independent Variables
Sales	Sales of a product	Amount of advertising
Spare parts	Demand for spare parts	Usage of equipment
Economic trends	Gross domestic product	Various economic factors

b. Time Series Forecasting Methods

Time series models are based on the assumption that historical data is able to be used to predict the future. There are several different time series models that are available for use. An important step in selecting a forecasting method is examining the underlying pattern of the data. Makridakis, Wheelwright and McGee (1983) suggest that there are four different demand patterns:

1. *Horizontal*: Exist when data points do not deviate far from the mean.
2. *Seasonal*: Exist when a series of data points are influenced by seasonal factors (quarters of a year, weeks of the month and day of the week).
3. *Cyclical*: Exist when the data are influenced by long-term economic fluctuations. The major difference between seasonal and cyclical is that

seasonal patterns are constant in length and recur on a regular, periodic basis while cyclical pattern durations vary in length and magnitude.

4. *Trend*: Exist when over a long-term the data increases or decreases consistently.

Choosing the best forecasting model for the demand pattern will decrease the error and ensure the best prediction of future data points. Four different time series models were evaluated for this forecasting tool. Each method was chosen to detect one of the demand patterns if they existed.

One forecasting method used for horizontal trends is the moving average method. The average demand for the *n* most current periods of time is calculated and used to forecast the demand for the next time period.

$$M_t = \frac{1}{n}\sum_{i=t-n}^{t-1} d_i = \frac{1}{n}(d_{t-1} + d_{t-2} + ... + d_{t-n}) \qquad (2)$$

where d_t= observed demand for period t
n = number of periods used in calculation

To initiate this method the number of periods *n* must be selected. Once this is determined the corresponding demand points are used to calculate the forecast. The number of *n* periods selected will affect how quickly the forecast will respond to changes in the demand pattern. The larger the *n* the slower the forecast will react to a quick change in the demand pattern; however, if the demand does stay constant, a large *n* will help decrease the variability experienced from one period to the other. The selection of the number of periods used in the forecast is a tradeoff between quicker response time to changes and ignoring random fluctuations between periods.

Another forecasting method used to calculate horizontal trends is single exponential smoothing. Unlike the moving average the forecast is calculated based on the new data point and the old forecast.

$$S_t = \alpha d_t + (1-\alpha)S_{t-1} \tag{3}$$

where d_t= observed demand for period t
α = weight variable
S_{t-1}= forecast for previous period

From the equation it can be seen that α is the weight given to the most recent demand point. A large α value will put the majority of the emphasis on the last demand point and reduce the impact of the last forecast made. On the other hand, a small value for α will weight the previous forecast more than the most current demand point. The value for α must be $0 \leq \alpha \leq 1$. Similar to the selection of *n* for the moving average, the selection for α is a tradeoff between responsiveness to demand changes versus stability over the long term.

For a forecasting method to quickly react to a trend demand pattern a different method must be used. Holt's double exponential smoothing uses two variables which helps the data adjust quickly to trend demand patterns. There are three equations used for Holt's double exponential smoothing.

$$S_t = \alpha d_t + (1-\alpha)(S_{t-1} - B_{t-1}) \tag{4}$$

$$B_t = \beta(S_t - S_{t-1}) + (1-\beta)B_{t-1} \tag{5}$$

$$F_{t+k} = S_t + kB_t \tag{6}$$

Equation 4 adjusts the S_t for the trend of the previous period, decreases the lag and brings it close to the current data point. Equation 5 updates the trend for future events and smoothes the data again to eliminate any random noise. Equation 6 takes the two previous calculated values and multiplies the B_t by k which is the number of periods in the future being forecasted.

Winter's additive model is an effective forecasting model for seasonal and cyclical demand patterns. Winter's additive model assumes that the seasonal influences are of the same magnitude year after year. The model can be defined as:

$$D_t = \mu + Gt + C_t + \varepsilon_t \tag{7}$$

where G = trend or slope component
t = period
C_t = seasonal component
ε_t = error

$$S_t = \alpha(D_t - C_{t-N}) + (1-\alpha)(S_{t-1} + G_{t-1}) \tag{8}$$
$$G_t = \beta(S_t - S_{t-1}) + (1-\beta)G_{t-1} \tag{9}$$
$$C_t = \gamma(D_t - S_t) + (1-\gamma)C_{t-N} \tag{10}$$

where S_t= current level of the deseasonalized series
α, β, γ= smoothing constants

$$F_{t,t+\tau} = S_t + \tau G_t + C_{t+\tau-N} \tag{11}$$

where $F_{t,t+\tau}$= forecast made in period t for future period t+τ

B. Evaluation Methods

To evaluate the effectiveness and accuracy of each forecasting method, four different statistical evaluation measures were used. All of the measures use the forecast error, which is the difference between the actual demand and the forecast.

$$e_t = d_t - F_t \tag{12}$$

A positive e_t means that the forecast was an underestimate while a negative e_t is an overestimate. Looking at just one or even a small isolated period of the error does not provide much useful information, so the summation of the forecast error over the duration of the data entered will be used to evaluate the forecast.

Bias is a statistical measure used to evaluate the forecasts. It is the sum of the total forecasting error for all periods. If the bias is close to zero, the forecasting method is possibly an effective representation of the data set. The reason a small bias does not guarantee a good forecasting method is there could be large positive and negative errors that offset each other. For this reason other statistical measures need to be considered.

$$Bias = \sum_{t=1}^{T} e_t \tag{13}$$

Mean absolute deviation (MAD) is defined as the sum of the absolute value of the total forecasting error divided by the total number of entries. This statistical measure is more comprehensible than the bias because it calculates the distribution of the error. If it is positive or negative, a small MAD means that the forecast should be close to demand pattern. A MAD with a large magnitude means that the forecasting method may need to be reevaluated and reconsidered.

$$MAD = \frac{1}{T} \sum_{t=1}^{T} |e_t| \tag{14}$$

The mean square deviation (MSD) is a similar statistical measure. It is defined as the sum of the squared forecast error divided by the total number of periods. By squaring the error term, a larger penalty is assessed to large forecast errors.

$$MSD = \frac{1}{T} \sum_{t=1}^{T} e_t^2 \tag{15}$$

The last statistical measure is the mean absolute percent error (MAPE). MAPE is a different statistical measure from the others because it is not affected by the magnitude of the forecasts or error size. In general, if the forecast is large the error will also be large; this will directly influence the other statistical measures, but not the MAPE.

MAPE is also interpreted as the average percent deviation the forecast is from the demand.

$$MAPE = \frac{1}{T}\left(\sum_{t=1}^{T} \frac{|e_t|}{d_t} x100\right) \quad (16)$$

III. PROCEDURE AND DEVELOPMENT

A. Data Collection

With clients located all over the world, UPS-SCS has a central data hub that is used to record all historical data for six different units of metrics. Inbound Advanced Shipping Notice (ASN), Inbound Lines, Inbound Eaches, Picking Orders, Picking Lines and Picking Eaches are the six different recorded volumes. The Dynamic Reporting System (DRS) houses all of the historical data and it can be accessed by all UPS-SCS employees. The forecasting tool is formatted to analyze all six volume measures each time it is updated.

Of the six different volume metrics there are four unique volume types: ASNs, lines, eaches and orders. A company will send an ASN for scheduled receipts of products that will arrive at UPS-SCS that day. A line is a count of all unique skus. Eaches are a count of all the pieces that are either received or shipped. An order is a request from a customer for specific product. An example of this nomenclature follows; a customer places an order for five parts of product A and ten parts of product B. For this example there was one order, two lines, and fifteen eaches and they would all be classified as Picking because it is an outbound order. If the products were received from a supplier, it would be classified as Inbound.

B. UPS-SCS Forecasting Tool Graphic Interfaces

The main focus during the development of the forecasting tool was to make the process as automated as possible. All of the interfaces were created using forms and the output is in the body of a Microsoft Excel sheet. Figure 1 is the main user interface. All areas of the forecasting tool can be accessed from this page. Every time the Microsoft Excel workbook is opened this form will open and allow the user to make their desired selection.

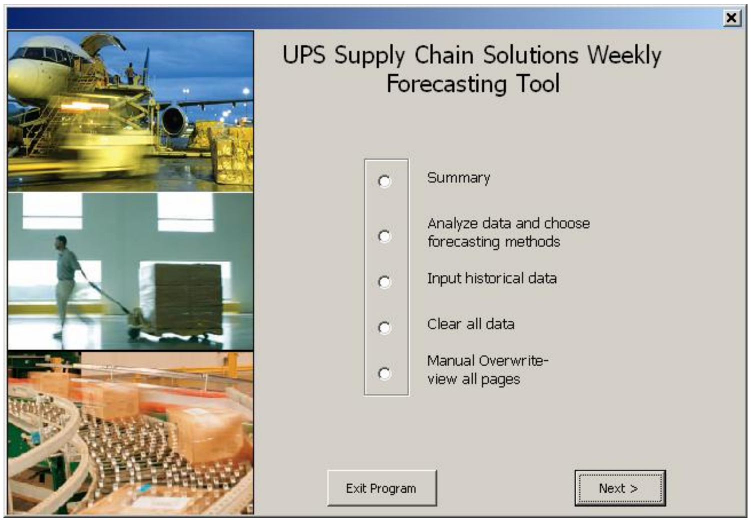


Figure 1. UPS-SCS Forecasting Tool Main Menu

To run the forecasting tool the user should choose the option "Analyze data and choose forecasting methods". Figure 2 shows the user interface that will appear once this selection has been made. The number of weeks to forecast, the number of weeks to use for the calculations in the moving average and the length of the period for the data set are required input fields. These are the only user inputs required for the program to run.

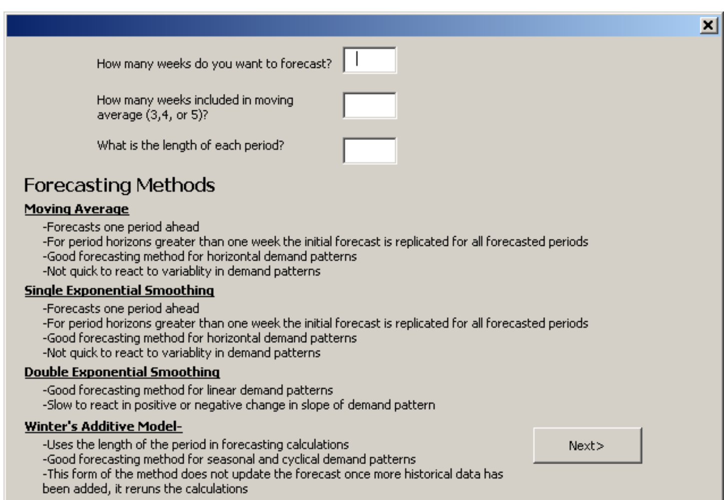


Figure 2. Analyze Data User Interface

Once the program has finished running the statistical evaluations methods for each volume metric will appear. Figure 3 shows the user interface for the Inbound ASNs for a sample data set. For each different forecasting method the statistical evaluation methods are shown. From this the user is able to make an educated decision on which of the four forecasting methods is the best fit.

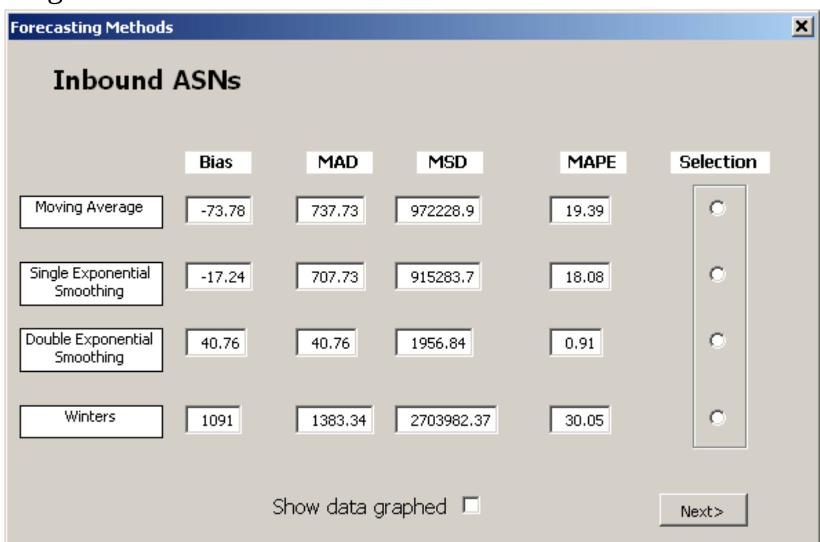


Figure 3. Inbound ASNs Statistical Evaluation Methods

Each volume metric has an option to graph the data set. The graph is to assist in making the decision by showing the four forecasting methods plotted against the actual data set. Figure 4 shows a sample graph for Inbound ASNs.

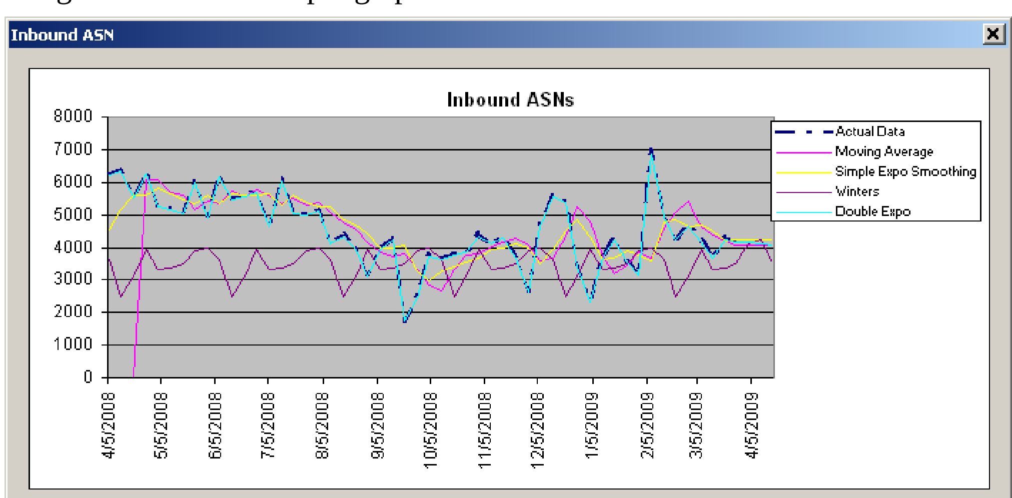


Figure 4. Inbound ASNs Graph

C. UPS-SCS Forecasting Tool Outputs and Results

Once all of the forecasting methods have been chosen the output will be generated for the planning horizon that was inputted in Figure 2. Two different outputs are available. The first is the weekly forecast for each volume metric for the planning horizon. Figure 5 shows an example of these results.

	Inbound ASNs	Inbound Lines	Inbound Eaches	Picking Orders	Picking Lines	Picking Eaches
4/4/2009	114	208	741	16,377	72,010	300,942
4/11/2009	114	224	111	19,888	72,010	371,955
4/18/2009	114	240	100	19,817	72,010	394,221
4/25/2009	115	256	113	20,257	72,010	417,192
5/2/2009	115	272	126	23,023	72,010	367,378
5/9/2009	115	288	111	21,923	72,010	510,580
5/16/2009	115	305	72	19,515	72,010	461,180

Figure 5. Results Output: Weekly Forecasts

The second available output is the average daily volume estimates based on the generated forecasts. The program will calculate the daily volume distribution for each volume metric from the historical data. By using the average forecasted weekly volume for each volume metric, the average daily volume is computed. Figure 6 shows a sample of the output results for the average daily volume calculations.

	Inbound ASNs	Inbound Lines	Inbound Eaches	Picking Orders	Picking Lines	Picking Eaches
Average Volume	115	256	196	20,114	72,010	403,350

Inbound Volume Weekly Distribution

	% Dist.	Inbound ASNs	% Dist.	Inbound Lines	% Dist.	Inbound Eaches
Sun	12%	14	13%	32	0%	0
Mon	18%	20	19%	49	21%	41
Tue	18%	21	19%	48	19%	37
Wed	16%	19	18%	45	18%	36
Thur	18%	21	17%	43	20%	39
Fri	18%	20	14%	37	21%	41
Sat	1%	1	1%	2	1%	2

Outbound Volume Weekly Distribution

	% Dist.	Picking Orders	% Dist.	Picking Lines	% Dist.	Picking Eaches
Sun	0%	79	0%	199	0%	1121
Mon	17%	3361	20%	14753	23%	91223
Tue	21%	4301	19%	13493	21%	84780
Wed	22%	4471	19%	13418	19%	76360
Thur	21%	4310	18%	13108	17%	69472
Fri	18%	3527	23%	16719	20%	79044
Sat	0%	65	0%	319	0%	1349

Figure 6. Results Output: Average Daily Volume Forecasts

D. Error Proofing

If any required input field is not entered, an error message will prompt for the missing value(s). During the process of going through the six different volume metrics and selecting the forecasting method to use, a selection must be made or an error message will appear.

IV. EXPERIMENTATION AND RESULTS

A. Model Validation

Minitab 15, a statistical analysis software package, was used to validate the UPS-SCS Forecasting Tool. The validation is to ensure that the forecasts the UPS-SCS Forecasting Tool generates are close to the forecast Minitab will generate. This validation is only to show that the UPS-SCS Forecasting Tool has the correct forecasting formulas programmed. It is not to show that Microsoft Excel solver selects the correct variables.

To compare the two and see the difference, the statistical evaluation methods were compared for the same data set for all six volume measures. The forecasting tool uses Microsoft Excel solver program to minimize the MSD of each forecast by changing the variables in each forecasting model. The variables that solver selected were used in Minitab 15. Table 2 shows the values for three different statistical evaluation measures and the percent difference for each different forecasting method.

Table 2. Model Comparison with Statistical Evaluation Measures

		Inbound ASN's			Inbound Lines			Inbound Eaches		
		Forecasting Tool	Minitab 15	Percent Difference	Forecasting Tool	Minitab 15	Percent Difference	Forecasting Tool	Minitab 15	Percent Difference
Moving Average	MAE	9.36E+01	9.36E+01	0%	1.54E+02	1.54E+02	0%	1.27E+05	127000	0%
	MSD	6.37E+04	6.37E+04	0%	2.24E+05	2.24E+05	0%	2.64E+10	2.64E+10	0%
	MAPE	64	64	0%	65	65	0%	34	34	1%
Single Exponential Smoothing	MAE	8.29E+01	8.32E+01	0%	1.48E+02	1.47E+02	1%	1.19E+05	118513.7	0%
	MSD	8.93E+04	8.93E+04	0%	2.65E+05	2.64E+05	0%	2.38E+10	2.37 E +10	0%
	MAPE	52	51	1%	62	62	0%	32	32	2%
Double Exponential Smoothing	MAE	8.24E+01	8.14E+01	1%	1.50E+02	1.52E+02	-1%	1.20E+05	118806.6	1%
	MSD	6.73E+04	6.70E+04	1%	6.94E+04	6.87E+04	1%	1.84E+10	1.83E+10	0%
	MAPE	54	54	0%	35	35	-1%	23	23	0%
Winter's Additive	MAE	9.59E+01	1.02E+02	-6%	1.67E+02	1.84E+02	-9%	1.26E+05	124828.8	1%
	MSD	3.11E+04	3.09E+04	1%	1.33E+05	1.26E+05	6%	2.86E+10	2.77E+10	3%
	MAPE	101	105	-4%	77	84	-8%	36	35	3%

		Picking Orders			Picking Lines			Picking Eaches		
		Forecasting Tool	Minitab 15	Percent Difference	Forecasting Tool	Minitab 15	Percent Difference	Forecasting Tool	Minitab 15	Percent Difference
Moving Average	MAE	3.55E+03	3.55 E +03	0%	8.81 E +03	8.81 E +03	0%	7.95E+04	7.95 E+04	0%
	MSD	2.49E+07	2.49 E +07	0%	1.30E+08	1.30 E +08	0%	1.03E+10	1.03 E+10	0%
	MAPE	18	18	0%	13	13	2%	21	21	0%
Single Exponential Smoothing	MAE	3.48E+03	3.46E+03	1%	7.81 E +03	7.84 E +03	0%	6.78E+04	6.79 E +04	-1%
	MSD	2.52E+07	2.52E+07	0%	1.01 E+08	1.02 E +08	1%	7.27E+09	7.26 E +9	0%
	MAPE	18	18	1%	12	12	0%	18	18	-1%
Double Exponential Smoothing	MAE	3.61E+03	3.61E+03	0%	9.72E+03	9.71E+03	0%	7.68E+04	77100	0%
	MSD	2.62E+07	2.62E+07	0%	1.63E+08	1.63E+08	0%	1.84E+10	1.83E+10	0%
	MAPE	18	18	-1%	13	13	-1%	18	18	-1%
Winter's Additive	MAE	4.58E+03	4.68E+03	-2%	1.16E+04	1.17E+04	-1%	8.56E+04	84400	1%
	MSD	3.74E+07	3.84E+07	-3%	2.54E+08	2.53E+08	1%	1.10E+10	1.14E+10	-4%
	MAPE	24	23	4%	16	16	0%	22	23	-7%

The results show that some of the forecasting models are closer for certain volume measures; for example, the percent difference for the double exponential smoothing forecasting model for Inbound Lines is much greater than the percent difference for the double exponential smoothing for the Picking Lines. Some of the variations can be attributed to the variables that are used to minimize the statistical evaluation measures, and round-off error. Table 3 shows the average percent deviation for the combined inbound and outbound volume measures for each forecasting method. It shows that the inbound models have a greater percent difference than the outbound models. Inbound volumes generally have a much greater risk of variability than the outbound numbers. Overall the forecasts that the forecasting tool and Minitab 15 generates are within an acceptable error rate.

Table 3. Combined Inbound and Outbound Percent Difference between Forecasting Tools

		Inbound	Outbound	Combined
Moving Average	MAE	0%	0%	0%
	MSD	0%	0%	0%
	MAPE	0%	1%	1%
Single Exponential Smoothing	MAE	0%	0%	0%
	MSD	0%	0%	0%
	MAPE	1%	0%	0%
Double Exponential Smoothing	MAE	0%	0%	0%
	MSD	1%	0%	0%
	MAPE	0%	-1%	-1%
Winter's Additive	MAE	-5%	-1%	-3%
	MSD	3%	-2%	1%
	MAPE	-3%	-1%	-2%

To demonstrate the UPS-SCS Forecasting Tool's accuracy, two case studies were performed; each highlighting a different demand pattern. All of the data sets are actual historical data obtained from DRS. A four week forecast will be made and compared to the actual data. A comparison will then be made with the current forecasting method that UPS-SCS uses.

B. Case Study 1

Case study 1 was focused on an account that became partners with UPS-SCS in December of 2007. The account sends return kits to the customers that want to upgrade their current product to a newer model. The kits consist of a cardboard box, directions on the steps to return the product and a return label. No inbound data is recorded for this account. Since each outbound order consists of one box, all of the outbound volume metrics (orders, lines and eaches) will be the same. The UPS-SCS Forecasting Tool can analyze up to fifty-two weeks of data at one time. The data set used was from 3/28/2008 to 2/28/2009. A four week forecast horizon was used. Three weeks were used for the moving average calculation. The length of the period for Winter's additive model was nine weeks. Using the UPS-SCS Forecasting Tool, Figure 7 shows the statistical evaluation measures.

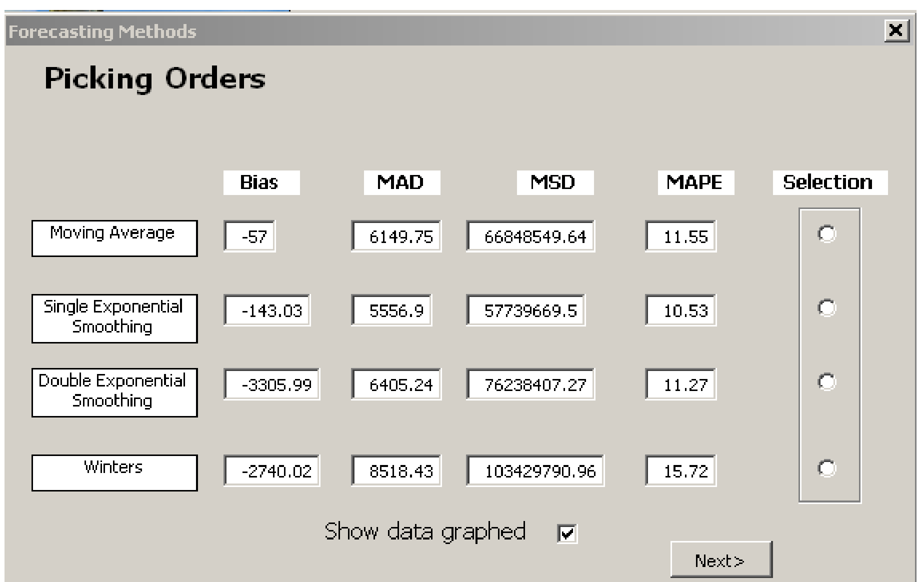


Figure 7. Statistical Evaluation Measures

Looking at the measures, single exponential smoothing seems to be the best method; however, when the graph is displayed it is obvious that the historical data seems to increase and the single exponential smoothing forecasts are at a lower level. The moving average forecasts are also at a lower level. The double exponential smoothing forecasts increase at a greater rate than any of the past data points. The Winter's additive forecast is forecasting what seems most likely to actually happen with the orders. As a result Winter's additive model was selected. Figure 8 shows the historical data and the forecasting methods graphed.

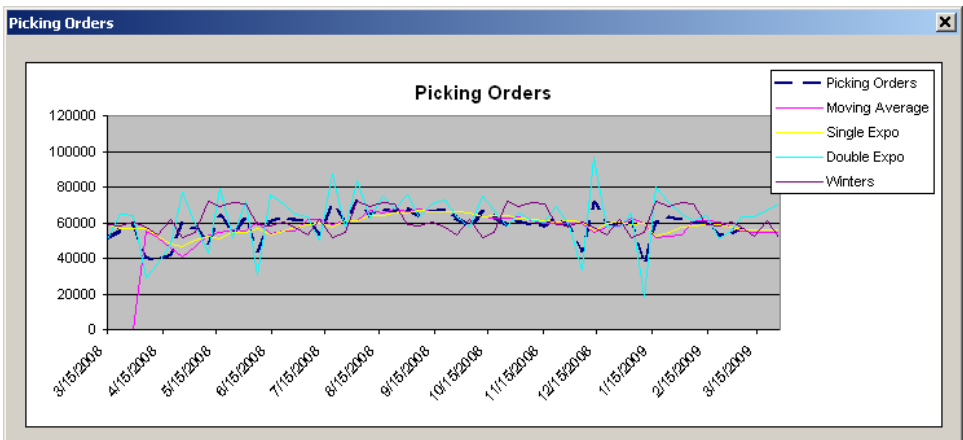


Figure 8. Historical Data Versus Forecasting Methods

With the forecasting methods selected, the UPS-SCS Forecasting Tool supplies multiple output results. The four week forecast that was generated is shown in Table 4. As seen below, there were not any inbound forecasts generated because the data is not recorded and all of the outbound forecasts are the same.

Table 4. Case Study 1: UPS-SCS Forecasting Tool Output- Weekly Forecasts

	Inbound ASNs	Inbound Lines	Inbound Eaches	Picking Orders	Picking Lines	Picking Eaches
3/7/2009	0	0	0	48,877	48,877	48,877
3/14/2009	0	0	0	60,877	60,877	60,877
3/21/2009	0	0	0	50,944	50,944	50,944
3/28/2009	0	0	0	53,715	53,715	53,715

The other supplied forecast output is the average daily forecast. This is obtained from the actual daily volume distribution and the average weekly forecast that is generated. Table 5 shows the average daily forecast.

Table 5. Case Study 1: UPS-SCS Forecasting Tool Output- Average Daily Forecasts

	Inbound ASNs	Inbound Lines	Inbound Eaches	Picking Orders	Picking Lines	Picking Eaches
Average Volume	0	0	0	53,603	53,603	53,603

Inbound Volume Weekly Distribution

	% Dist.	Inbound ASNs	% Dist.	Inbound Lines	% Dist.	Inbound Eaches
Sun	0%	0	0%	0	0%	0
Mon	0%	0	0%	0	0%	0
Tue	0%	0	0%	0	0%	0
Wed	0%	0	0%	0	0%	0
Thur	0%	0	0%	0	0%	0
Fri	0%	0	0%	0	0%	0
Sat	0%	0	0%	0	0%	0

Outbound Volume Weekly Distribution

	% Dist.	Picking Orders	% Dist.	Picking Lines	% Dist.	Picking Eaches
Sun	20%	10825	20%	10825	20%	10825
Mon	19%	10447	19%	10447	19%	10447
Tue	18%	9693	18%	9693	18%	9693
Wed	14%	7763	14%	7763	14%	7763
Thur	11%	5828	11%	5828	11%	5828
Fri	16%	8764	16%	8764	16%	8764
Sat	1%	282	1%	282	1%	282

Using the current forecasting tool that UPS-SCS uses, forecasts for the same forecast horizon were generated. Table 6 shows a summary of the different forecasting techniques and the actual data. The results show for the four week planning horizon the UPS-SCS Forecasting Tool was 92% effective. If the last data point is discounted from the calculation, the forecasts were 96% effective. The current method that is used by UPS-SCS was 79% effective for the planning horizon. The main reason the current tool is much worse than the forecasting tool is because the demand pattern is not linear and double exponential smoothing does not work well with demand patterns other than linear.

Table 6. Case Study 1: Forecast Comparisons

Weekending Dates	Actual Data	UPS-SCS Forecasting Tool	% Effective	Current Forecasting Method	% Effective
3/7/2009	46,128	48,877	94%	59,410	71%
3/14/2009	61,762	60,877	99%	52,212	85%
3/21/2009	52,427	50,944	97%	60,456	85%
3/28/2009	44,428	53,715	79%	55,432	75%
			92%		79%

C. Case Study 2

Case study 2 was more involved than the first example. All six volume metrics are recorded for this account. The second case study was focused on an account that has been partners with UPS-SCS since 2004. It is one of the oldest accounts that UPS-SCS has. The account manufactures computers and computer accessories such as printers and fax machines. Historical data was obtained from DRS. The previous fifty-two weeks, 3/8/2008 – 2/28/2009, were used in the calculations. A four week planning horizon was used. Since this account's ordering pattern has a lot of variability, a three week moving average was used. The period length was determined to be nine weeks. Once the forecasting tool finished running, the forecasting methods needed to be selected for each volume metric.

a. Inbound ASNs

The Inbound ASNs statistical evaluation measures are shown in Figure 9 below. Double exponential smoothing has the least amount of error out of all of the forecasting methods. The two smoothing variables for the double exponential smoothing, the slope and intercept, are 1 and 0 respectfully.

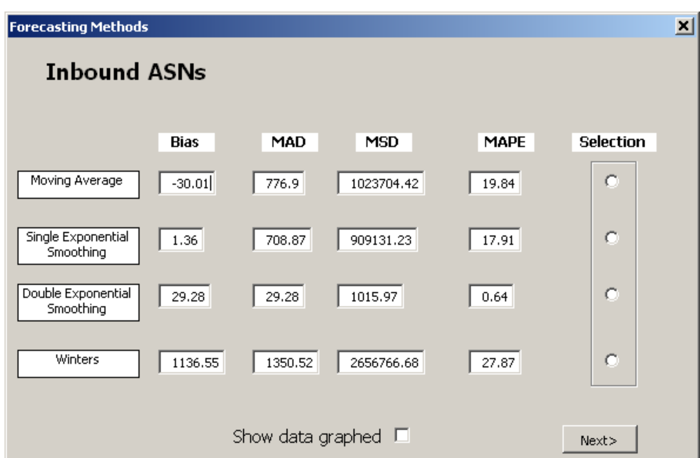


Figure 9. Case Study 2 Inbound ASNs: Statistical Evaluation Methods

Before making the decision the graphed data shown in Figure 10 was considered. It is noticeable that double exponential smoothing mimics the actual data well, especially compared to the other forecasting methods. Double exponential smoothing was selected.

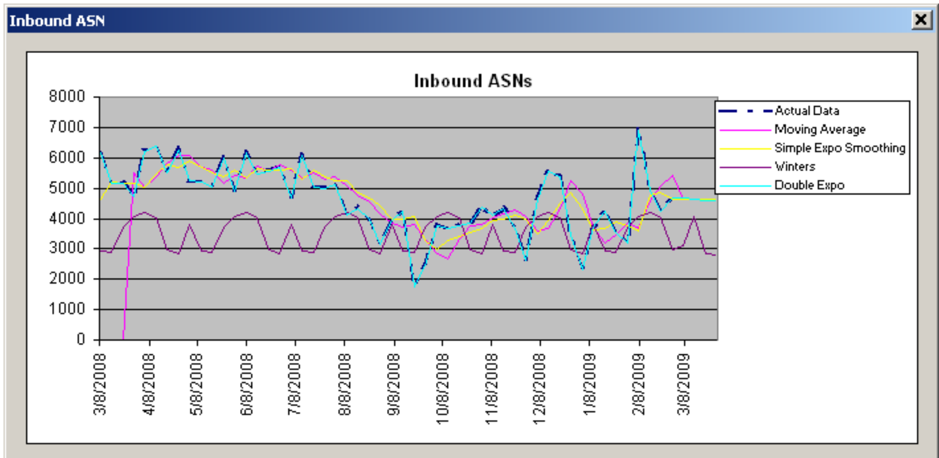
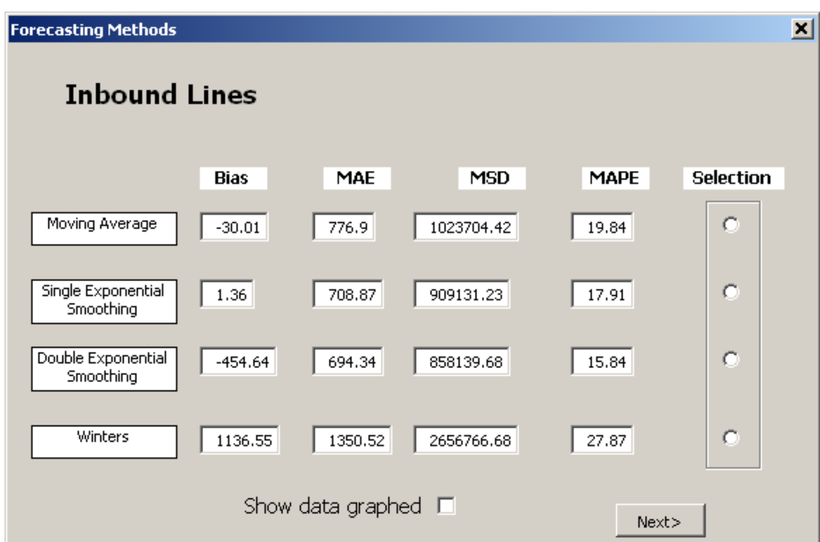


Figure 10. Inbound ASNs: Graphed Historical Data and Forecasting Methods

<u>b. Inbound Lines</u>

The statistical evaluation measures were evaluated to determine which forecasting method was best for inbound lines. Double exponential smoothing has all of the smallest statistical evaluation measures. The statistical evaluation measures are shown in Figure 11.



Forecasting Methods

Inbound Lines

	Bias	MAE	MSD	MAPE	Selection
Moving Average	-30.01	776.9	1023704.42	19.84	
Single Exponential Smoothing	1.36	708.87	909131.23	17.91	
Double Exponential Smoothing	-454.64	694.34	858139.68	15.84	
Winters	1136.55	1350.52	2656766.68	27.87	

Show data graphed

Next>

Figure 11. Inbound Lines: Statistical Evaluation Methods

Before making a decision on the forecasting method, the graph of the historical data and forecasting methods was reviewed. From the graph it can be seen that the forecasts double exponential smoothing generate increase at a greater rate then the historical data. Winter's additive model is better suiting for the data set because it is capturing some of the variability in the data set. As a result, Winter's additive model was selected. Figure 12 shows the graph of the historical data and the forecasting methods.

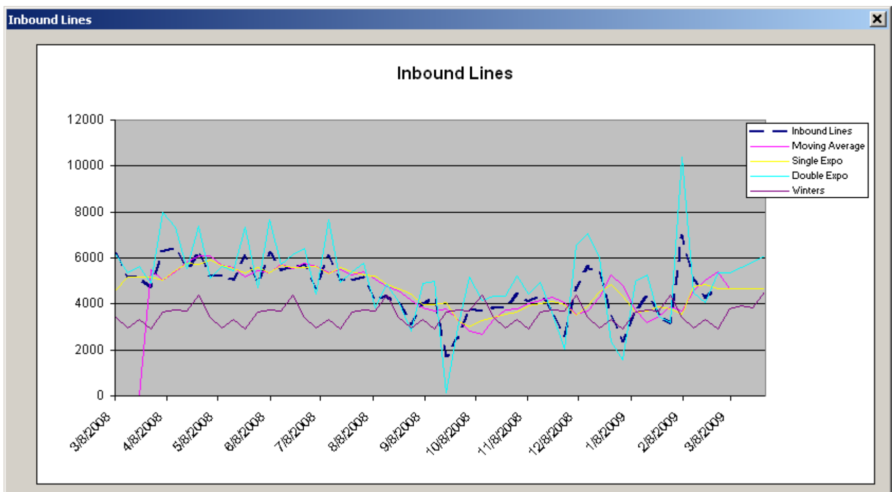


Figure 12. Inbound Lines: Graphed Historical Data and Forecasting Methods

<u>c. Inbound Eaches</u>

The statistical evaluation measures for the Inbound Eaches are shown in Figure 13. The measures show that double exponential smoothing has the least amount of error. The two smoothing variables for double exponential smoothing, the slope and intercept, are 1 and 0.9 respectfully.

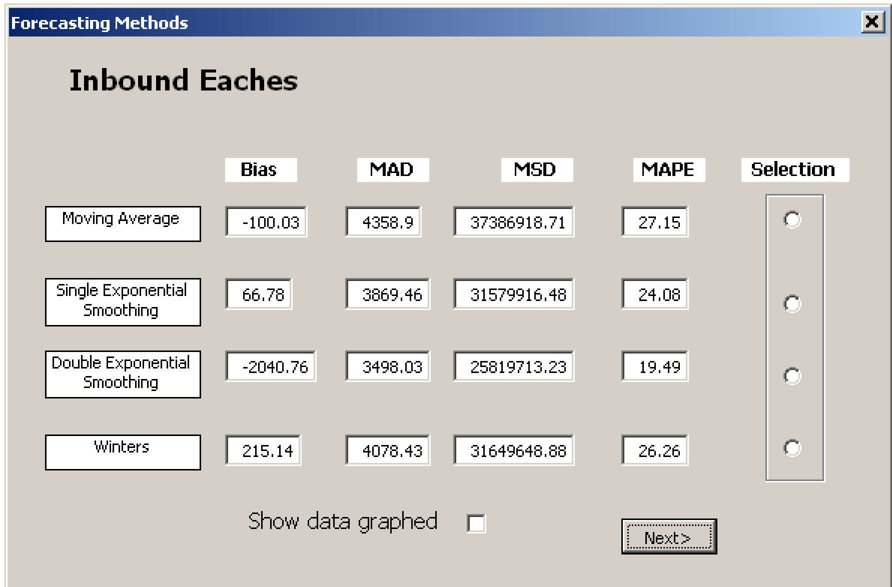


Figure 13. Inbound Eaches: Statistical Evaluation Methods

The graph of the historical data and forecasting methods shows the double exponential smoothing forecasts are relatively level and decrease over forecasting horizon. Winter's additive model on the other hand has some week-to-week variability which can be seen in the actual data. For this reason, Winter's additive model was selected over double exponential smoothing. The graph of this data is shown in Figure 14.

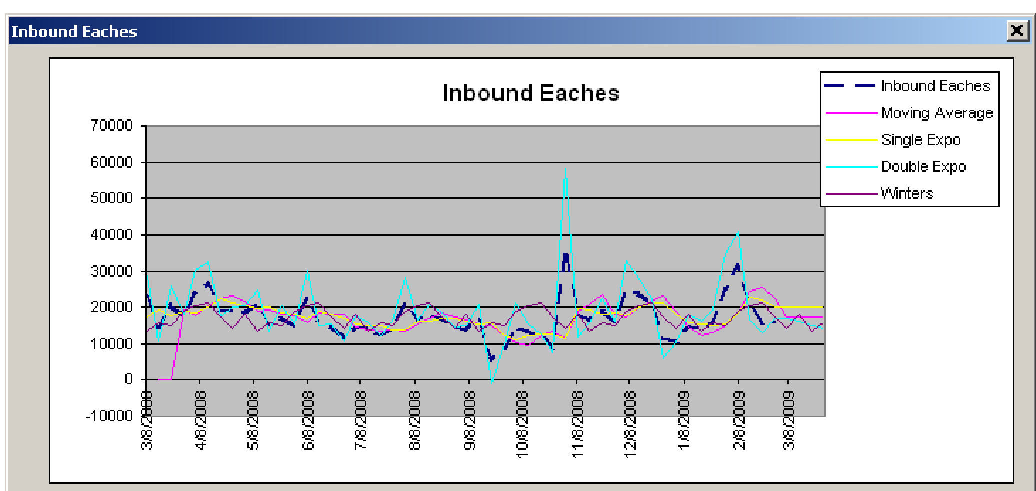
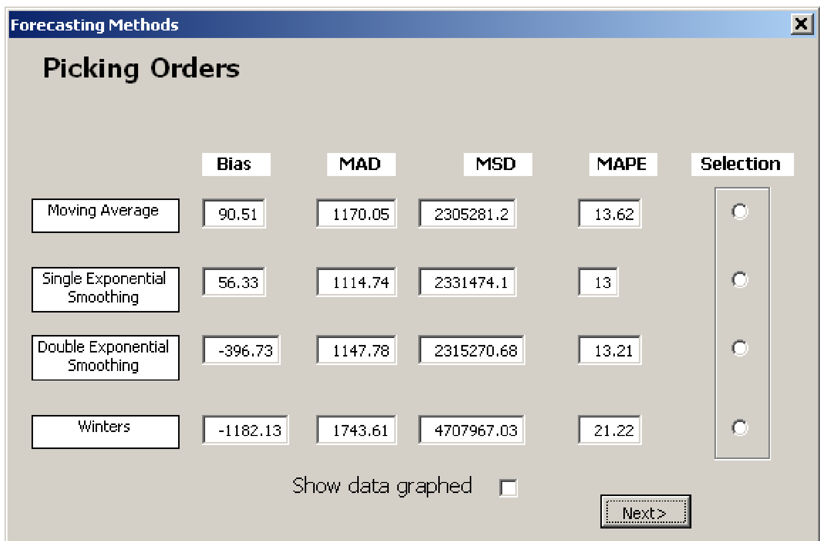


Figure 14. Inbound Eaches: Graphed Historical Data and Forecasting Methods

d. Picking Orders

Picking Orders are the first outbound volume metric. By examining the statistical evaluation measures, single exponential smoothing has the smallest error on all measures except for the MSD. Moving Average actually has the lowest MSD value. Considering nothing else but these measures single exponential smoothing is the best method. The variable for single exponential smoothing has a value of .576.


Forecasting Methods

Picking Orders

	Bias	MAD	MSD	MAPE	Selection
Moving Average	90.51	1170.05	2305281.2	13.62	
Single Exponential Smoothing	56.33	1114.74	2331474.1	13	
Double Exponential Smoothing	-396.73	1147.78	2315270.68	13.21	
Winters	-1182.13	1743.61	4707967.03	21.22	

Show data graphed

Next>

Figure 15. Picking Orders: Statistical Evaluation Methods

When the graphed historical data and forecasting methods are presented, it is understood that Picking Orders are on a three week decline. Single exponential smoothing forecasts are almost 2,000 more orders for the next four weeks then the last actual data point. This is because single exponential smoothing is slow to react to quick changes in the demand pattern. Over the long run it has stayed close to the demand pattern, but for this forecast it is not close enough. Of all the methods, Winter’s additive model displays the most accurate projection of the next four data points. Figure 16 shows the Picking Orders graph.

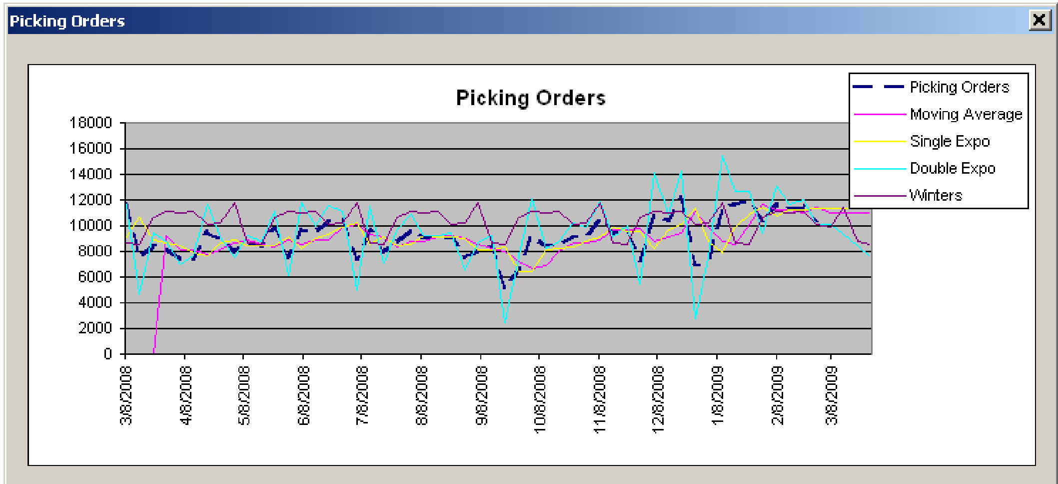


Figure 16. Picking Orders: Graphed Historical Data and Forecasting Methods

Since there was a recent reduction in picking orders a reactive model should be selected. Even though single exponential smoothing had the least amount of forecast error, it is not the best method to use. Winter's additive model was selected, since it is reacting to the variability in the demand pattern.

e. Picking Lines

By analyzing the statistical measures it can be seen that double exponential smoothing has the smallest MAD and MAPE values. Single exponential smoothing has the smallest bias and MSD value. Figure 17 shows the statistical evaluation measures for picking lines.

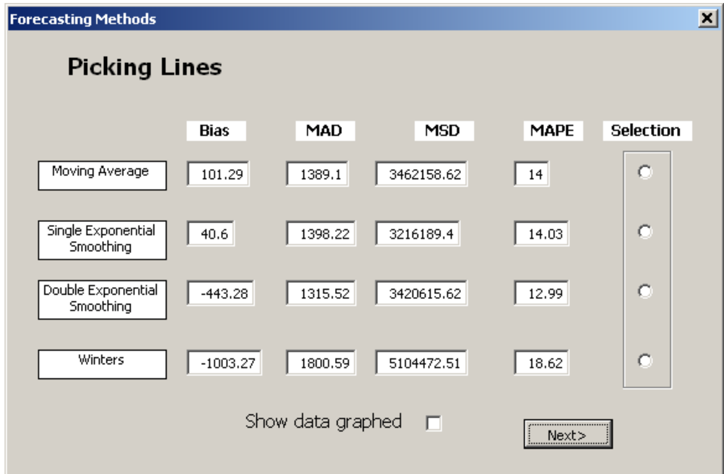


Figure 17. Picking Lines Statistical Evaluation Methods

The graph of the historical data and the forecasting methods show that the data has many quick changes in the demand pattern. The overall demand pattern could be described as horizontal with a lot of weekly variability. If a straight line was drawn from the beginning of the data set to the end, there would be close to fifty percent of the data points above and below the line. The forecasting tool uses Microsoft Excel solver to minimize the MSD value for the recommended best forecast. In this case, to minimize the MSD value, the single exponential smoothing constant is zero which makes the single exponential smoothing forecast a flat line. The graph shows that Winter's additive model is the best model to describe what is going to happen in the next four weeks. Figure 18 shows the graphed picking lines and forecasting models.

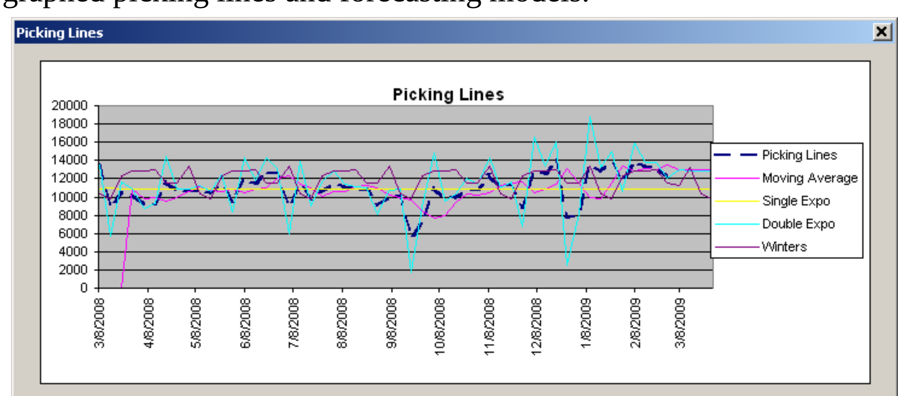


Figure 18. Picking Lines- Graphed Historical Data and Forecasting Methods

f. Picking Eaches

The statistical evaluation measures show that double exponential smoothing has the smallest MAPE value. Single exponential smoothing has the smallest MAD and MSD values. Figure 19 shows the statistical evaluation measures for the picking eaches.

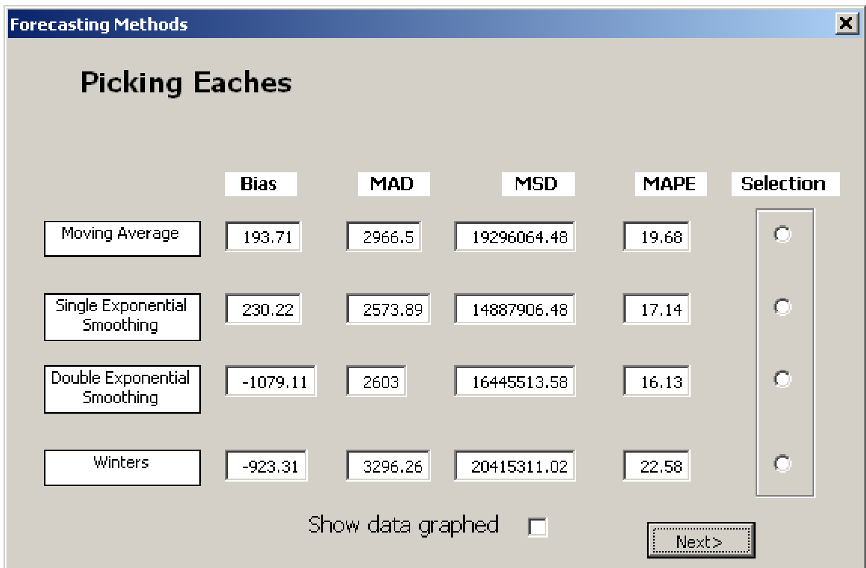


Figure 19. Picking Eaches: Statistical Evaluation Methods

According to the graphed data, both single and double exponential smoothing models seem to be accurately forecasting the upcoming data points. Analyzing the demand pattern, it shows that the previous four weeks have been extremely flat. Single exponential smoothing was selected because of this reason.

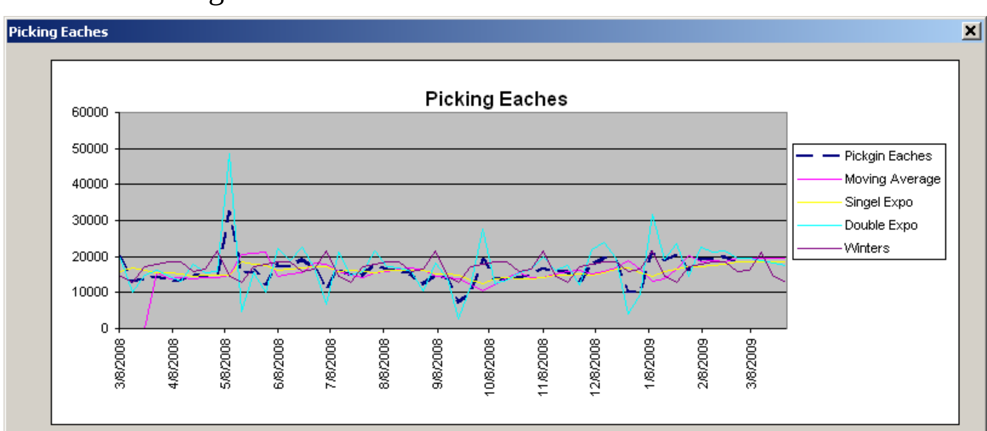


Figure 20. Picking Eaches: Graphed Historical Data and Forecasting Methods

g. Results

Once all of the forecasting methods are selected the output results are displayed. Table 7 shows the four week forecasts for each volume metrics and Table 8 shows the average daily forecasts for each volume metric.

Table 7. Case Study 2: UPS-SCS Forecasting Tool Output Weekly Forecasts

	Inbound ASNs	Inbound Lines	Inbound Eaches	Picking Orders	Picking Lines	Picking Eaches
3/7/2009	4,658	3,798	17,059	9,907	12,941	18,402
3/14/2009	4,628	3,904	16,099	11,499	12,911	18,402
3/21/2009	4,599	3,834	15,139	8,791	12,882	18,402
3/28/2009	4,570	4,542	14,179	8,582	12,853	18,402

Table 8. Case Study 2: UPS-SCS Forecasting Tool Output Average Daily Forecasts

	Inbound ASNs	Inbound Lines	Inbound Eaches	Picking Orders	Picking Lines	Picking Eaches
Average Volume	4,614	4,019	15,619	9,695	12,897	18,402

Inbound Volume Weekly Distribution

	% Dist.	Inbound ASNs	% Dist.	Inbound Lines	% Dist.	Inbound Eaches
Sun	0%	0	0%	0	0%	0
Mon	20%	924	20%	802	21%	3332
Tue	20%	934	20%	814	20%	3166
Wed	21%	956	21%	833	21%	3288
Thur	20%	905	20%	790	18%	2796
Fri	18%	842	18%	734	18%	2742
Sat	1%	54	1%	46	2%	294

Outbound Volume Weekly Distribution

	% Dist.	Picking Orders	% Dist.	Picking Lines	% Dist.	Picking Eaches
Sun	0%	21	0%	28	0%	32
Mon	22%	2103	22%	2777	21%	3898
Tue	22%	2161	22%	2872	22%	4005
Wed	20%	1965	20%	2624	21%	3792
Thur	19%	1806	19%	2412	19%	3456
Fri	16%	1585	16%	2115	17%	3137
Sat	1%	54	1%	68	0%	82

h. Model Comparison and Actual Data Comparison

A comparison was made between the actual data and the forecasts that the UPS-SCS Forecasting Tool generated. On average the overall inbound percent effective was 91% and the outbound forecasts were 91% effective. Table 9 shows the percent effective for each volume metric.

Table 9. Actual Data Compared to UPS-SCS Forecasting Tool

	Inbound ASNs			Inbound Lines			Inbound Eaches		
	Acutal Data	Forecasts	% Effective	Acutal Data	Forecasts	% Effective	Acutal Data	Forecasts	% Effective
3/7/2009	4,203	4,658	89%	4,203	3,798	90%	20,606	17,059	83%
3/14/2009	3,699	4,628	75%	3,699	3,904	106%	15,838	16,099	98%
3/21/2009	4,302	4,599	93%	4,302	3,834	89%	17,445	15,139	87%
3/28/2009	4,187	4,570	91%	4,187	4,542	92%	14,790	14,179	96%
			87%			**94%**			**91%**

	Picking Orders			Picking Lines			Picking Eaches		
	Acutal Data	Forecasts	% Effective	Acutal Data	Forecasts	% Effective	Acutal Data	Forecasts	% Effective
3/7/2009	10,356	9,907	96%	12,378	12,941	95%	19,696	18,402	93%
3/14/2009	9,860	11,499	83%	12,023	12,911	93%	17,071	18,402	92%
3/21/2009	9,162	8,791	96%	11,537	12,882	88%	16,071	18,402	85%
3/28/2009	10,290	8,582	83%	12,508	12,853	97%	19,707	18,402	93%
			90%			**93%**			**91%**

To compare the UPS-SCS Forecasting Tool's ability to forecast daily volume, week ending 3/07/2009 was considered. The daily forecasts were generated by calculating the average volume distribution for each volume metric for the individual day of the week and using the forecasts made for week ending 3/07/2009. On average the inbound metrics were 81% accurate and the outbound metrics were 84% accurate. There are several reasons why the daily forecasts were so much worse then the weekly forecasts. One of the main reasons is that the daily distributions were based on the overall daily distribution averages. There could have been a recent change on which day of the week the most inbound receipts came to UPS-SCS or a change on which day of the week the most orders were shipped. Another factor playing a role in the daily forecasts being lower then the weekly forecasts is that forecasts generally get worse for smaller time intervals. This is because there is more variability present which causes greater error. Table 10 shows the forecast and actual data for each volume metric.

Table 10. Week Ending 3/7/2009 Average Daily Forecast and Actual Data

	Inbound ASNs			Inbound Lines			Inbound Eaches		
	Acutal Data	Forecasts	% Effective	Acutal Data	Forecasts	% Effective	Acutal Data	Forecasts	% Effective
Sun	0	0		0	0		0	0	
Mon	997	933	94%	997	926	93%	6,374	3,640	57%
Tue	787	942	80%	787	941	80%	4,976	3,458	70%
Wed	839	965	85%	839	963	85%	3,981	3,591	90%
Thur	872	913	95%	872	913	95%	3,502	3,412	97%
Fri	708	885	75%	708	882	75%	1,773	2,900	36%
Sat	0	0		0	0		0	0	
			86%			**86%**			**70%**

	Picking Orders			Picking Lines			Pickjng Eaches		
	Acutal Data	Forecasts	% Effective	Acutal Data	Forecasts	% Effective	Acutal Data	Forecasts	% Effective
Sun	42	21	51%	53	28	52%	53	34	65%
Mon	2,513	2,149	86%	2,913	2,787	96%	4,188	4,160	99%
Tue	2,081	2,208	94%	2,535	2,882	86%	5,466	4,275	78%
Wed	1,887	2,008	94%	2,264	2,633	84%	3,317	4,047	78%
Thur	1,793	1,846	97%	2,214	2,420	91%	3,305	3,689	88%
Fri	2,040	1,619	79%	2,399	2,122	88%	3,367	3,348	99%
Sat	0	0		0	0		0	0	
			83%			**83%**			**85%**

Using the same data set and the current forecasting tool that UPS-SCS uses, forecasts were generated for the same planning horizon (3/7/2009-3/28/2009). On average the inbound forecasts were 79% accurate and the outbound forecasts were 85% accurate. Table 11 below shows the actual data and the forecasts that were generated by UPS-SCS.

Table 11. Actual Data Compared to UPS-SCS Current Forecasting Tool

	Inbound ASNs			Inbound Lines			Inbound Eaches		
	Acutal Data	Forecasts	% Effective	Acutal Data	Forecasts	% Effective	Acutal Data	Forecasts	% Effective
3/7/2009	4,203	5,254	75%	4,203	5,048	80%	20,606	22,177	92%
3/14/2009	3,699	3,156	85%	3,699	2,950	80%	15,838	11,755	126%
3/21/2009	4,302	2,916	68%	4,302	2,917	68%	17,445	16,329	94%
3/28/2009	4,187	2,596	62%	4,187	2,984	71%	14,790	7,898	53%
			73%			**75%**			**91%**

	Picking Orders			Picking Lines			Picking Eaches		
	Acutal Data	Forecasts	% Effective	Acutal Data	Forecasts	% Effective	Acutal Data	Forecasts	% Effective
3/7/2009	10,356	11,685	87%	12,378	14,893	80%	19,696	19,611	100%
3/14/2009	9,860	7,133	72%	12,023	9,549	79%	17,071	15,202	89%
3/21/2009	9,162	7,508	82%	11,537	9,175	80%	16,071	15,012	93%
3/28/2009	10,290	11,581	113%	12,508	9,097	73%	19,707	14,609	74%
			89%			**78%**			**89%**

The comparison of the two forecasting methods shows that the new UPS-SCS Forecasting Tool is a more effective forecasting tool than the current one used. Instead of only having one option, the user is able to select the best fitting forecasting method; this will help decrease the forecasting error.

V. CONCLUSIONS

Developing a complex forecasting tool that evaluated multiple forecasting methods was the main objective. The UPS-SCS Forecasting Tool does just that; it evaluates four different forecasting methods. It also supplies the user with statistical evaluation measures, a graph of the historical data and the generated forecast to aid in decision making. In comparison to the current tool that UPS-SCS uses, it is much more dynamic and adaptive to all demand patterns. Another objective was to make the tool as automated and user friendly as possible. To operate the tool there are only three required user inputs. From there the forecast method selections are the only other requirements of the user.

The two case studies showed that the UPS-SCS Forecasting Tool is on average more than 90% accurate and the current method that UPS-SCS uses is on average 80% effective. Originally the goal was to develop a tool that generated at least 95% effective forecasts; this tool is still effective and applicable for use at UPS-SCS even though the generated forecasts are not 95% effective. Exploring forecasting methods other than the current four, may increase the percent effective of the forecasts.

VI. RECOMMENDATIONS

The purpose of this forecasting tool was to generate weekly forecasts that would assist UPS-SCS in operation planning. In addition to weekly forecasts, UPS-SCS also generate monthly forecasts to determine staffing levels for upcoming months. By altering the Visual Basic code for the UPS-SCS Forecasting Tool monthly forecasts could be generated instead of weekly. Since aggregated forecasts are generally more accurate the accuracy of the UPS-SCS Forecasting Tool should also improve. If UPS-SCS thought that the forecasting methodology that they currently use was superior to Winter's additive model, then their model could replace Winter's additive model or be added and have five methods evaluating the historical data.

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APPENDIX I

UPS-SCS Weekly Forecasting Tool User Manual

I. SETUP

The user manual was built using Microsoft Excel 2003. The tool is applicable with all other versions but the steps for setup maybe slightly different.

- To get started, open the UPS-SCS Forecasting Tool file.
- Next, click on the **Tools** menu, select **Macros** and then **Security**. Adjust security level to either Medium or Low to enable macros.

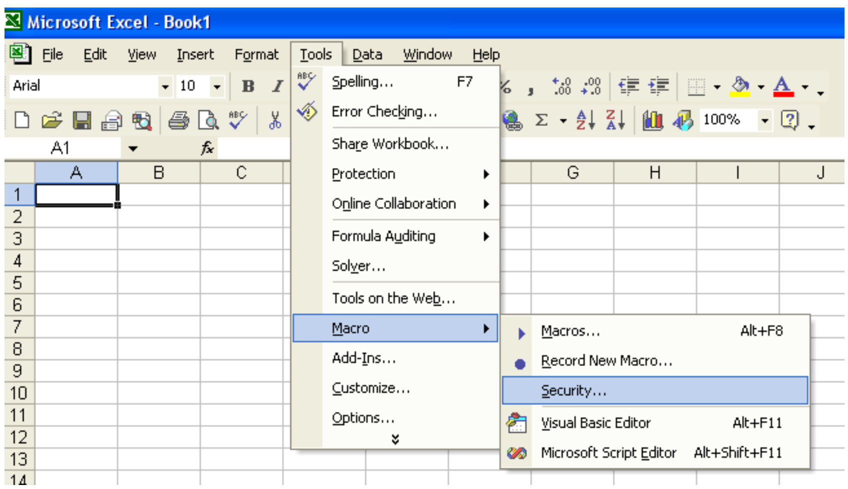

Figure 1. Adjusting Macros Settings

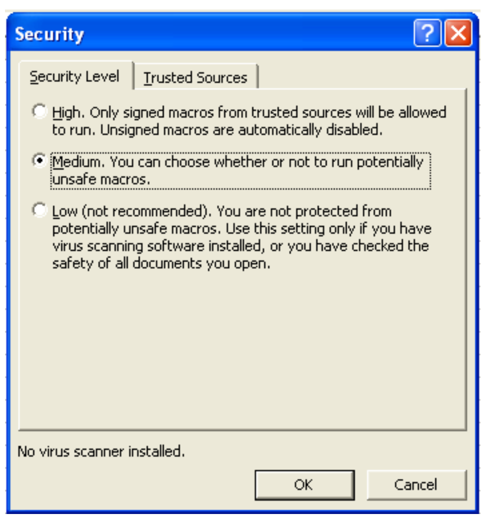

Figure 2. Security Level Selection Window

- Next, install solver by accessing the **Tools** menu, select **Add-Ins** and select **Solver Add-In.**

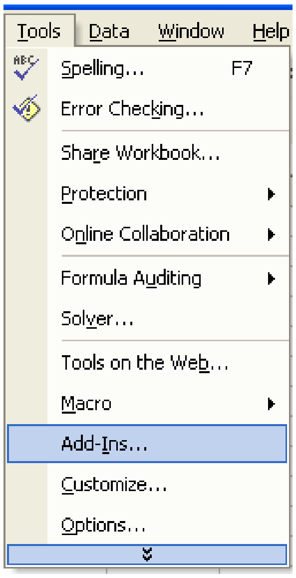

Figure 3. Tools Menu

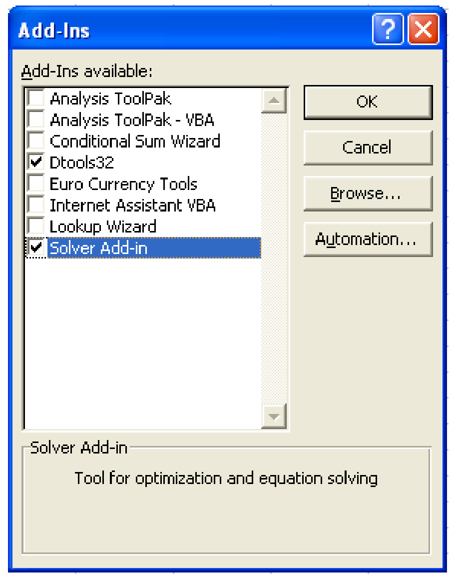

Figure 4. Add-Ins Menu

- The next step is to again access the **Tools** menu and select **Solver**. Then just close out of the solver window that is prompted. This initiates solver so that it will work to lower errors in the forecast. This step must be performed every time the UPS-SCS Forecasting Tool is opened.

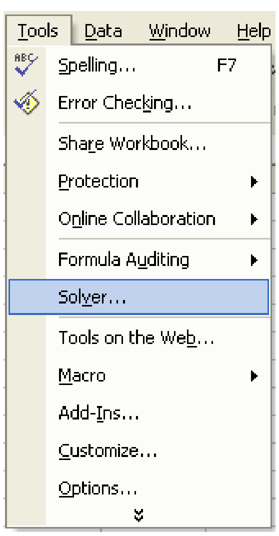

Figure 5. Tools Menu

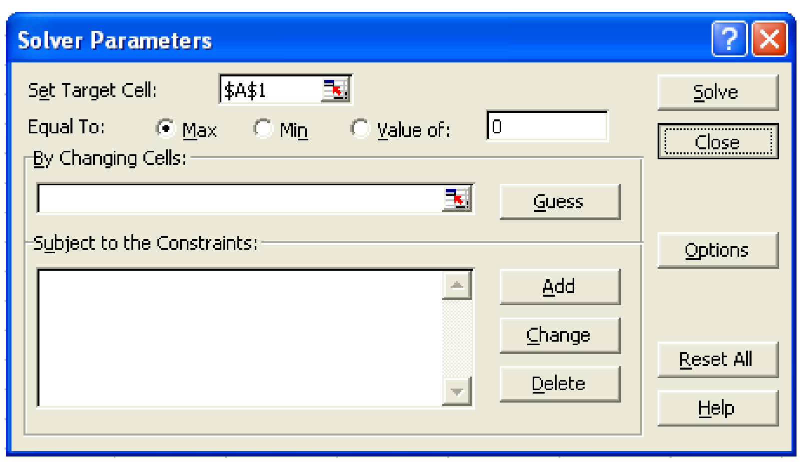

Figure 6. Solver Window

- Set up is now complete.

II. DATA INPUT

- If the main menu is not shown, which is displayed automatically every time the tool is opened, select the Home Page tab.
- Next click the Launch Forecasting Tool button located in the center of the page.

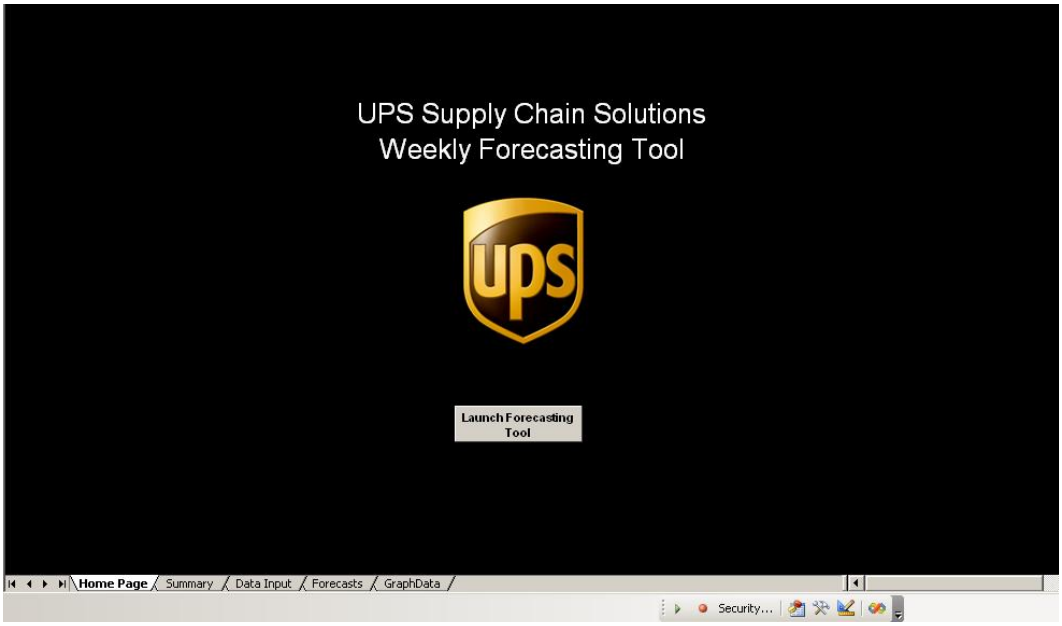

Figure 7. Home Page

- The main menu allows the user to access all of the functionality of the tool. Although for entering in historical data it in not necessary to make the selection from the main menu the Data Input tab can also be selected.

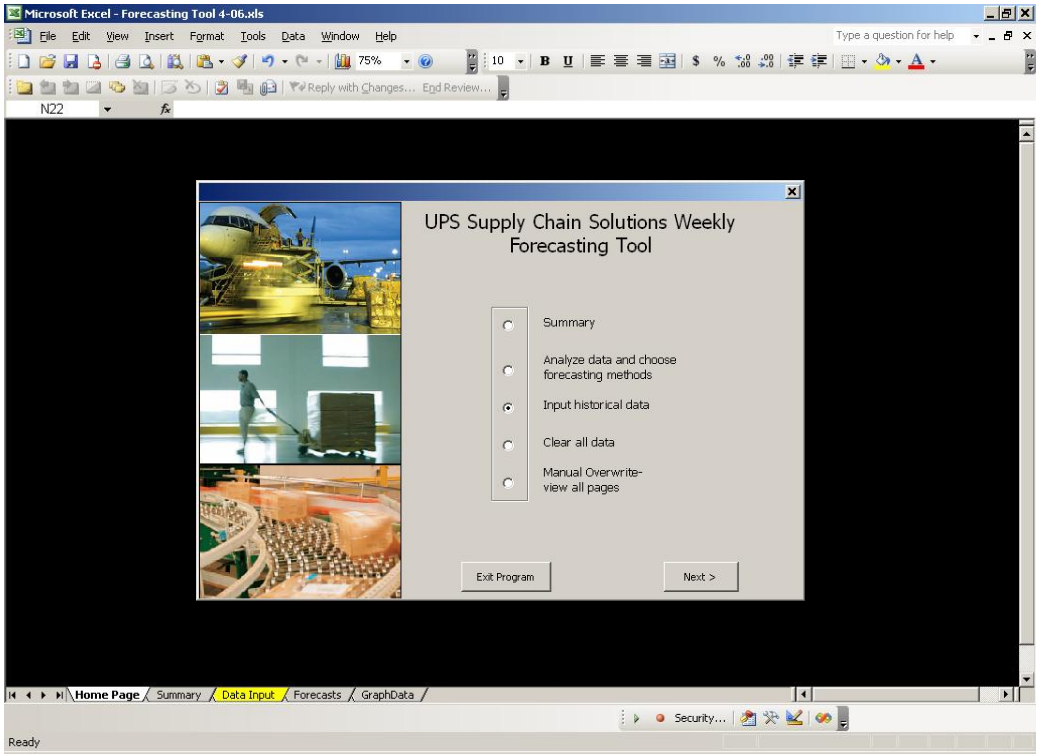

Figure 8. Two different alternatives to access Data Input tab

- The historical data can be obtained from the Dynamic Reporting System (DRS). Once the data is obtained, paste it into the correct fields on the Data Input tab.

Account	Date	Inbound ASNs	Inbound Lines	Inbound Eaches	Picking Ordes	Picking Lines	Picking Ecahes

Figure 9. Data Input required fields

III. ANALYSZING DATA AND GENERATING FORECASTS

- Access the main menu again by clicking on the Home Page tab.
- Choose Analyze data and choose forecasting methods

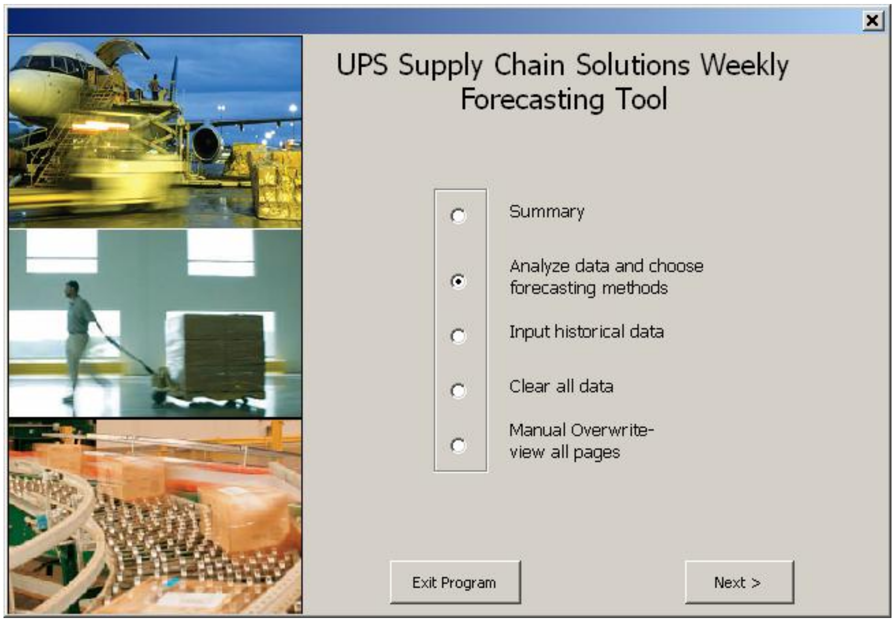

Figure 10. Analyze data and choose forecasting methods selection

- There are three required data inputs. The first is the defining how many weeks to forecast. The second required input is how many weeks to include in the moving average calculations. The last input is the length of the each period for the data set. The period length is used to calculate the Winter's Additive model.
- Once these fields are entered press Next.

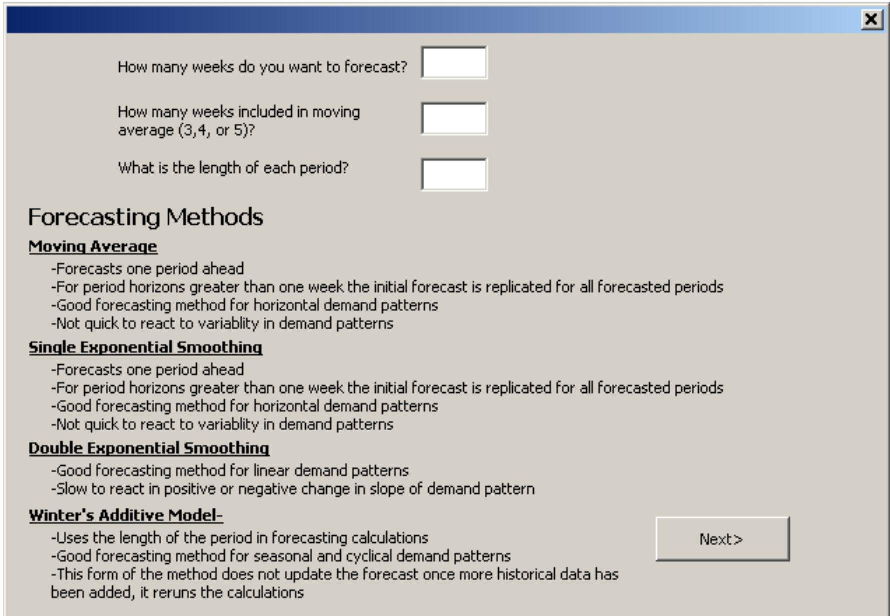

Figure 11. Analyze data and choose forecasting method required inputs

- The tool will now run for approximately two minutes, depending on the computing power. During the run time the program is using the Solver program to minimize the MSD for all of the single exponential smoothing and double models.

IV. EVALUATION AND SELECTION OF FORECASTS

- Once the program has finished running the Inbound ASNs statistical measures will appear.

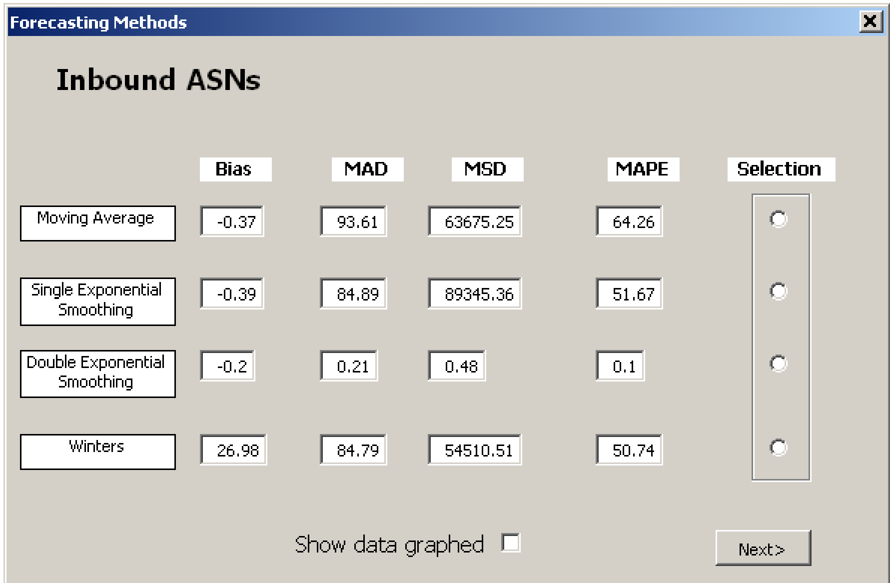

Figure 12. Inbound ASNs Statistical Evaluation Measures

- At the bottom of the form there is an option to show the graphed data. By selecting this, a graph of all the historical data and each forecasting method will be displayed.

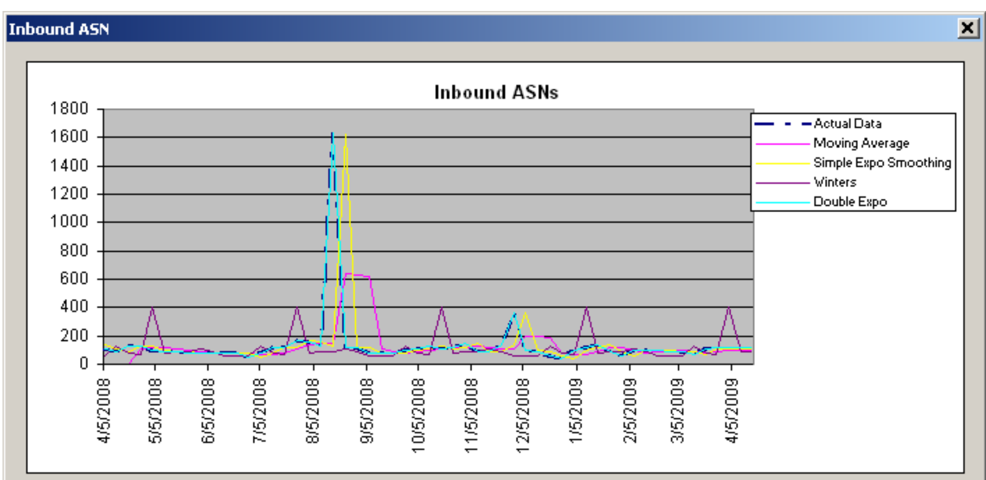

Figure 13. Graph of Historical Data and Forecasting Methods

- After evaluating the methods a selection must be made.

- This process is repeated for all six volume metrics.

V. SUMMARY AND RESULTS

- After the forecasting method is selected for Picking Eaches the Summary tab will be displayed. The forecasts for the planning horizon that was defined on the Analyze data and choose forecasting method form will be displayed.

Table 1. Generated weekly forecasts for planning horizon

	Inbound ASNs	Inbound Lines	Inbound Eaches	Picking Orders	Picking Lines	Picking Eaches
4/4/2009	114	208	741	16,377	72,010	300,942
4/11/2009	114	224	111	19,888	72,010	371,955
4/18/2009	114	240	100	19,817	72,010	394,221
4/25/2009	115	256	113	20,257	72,010	417,192
5/2/2009	115	272	126	23,023	72,010	367,378
5/9/2009	115	288	111	21,923	72,010	510,580
5/16/2009	115	305	72	19,515	72,010	461,180

- The UPS-SCS Forecasting Tool also calculates the daily average distribution by each individual volume metric. The average daily volume for each metric is also displayed on the Summary tab.

Table 2. Average Daily Forecasts

	Inbound ASNs	Inbound Lines	Inbound Eaches	Picking Orders	Picking Lines	Picking Eaches
Average Volume	115	256	196	20,114	72,010	403,350

Inbound Volume Weekly Distribution

	% Dist.	Inbound ASNs	% Dist.	Inbound Lines	% Dist.	Inbound Eaches
Sun	12%	14	13%	32	0%	0
Mon	18%	20	19%	49	21%	41
Tue	18%	21	19%	48	19%	37
Wed	16%	19	18%	45	18%	36
Thur	18%	21	17%	43	20%	39
Fri	18%	20	14%	37	21%	41
Sat	1%	1	1%	2	1%	2

Outbound Volume Weekly Distribution

	% Dist.	Picking Orders	% Dist.	Picking Lines	% Dist.	Picking Eaches
Sun	0%	79	0%	199	0%	1121
Mon	17%	3361	20%	14753	23%	91223
Tue	21%	4301	19%	13493	21%	84780
Wed	22%	4471	19%	13418	19%	76360
Thur	21%	4310	18%	13108	17%	69472
Fri	18%	3527	23%	16719	20%	79044
Sat	0%	65	0%	319	0%	1349

VI. CLEARING DATA AND RESETTING FORMULAS

- To clear all of the historical data and reset all of the formulas click on the Home Page tab.
- Next click on the Launch Forecasting Tool button.
- Choose the Clear Data selection.
- A message box will be displayed asking if you are sure you want to clear all data and reset all formulas.
- Click Yes to clear all the data and reset formulas.

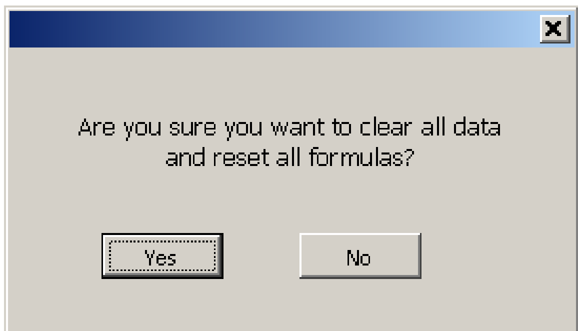

Figure 14. Clear Data Message Box

VII. VIEW ALL DATA SHEETS IN THE WORKBOOK

- There are five data sheets in the workbook:
  - Home Page
  - Summary
  - Data Input
  - Forecasts
  - Graph Data
- At any time all of the sheets can be viewed by selecting the Manual Overwrite- view all pages selection on the main menu.

APENDIX II

UPS-SCS FORECASTING TOOL VISUAL BASIC CODE

I. MAIN CODE

```
Dim totEntries As Double
Dim acctID As String
Dim totFacs, totAccts, totFIDS As Double
Dim startDate() As Double
Dim sheet As Double

Private Sub CommandButton1_Click()
Dim movvalue, periodvalue As Double

movvalue = movavg
If movvalue = 3 Then
   Sheets("Forecasts").Range("S1") = movvalue
   Sheets("Forecasts").Range("AX1") = movvalue
   Sheets("Forecasts").Range("CC1") = movvalue
   Sheets("Forecasts").Range("DH1") = movvalue
   Sheets("Forecasts").Range("EM1") = movvalue
   Sheets("Forecasts").Range("FR1") = movvalue
ElseIf movvalue = 4 Then
   Sheets("Forecasts").Range("S1") = movvalue
   Sheets("Forecasts").Range("AX1") = movvalue
   Sheets("Forecasts").Range("CC1") = movvalue
   Sheets("Forecasts").Range("DH1") = movvalue
   Sheets("Forecasts").Range("EM1") = movvalue
   Sheets("Forecasts").Range("FR1") = movvalue
ElseIf movvalue = 5 Then
   Sheets("Forecasts").Range("S1") = movvalue
   Sheets("Forecasts").Range("AX1") = movvalue
   Sheets("Forecasts").Range("CC1") = movvalue
   Sheets("Forecasts").Range("DH1") = movvalue
   Sheets("Forecasts").Range("EM1") = movvalue
   Sheets("Forecasts").Range("FR1") = movvalue
Else
MsgBox ("Please enter the number of weeks to use for moving average forecast")

End If

periodvalue = periodlength

   If periodvalue = 0 Then
      MsgBox ("Please enter the period length")
```

```
   ElseIf periodvalue > 52 Then
      MsgBox ("Length of period must be less then 52 weeks")
   Else
      Sheets("Forecasts").Range("AI2") = periodvalue
      Sheets("Forecasts").Range("BN2") = periodvalue
      Sheets("Forecasts").Range("CS2") = periodvalue
      Sheets("Forecasts").Range("DX2") = periodvalue
      Sheets("Forecasts").Range("FC2") = periodvalue
      Sheets("Forecasts").Range("GH2") = periodvalue

   End If


Application.Calculation = xlCalculationManual
Application.ScreenUpdating = False
Application.StatusBar = "Executing Code"

"""""""""""""Clear Old Data Set""""""""""""""

Sheets("Forecasts").Select

Dim ClCom As String

'Calculate total number of entries
Do While IsEmpty(Sheets("Forecasts").Range("J" & 2 + totEntries).Value) = 0
   totEntries = totEntries + 1
Loop
totEntries = totEntries + 2

If totEntries = 1 Then
totEntries = 2
Else
totEntries = totEntries

End If

'Clear Data on Forecasts Page
ClCom = "B3:" & "J" & totEntries
Range(ClCom).Select
Selection.ClearContents

'Clear grouped volume metrics
Range("N9:O60").Select
Selection.ClearContents

Range("AS9:AT60").Select
```

```
Selection.ClearContents

Range("BX9:BY60").Select
Selection.ClearContents

Range("DC9:DD60").Select
Selection.ClearContents

Range("EH9:EI60").Select
Selection.ClearContents

Range("FM9:FN60").Select
Selection.ClearContents

'Clear Forecast durations
Range("N61:N112").Select
Selection.ClearContents

Range("AS61:AS112").Select
Selection.ClearContents

Range("BX61:BX112").Select
Selection.ClearContents

Range("DC61:DC112").Select
Selection.ClearContents

Range("EH61:EH112").Select
Selection.ClearContents

Range("FM61:FM112").Select
Selection.ClearContents

'''''''''''''''''''''Sum Volume by Metric''''''''''''''''''''''''
Sheets("Data Input").Select

'Calculate total number of entries
Do While IsEmpty(Sheets("Data Input").Range("C" & 3 + totEntries).Value) = 0
   totEntries = totEntries + 1
Loop

'Sort Data By Actiivty Date
Sheets("Data Input").Select
Range("C3", "L" & 3 + totEntries).Select
Range("J" & 3 + totEntries).Activate
Selection.Sort Key1:=Range("D4"), Order1:=xlAscending, Header:=xlGuess, _
```

```
    OrderCustom:=1, MatchCase:=False, Orientation:=xlTopToBottom, _
    DataOption1:=xlSortNormal

Range("C3").Select

ReDim startDate(totEntries) As Double
Dim i, x, fieldID, sDate, eDate As Double
i = 1
Dim days, weeks As Double

acctID = Sheets("Data Input").Range("C3")

'Finds the first entries per acctID
Do Until acctID = Sheets("Data Input").Range("C" & 3 + i)
    i = i + 1
Loop

'Calculates the startdate per facID and acctID

Do While acctID = Sheets("Data Input").Range("C" & 3 + i).Value And
IsEmpty(Sheets("Data Input").Range("C" & 3 + i).Value) = 0

    sDate = Int(Sheets("Data Input").Range("D" & 2 + i).Value)
     startDate(i) = sDate
    x = i

 'Finds the last entry per facId and acctID

    Do While acctID = Sheets("Data Input").Range("C" & 3 + i).Value And
IsEmpty(Sheets("Data Input").Range("C" & 3 + i).Value) = 0
        i = i + 1
    Loop

    eDate = Int(Sheets("Data Input").Range("D" & 2 + i).Value)
    Sheets("Data Input").Range("K" & 3 + x) = eDate - sDate + 1
    days = Sheets("Data Input").Range("K" & 3 + x)

 'Calculates the number of weeks per facility ID and account ID

    weeks = 1
    days = days - (8 - Weekday(sDate))

    Do While days > 0
        days = days - 7
        weeks = weeks + 1
    Loop
```

```
    Sheets("Data Input").Range("L" & 3 + x) = weeks

Loop

Dim j, k, n, dates As Double
Dim startDate1, tempStartDate, tempEndDate, countStart, countEnd, points, wk,
numOfweeks, weekTotal As Double
Dim tabName As String
sheet = Sheets(1).Range("A1").Value

For i = 1 To 1

numOfweeks = Int(Sheets("Data Input").Range("L" & 3 + i).Value)

'Paste acct id

        Sheets("Forecasts").Range("B1") = acctID

'Week Ending Calc

        points = Sheets("Data Input").Range("K" & 3 + i)
        startDate1 = Sheets("Data Input").Range("D" & 3) - 1
        tempStartDate = startDate1 + 1
        tempEndDate = startDate1 + points

'Finds the Sunday of the week

        If Int(Weekday(tempStartDate)) <> 1 And Int(Weekday(tempStartDate)) <> 2 Then
            Do Until Int(Weekday(tempStartDate)) = 1 Or Int(Weekday(tempStartDate)) = 2
                countStart = countStart + 1
                tempStartDate = tempStartDate + 1

            Loop
            numOfweeks = numOfweeks - 1
        End If

'Finds the Saturday of the week

        If Int(Weekday(tempEndDate)) <> 7 And Int(Weekday(tempEndDate)) <> 6 Then
            Do Until Int(Weekday(tempEndDate)) = 7 Or Int(Weekday(tempEndDate)) = 6
                countEnd = countEnd + 1
                tempEndDate = tempEndDate - 1
            Loop
            numOfweeks = numOfweeks - 1
        End If
```

```
        Dim dayVol() As Double
        ReDim dayVol(points) As Double

        Dim dayVol1() As Double
        ReDim dayVol1(points) As Double

        Dim dayOfWeek() As Double
        ReDim dayOfWeek(points) As Double

        Dim dayOfWeek1() As Double
        ReDim dayOfWeek1(points) As Double


'''''''''''''''''''''Sum volume by acctid''''''''''''''''''''''''''

'''''''''''''''''''''''Inbound ASNs'''''''''''''''''''''''''''''''
        Sheets("Forecasts").Range("D2") = Sheets("Data Input").Range("E2")


        For j = 1 To totEntries
            If acctID = Sheets("Data Input").Range("C" & 2 + j) Then
                dayVol1(Sheets("Data Input").Range("D" & 2 + j) - startDate1) = Sheets("Data
Input").Range("E" & 2 + j)

            End If
        Next

          dayOfWeek1(1) = startDate1 + 1

        For dates = 2 To points
          dayOfWeek1(dates) = startDate1 + dates
        Next

        wk = 1
        For n = (countStart + 1) To (points - countEnd)

                If Weekday(dayOfWeek1(n)) <> 7 Then
                    weekTotal = weekTotal + dayVol1(n)
                    If n = points Then
                        Sheets("Forecasts").Range("D" & 2 + wk) = weekTotal
                        Sheets("Forecasts").Range("C" & 2 + wk) = dayOfWeek1(n)
                        If wk = 1 Then
                            Sheets("Forecasts").Range("B" & 2 + wk) = dayOfWeek1(countStart +
1)
                        Else
```

```
                    Sheets("Forecasts").Range("B" & 2 + wk) = dayOfWeek1(n -
Weekday(dayOfWeek1(n)) + 1)
                End If
                weekTotal = 0
            End If
        Else
                weekTotal = weekTotal + dayVol1(n)
                Sheets("Forecasts").Range("D" & 2 + wk) = weekTotal
                Sheets("Forecasts").Range("C" & 2 + wk) = dayOfWeek1(n)

                If wk = 1 Then
                    Sheets("Forecasts").Range("B" & 2 + wk) = startDate1 + 1 + countStart
                Else
                    Sheets("Forecasts").Range("B" & 2 + wk) = dayOfWeek1(n - 6)
                End If

                wk = wk + 1
                weekTotal = 0

        End If

    Next

'''''''''''''''''Calculates the Daily Distribution Sun-Sat of average week''''''''''''''''''''''''''

    Dim p, q, dailydist1(7), allTotal1 As Double
    For p = 1 To points
        q = Weekday(dayOfWeek1(p))
        dailydist1(q) = dailydist1(q) + dayVol1(p)
        allTotal1 = allTotal1 + dayVol1(p)
    Next

    If allTotal1 <> 0 Then
        Sheets("Summary").Range("k7") = dailydist1(1) / allTotal1
        Sheets("Summary").Range("K8") = dailydist1(2) / allTotal1
        Sheets("Summary").Range("K9") = dailydist1(3) / allTotal1
        Sheets("Summary").Range("K10") = dailydist1(4) / allTotal1
        Sheets("Summary").Range("K11") = dailydist1(5) / allTotal1
        Sheets("Summary").Range("K12") = dailydist1(6) / allTotal1
        Sheets("Summary").Range("K13") = dailydist1(7) / allTotal1
    End If

''''''''''''''''''''''''''''''''Inbound Lines''''''''''''''''''''''''''''''''''

    Dim dayvol2() As Double
    ReDim dayvol2(points) As Double
```

```
    Dim dayofweek2() As Double
    ReDim dayofweek2(points) As Double

    Sheets("Forecasts").Range("E2") = Sheets("Data Input").Range("F2")

    For j = 1 To totEntries
     If acctID = Sheets("Data Input").Range("C" & 2 + j) Then
         dayvol2(Sheets("Data Input").Range("D" & 2 + j) - startDate1) = Sheets("Data
Input").Range("F" & 2 + j)
      End If
    Next

    dayofweek2(1) = startDate1 + 1

    For dates = 2 To points
      dayofweek2(dates) = startDate1 + dates
    Next

    wk = 1
    For n = (countStart + 1) To (points - countEnd)

        If Weekday(dayofweek2(n)) <> 7 Then
          weekTotal = weekTotal + dayvol2(n)
          If n = points Then
            Sheets("Forecasts").Range("E" & 2 + wk) = weekTotal
            weekTotal = 0
          End If
        Else
            weekTotal = weekTotal + dayvol2(n)
            Sheets("Forecasts").Range("E" & 2 + wk) = weekTotal
            wk = wk + 1
            weekTotal = 0
        End If
    Next

 Dim dailydist2(7), allTotal2 As Double
    For p = 1 To points
      q = Weekday(dayofweek2(p))
      dailydist2(q) = dailydist2(q) + dayvol2(p)
     allTotal2 = allTotal2 + dayvol2(p)
    Next

    If allTotal2 <> 0 Then
      Sheets("Summary").Range("M7") = dailydist2(1) / allTotal2
      Sheets("Summary").Range("M8") = dailydist2(2) / allTotal2
```

```
        Sheets("Summary").Range("M9") = dailydist2(3) / allTotal2
        Sheets("Summary").Range("M10") = dailydist2(4) / allTotal2
        Sheets("Summary").Range("M11") = dailydist2(5) / allTotal2
        Sheets("Summary").Range("M12") = dailydist2(6) / allTotal2
        Sheets("Summary").Range("M13") = dailydist2(7) / allTotal2
    End If

''''''''''''''''''''''''''''''''''''''''''''''''"Inbound Eaches"''''''''''''''''''''''''''''''''''''''''''''

    Dim dayvol3() As Double
    ReDim dayvol3(points) As Double

    Dim dayofweek3() As Double
    ReDim dayofweek3(points) As Double

   Sheets("Forecasts").Range("F2") = Sheets("Data Input").Range("G2")

    For j = 1 To totEntries
      If acctID = Sheets("Data Input").Range("C" & 2 + j) Then
            dayvol3(Sheets("Data Input").Range("D" & 2 + j) - startDate1) = Sheets("Data
Input").Range("G" & 2 + j)
        End If
    Next

    dayofweek3(1) = startDate1 + 1
    For dates = 2 To points
        dayofweek3(dates) = startDate1 + dates
    Next

    wk = 1
    For n = (countStart + 1) To (points - countEnd)

            If Weekday(dayofweek3(n)) <> 7 Then
                weekTotal = weekTotal + dayvol3(n)
                If n = points Then
                    Sheets("Forecasts").Range("F" & 2 + wk) = weekTotal
                    weekTotal = 0
                End If
            Else
                    weekTotal = weekTotal + dayvol3(n)
                    Sheets("Forecasts").Range("F" & 2 + wk) = weekTotal
                    wk = wk + 1
                    weekTotal = 0
            End If
    Next
```

```
 Dim dailydist3(7), allTotal3 As Double
        For p = 1 To points
            q = Weekday(dayofweek3(p))
            dailydist3(q) = dailydist3(q) + dayvol3(p)
           allTotal3 = allTotal3 + dayvol3(p)
        Next

        If allTotal3 <> 0 Then
            Sheets("Summary").Range("O7") = dailydist3(1) / allTotal3
            Sheets("Summary").Range("O8") = dailydist3(2) / allTotal3
            Sheets("Summary").Range("O9") = dailydist3(3) / allTotal3
            Sheets("Summary").Range("O10") = dailydist3(4) / allTotal3
            Sheets("Summary").Range("O11") = dailydist3(5) / allTotal3
            Sheets("Summary").Range("O12") = dailydist3(6) / allTotal3
            Sheets("Summary").Range("O13") = dailydist3(7) / allTotal3
        End If

'''''''''''''''''''''''''''''''''Picking Orders''''''''''''''''''''''''''''''''''''''''

        Dim dayvol4() As Double
        ReDim dayvol4(points) As Double

        Dim dayofweek4() As Double
        ReDim dayofweek4(points) As Double

        Sheets("Forecasts").Range("G2") = Sheets("Data Input").Range("H2")

        For j = 1 To totEntries
          If acctID = Sheets("Data Input").Range("C" & 2 + j) Then
                dayvol4(Sheets("Data Input").Range("D" & 2 + j) - startDate1) = Sheets("Data
Input").Range("H" & 2 + j)
            End If
        Next

        dayofweek4(1) = startDate1 + 1
        For dates = 2 To points
            dayofweek4(dates) = startDate1 + dates
        Next

        wk = 1
        For n = (countStart + 1) To (points - countEnd)

                If Weekday(dayofweek4(n)) <> 7 Then
                    weekTotal = weekTotal + dayvol4(n)
                    If n = points Then
                        Sheets("Forecasts").Range("G" & 2 + wk) = weekTotal
```

```
                weekTotal = 0
             End If
          Else
                weekTotal = weekTotal + dayvol4(n)
                Sheets("Forecasts").Range("G" & 2 + wk) = weekTotal
                wk = wk + 1
                weekTotal = 0
          End If
      Next

 Dim dailydist4(7), allTotal4 As Double
      For p = 1 To points
         q = Weekday(dayofweek4(p))
         dailydist4(q) = dailydist4(q) + dayvol4(p)
        allTotal4 = allTotal4 + dayvol4(p)
      Next

      If allTotal4 <> 0 Then
         Sheets("Summary").Range("k17") = dailydist4(1) / allTotal4
         Sheets("Summary").Range("K18") = dailydist4(2) / allTotal4
         Sheets("Summary").Range("K19") = dailydist4(3) / allTotal4
         Sheets("Summary").Range("K20") = dailydist4(4) / allTotal4
         Sheets("Summary").Range("K21") = dailydist4(5) / allTotal4
         Sheets("Summary").Range("K22") = dailydist4(6) / allTotal4
         Sheets("Summary").Range("K23") = dailydist4(7) / allTotal4
      End If

''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''Picking Lines''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''

      Dim dayvol5() As Double
      ReDim dayvol5(points) As Double

      Dim dayofweek5() As Double
      ReDim dayofweek5(points) As Double

      Sheets("Forecasts").Range("H2") = Sheets("Data Input").Range("I2")

      For j = 1 To totEntries
        If acctID = Sheets("Data Input").Range("C" & 2 + j) Then
            dayvol5(Sheets("Data Input").Range("D" & 2 + j) - startDate1) = Sheets("Data
Input").Range("I" & 2 + j)
         End If
      Next

      dayofweek5(1) = startDate1 + 1
      For dates = 2 To points
```

```
            dayofweek5(dates) = startDate1 + dates
        Next

        wk = 1
        For n = (countStart + 1) To (points - countEnd)

                If Weekday(dayofweek5(n)) <> 7 Then
                    weekTotal = weekTotal + dayvol5(n)
                    If n = points Then
                        Sheets("Forecasts").Range("H" & 2 + wk) = weekTotal
                        weekTotal = 0
                    End If
                Else
                        weekTotal = weekTotal + dayvol5(n)
                        Sheets("Forecasts").Range("H" & 2 + wk) = weekTotal
                        wk = wk + 1
                        weekTotal = 0
                End If
        Next

  Dim dailydist5(7), allTotal5 As Double
        For p = 1 To points
            q = Weekday(dayofweek5(p))
            dailydist5(q) = dailydist5(q) + dayvol5(p)
           allTotal5 = allTotal5 + dayvol5(p)
        Next

        If allTotal5 <> 0 Then
            Sheets("Summary").Range("M17") = dailydist5(1) / allTotal5
            Sheets("Summary").Range("M18") = dailydist5(2) / allTotal5
            Sheets("Summary").Range("M19") = dailydist5(3) / allTotal5
            Sheets("Summary").Range("M20") = dailydist5(4) / allTotal5
            Sheets("Summary").Range("M21") = dailydist5(5) / allTotal5
            Sheets("Summary").Range("M22") = dailydist5(6) / allTotal5
            Sheets("Summary").Range("M23") = dailydist5(7) / allTotal5
        End If


''''''''''''''''''''''''''''''''''''''''''''''''''''''Picking Eaches''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''

        Dim dayvol6() As Double
        ReDim dayvol6(points) As Double

        Dim dayofweek6() As Double
        ReDim dayofweek6(points) As Double
```

```
        Sheets("Forecasts").Range("I2") = Sheets("Data Input").Range("J2")

        For j = 1 To totEntries
          If acctID = Sheets("Data Input").Range("C" & 2 + j) Then
                dayvol6(Sheets("Data Input").Range("D" & 2 + j) - startDate1) = Sheets("Data
Input").Range("J" & 2 + j)
            End If
        Next

        dayofweek6(1) = startDate1 + 1
        For dates = 2 To points
            dayofweek6(dates) = startDate1 + dates
        Next

        wk = 1
        For n = (countStart + 1) To (points - countEnd)

                If Weekday(dayofweek6(n)) <> 7 Then
                    weekTotal = weekTotal + dayvol6(n)
                    If n = points Then
                        Sheets("Forecasts").Range("I" & 2 + wk) = weekTotal
                        weekTotal = 0
                    End If
                Else
                        weekTotal = weekTotal + dayvol6(n)
                        Sheets("Forecasts").Range("I" & 2 + wk) = weekTotal
                        wk = wk + 1
                        weekTotal = 0
                End If
        Next

 Dim dailydist6(7), allTotal6 As Double
        For p = 1 To points
            q = Weekday(dayofweek6(p))
            dailydist6(q) = dailydist6(q) + dayvol6(p)
           allTotal6 = allTotal6 + dayvol6(p)
        Next

        If allTotal6 <> 0 Then
            Sheets("Summary").Range("O17") = dailydist6(1) / allTotal6
            Sheets("Summary").Range("O18") = dailydist6(2) / allTotal6
            Sheets("Summary").Range("O19") = dailydist6(3) / allTotal6
            Sheets("Summary").Range("O20") = dailydist6(4) / allTotal6
            Sheets("Summary").Range("O21") = dailydist6(5) / allTotal6
            Sheets("Summary").Range("O22") = dailydist6(6) / allTotal6
            Sheets("Summary").Range("O23") = dailydist6(7) / allTotal6
```

```
        End If

    'Calculates the number of periods ahead

        Dim count As Integer
        count = 1
        k = 1

        Do While k <= 13
            If IsEmpty(Sheets("Forecasts").Range("D" & 2 + count).Value) = False Then
                Sheets("Forecasts").Range("J" & 2 + count) = k
                count = count + 1
            Else
                Sheets("Forecasts").Range("J" & 2 + count) = k
                k = k + 1
                count = count + 1
            End If
        Loop


Next

''''''''''''''''''''''''''''''''''Copy week data into forecast formulas''''''''''''''''''''''''''''''''''''''''''''''''

Dim vollen, endcell As Long
Dim Com, sel1, sel2, sel3, sel4, sel5, sel6 As String

Sheets("Forecasts").Select

Do While IsEmpty(Sheets("Forecasts").Range("D" & 3 + vollen).Value) = 0
    vollen = vollen + 1
Loop
    endcell = vollen + 2

    If vollen > 52 Then
        firstcell = endcell - 51
        endnum = 52
    Else
        firstcell = 3
        endnum = vollen
    End If

'Inbound ASN
sel1 = "C" & firstcell & ":D" & endcell
'Inbound Lines
sel2 = "E" & firstcell & ":E" & endcell
```

```
'Inbound Eaches
sel3 = "F" & firstcell & ":F" & endcell
'Picking Orders
sel4 = "G" & firstcell & ":G" & endcell
'Picking Lines
sel5 = "H" & firstcell & ":H" & endcell
'Picking Eaches
sel6 = "I" & firstcell & ":I" & endcell

Range(sel1).Select
Selection.copy
    Range("N9").Select
   Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone, SkipBlanks _
      :=False, Transpose:=False

Range(sel2).Select
Selection.copy
    Range("AT9").Select
   Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone, SkipBlanks _
      :=False, Transpose:=False

Range(sel3).Select
Selection.copy
    Range("BY9").Select
   Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone, SkipBlanks _
      :=False, Transpose:=False

Range(sel4).Select
Selection.copy
    Range("DD9").Select
   Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone, SkipBlanks _
      :=False, Transpose:=False

Range(sel5).Select
Selection.copy
    Range("EI9").Select
   Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone, SkipBlanks _
      :=False, Transpose:=False

Range(sel6).Select
Selection.copy
    Range("FN9").Select
   Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone, SkipBlanks _
      :=False, Transpose:=False

Range("N9:N60").Select
```

```
Selection.copy
     Range("AS9").Select
    Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone, SkipBlanks _
        :=False, Transpose:=False

Range("BX9").Select
    Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone, SkipBlanks _
        :=False, Transpose:=False

Range("DC9").Select
    Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone, SkipBlanks _
        :=False, Transpose:=False

Range("EH9").Select
    Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone, SkipBlanks _
        :=False, Transpose:=False

Range("FM9").Select
    Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone, SkipBlanks _
        :=False, Transpose:=False

Range("a1").Select

''''''''''''''''''''How many weeks to forecast''''''''''''''''''''''''

Dim MaxDate As Long

'Max Weekending Date
Do While IsEmpty(Sheets("Forecasts").Range("C" & 3 + MaxDate).Value) = 0
    MaxDate = MaxDate + 1
Loop
Com1 = "C" & MaxDate + 2

Range("N61").Value = Range(Com1) + 7
For i = 1 To fordur
m = i * 7
    Sheets("Forecasts").Range("n" & 60 + i) = Range(Com1) + m

Next

Range("N61:N112").Select
Selection.copy
     Range("AS61").Select
    Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone, SkipBlanks _
        :=False, Transpose:=False
```

```
Range("BX61").Select
    Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone, SkipBlanks _
        :=False, Transpose:=False

Range("DC61").Select
    Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone, SkipBlanks _
        :=False, Transpose:=False

Range("EH61").Select
    Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone, SkipBlanks _
        :=False, Transpose:=False

Range("FM61").Select
    Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone, SkipBlanks _
        :=False, Transpose:=False


    Application.ScreenUpdating = True
    Application.StatusBar = False
    Application.Calculation = xlCalculationAutomatic


""""""""""""""""""""""""""""Solver""""""""""""""""""""""""""""""""""


'Inbound ASNs


'Simple Exponential Smoothing
            Application.Run "Solver.xla!SolverReset"
            Application.Run "Solver.xla!SolverOk", Sheets("Forecasts").Range("x5"), 2, ,
Sheets("Forecasts").Range("x1")
            Application.Run "Solver.xla!SolverAdd", Sheets("Forecasts").Range("X1"), 1,
"1"
            Application.Run "Solver.xla!SolverAdd", Sheets("Forecasts").Range("X1"), 3,
"0"
            Application.Run "Solver.xla!SolverSolve", True
            Application.Run "Solver.xla!SolverFinish", 1

'Double Exponential Smoothing
            Application.Run "Solver.xla!SolverReset"
            Application.Run "Solver.xla!SolverOk", Sheets("Forecasts").Range("AE5"), 2, ,
Sheets("Forecasts").Range("AA4,AA5")
            Application.Run "Solver.xla!SolverAdd", Sheets("Forecasts").Range("AA4"), 1,
"1"
```

```
        Application.Run "Solver.xla!SolverAdd", Sheets("Forecasts").Range("AA4"), 3,
"0"
        Application.Run "Solver.xla!SolverAdd", Sheets("Forecasts").Range("AA5"), 1,
"1"
        Application.Run "Solver.xla!SolverAdd", Sheets("Forecasts").Range("AA5"), 3,
"0"
        Application.Run "Solver.xla!SolverSolve", True
        Application.Run "Solver.xla!SolverFinish", 1


'Inbound Lines

'Simple Exponential Smoothing
        Application.Run "Solver.xla!SolverReset"
        Application.Run "Solver.xla!SolverOk", Sheets("Forecasts").Range("BC5"), 2, ,
Sheets("Forecasts").Range("BC1")
        Application.Run "Solver.xla!SolverAdd", Sheets("Forecasts").Range("BC1"), 1,
"1"
        Application.Run "Solver.xla!SolverAdd", Sheets("Forecasts").Range("BC1"), 3,
"0"
        Application.Run "Solver.xla!SolverSolve", True
        Application.Run "Solver.xla!SolverFinish", 1

'Double Exponential Smoothing
        Application.Run "Solver.xla!SolverReset"
        Application.Run "Solver.xla!SolverOk", Sheets("Forecasts").Range("BJ5"), 2, ,
Sheets("Forecasts").Range("BF4,BF5")
        Application.Run "Solver.xla!SolverAdd", Sheets("Forecasts").Range("BF4"), 1,
"1"
        Application.Run "Solver.xla!SolverAdd", Sheets("Forecasts").Range("BF4"), 3,
"0"
        Application.Run "Solver.xla!SolverAdd", Sheets("Forecasts").Range("BF5"), 1,
"1"
        Application.Run "Solver.xla!SolverAdd", Sheets("Forecasts").Range("BF5"), 3,
"0"
        Application.Run "Solver.xla!SolverSolve", True
        Application.Run "Solver.xla!SolverFinish", 1


'Inbound Eaches

'Simple Exponential Smoothing
        Application.Run "Solver.xla!SolverReset"
        Application.Run "Solver.xla!SolverOk", Sheets("Forecasts").Range("CH5"), 2, ,
Sheets("Forecasts").Range("CH1")
```

```
        Application.Run "Solver.xla!SolverAdd", Sheets("Forecasts").Range("CH1"), 1,
"1"
        Application.Run "Solver.xla!SolverAdd", Sheets("Forecasts").Range("CH1"), 3,
"0"
        Application.Run "Solver.xla!SolverSolve", True
        Application.Run "Solver.xla!SolverFinish", 1

'Double Exponential Smoothing
        Application.Run "Solver.xla!SolverReset"
        Application.Run "Solver.xla!SolverOk", Sheets("Forecasts").Range("CO5"), 2, ,
Sheets("Forecasts").Range("CK4,CK5")
        Application.Run "Solver.xla!SolverAdd", Sheets("Forecasts").Range("CK4"), 1,
"1"
        Application.Run "Solver.xla!SolverAdd", Sheets("Forecasts").Range("CK4"), 3,
"0"
        Application.Run "Solver.xla!SolverAdd", Sheets("Forecasts").Range("CK5"), 1,
"1"
        Application.Run "Solver.xla!SolverAdd", Sheets("Forecasts").Range("CK5"), 3,
"0"
        Application.Run "Solver.xla!SolverSolve", True
        Application.Run "Solver.xla!SolverFinish", 1

'Picking Orders

'Simple Exponential Smoothing
        Application.Run "Solver.xla!SolverReset"
        Application.Run "Solver.xla!SolverOk", Sheets("Forecasts").Range("DM5"), 2, ,
Sheets("Forecasts").Range("DM1")
        Application.Run "Solver.xla!SolverAdd", Sheets("Forecasts").Range("DM1"), 1,
"1"
        Application.Run "Solver.xla!SolverAdd", Sheets("Forecasts").Range("DM1"), 3,
"0"
        Application.Run "Solver.xla!SolverSolve", True
        Application.Run "Solver.xla!SolverFinish", 1

'Double Exponential Smoothing
        Application.Run "Solver.xla!SolverReset"
        Application.Run "Solver.xla!SolverOk", Sheets("Forecasts").Range("DT5"), 2, ,
Sheets("Forecasts").Range("DP4,DP5")
        Application.Run "Solver.xla!SolverAdd", Sheets("Forecasts").Range("DP4"), 1,
"1"
        Application.Run "Solver.xla!SolverAdd", Sheets("Forecasts").Range("DP4"), 3,
"0"
        Application.Run "Solver.xla!SolverAdd", Sheets("Forecasts").Range("DP5"), 1,
"1"
```

```
        Application.Run "Solver.xla!SolverAdd", Sheets("Forecasts").Range("DP5"), 3,
"0"
        Application.Run "Solver.xla!SolverSolve", True
        Application.Run "Solver.xla!SolverFinish", 1

'Picking Lines


'Simple Exponential Smoothing
        Application.Run "Solver.xla!SolverReset"
        Application.Run "Solver.xla!SolverOk", Sheets("Forecasts").Range("ER5"), 2, ,
Sheets("Forecasts").Range("ER1")
        Application.Run "Solver.xla!SolverAdd", Sheets("Forecasts").Range("ER1"), 1,
"1"
        Application.Run "Solver.xla!SolverAdd", Sheets("Forecasts").Range("ER1"), 3,
"0"
        Application.Run "Solver.xla!SolverSolve", True
        Application.Run "Solver.xla!SolverFinish", 1

'Double Exponential Smoothing
        Application.Run "Solver.xla!SolverReset"
        Application.Run "Solver.xla!SolverOk", Sheets("Forecasts").Range("EY5"), 2, ,
Sheets("Forecasts").Range("EU4,EU5")
        Application.Run "Solver.xla!SolverAdd", Sheets("Forecasts").Range("EU4"), 1,
"1"
        Application.Run "Solver.xla!SolverAdd", Sheets("Forecasts").Range("EU4"), 3,
"0"
        Application.Run "Solver.xla!SolverAdd", Sheets("Forecasts").Range("EU5"), 1,
"1"
        Application.Run "Solver.xla!SolverAdd", Sheets("Forecasts").Range("EU5"), 3,
"0"
        Application.Run "Solver.xla!SolverSolve", True
        Application.Run "Solver.xla!SolverFinish", 1


'Picking Eahces


'Simple Exponential Smoothing
        Application.Run "Solver.xla!SolverReset"
        Application.Run "Solver.xla!SolverOk", Sheets("Forecasts").Range("FW5"), 2, ,
Sheets("Forecasts").Range("FW1")
        Application.Run "Solver.xla!SolverAdd", Sheets("Forecasts").Range("FW1"), 1,
"1"
        Application.Run "Solver.xla!SolverAdd", Sheets("Forecasts").Range("FW1"), 3,
"0"
```

```
            Application.Run "Solver.xla!SolverSolve", True
            Application.Run "Solver.xla!SolverFinish", 1

'Double Exponential Smoothing
            Application.Run "Solver.xla!SolverReset"
            Application.Run "Solver.xla!SolverOk", Sheets("Forecasts").Range("GD5"), 2, ,
Sheets("Forecasts").Range("FZ4,FZ5")
            Application.Run "Solver.xla!SolverAdd", Sheets("Forecasts").Range("FZ4"), 1,
"1"
            Application.Run "Solver.xla!SolverAdd", Sheets("Forecasts").Range("FZ4"), 3,
"0"
            Application.Run "Solver.xla!SolverAdd", Sheets("Forecasts").Range("FZ5"), 1,
"1"
            Application.Run "Solver.xla!SolverAdd", Sheets("Forecasts").Range("EU5"), 3,
"0"
            Application.Run "Solver.xla!SolverSolve", True
            Application.Run "Solver.xla!SolverFinish", 1



''''''''''Inbound ASN Evalutions by Forecasting Technique''''''''''''''''''''''

InbdAsn.TextBox10 = Round(Sheets("Forecasts").Range("S4").Value, 2)
InbdAsn.TextBox1 = Round(Sheets("Forecasts").Range("S2").Value, 2)
InbdAsn.TextBox6 = Round(Sheets("Forecasts").Range("S3").Value, 2)
InbdAsn.TextBox24 = Round(Sheets("Forecasts").Range("S5").Value, 2)
InbdAsn.TextBox2 = Round(Sheets("Forecasts").Range("X2").Value, 2)
InbdAsn.TextBox7 = Round(Sheets("Forecasts").Range("X3").Value, 2)
InbdAsn.TextBox11 = Round(Sheets("Forecasts").Range("X4").Value, 2)
InbdAsn.TextBox23 = Round(Sheets("Forecasts").Range("X5").Value, 2)
InbdAsn.TextBox5 = Round(Sheets("Forecasts").Range("AE2").Value, 2)
InbdAsn.TextBox8 = Round(Sheets("Forecasts").Range("AE3").Value, 2)
InbdAsn.TextBox12 = Round(Sheets("Forecasts").Range("AE4").Value, 2)
InbdAsn.TextBox16 = Round(Sheets("Forecasts").Range("AE5").Value, 2)
InbdAsn.TextBox4 = Round(Sheets("Forecasts").Range("AQ2").Value, 2)
InbdAsn.TextBox9 = Round(Sheets("Forecasts").Range("AQ3").Value, 2)
InbdAsn.TextBox13 = Round(Sheets("Forecasts").Range("AQ4").Value, 2)
InbdAsn.TextBox17 = Round(Sheets("Forecasts").Range("AQ5").Value, 2)
WeeksForecast.Hide
InbdAsn.Show


End Sub
```

II. CODE FOR FORMS

A. Main Menu

```
Private Sub CommandButton1_Click()

If forbtn = True Then
WeeksForecast.Show
ElseIf sumbtn = True Then
Sheets("Summary").Select
ElseIf clearbtn = True Then
Intro.Hide
ClearData.Show
ElseIf hisdata = True Then
Sheets("Data Input").Select
ElseIf manbtn = True Then
Sheet1.Visible = True
Sheet6.Visible = True
Sheet8.Visible = True
Sheet9.Visible = True
Else
UserForm4.Show
End If
Intro.Hide
End Sub
```

B. Statistical Evaluation Measures

```
Private Sub CommandButton1_Click()
InbdAsn.Hide

'Clear contents
Sheets("Summary").Select
Range("B2").Select

   Dim datelen As Double
   Dim str As String

   Do While IsEmpty(Sheets("Summary").Range("B" & 2 + datelen).Value) = 0
      datelen = datelen + 1
   Loop

If datelen = 0 Then
datelen = 2
Else
datelen = datelen
End If
```

```
str = "B2:" & "H" & datelen
MsgBox (datelen)
Range(str).Select
Selection.ClearContents

Sheets("Summary").Range("C1") = "Inbound ASNs"

'Find last row of data forecasted

   Dim forlen As Double
   Dim Com3 As String

   Do While IsEmpty(Sheets("Forecasts").Range("N" & 61 + forlen).Value) = 0
      forlen = forlen + 1
   Loop
forlen = forlen + 61
Com3 = "N61:" & "N" & forlen

Sheets("Forecasts").Select
Range(Com3).Select
Selection.copy
Sheets("Summary").Select
Range("B2").Select
Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone, SkipBlanks _
      :=False, Transpose:=False

'Determine forecasting method for Inbound ASNs
Dim asnchoice As String

If InbASNMA = True Then
asnchoice = "P61:" & "P" & forlen

ElseIf InbASNSE = True Then
asnchoice = "U61:" & "U" & forlen

ElseIf InbASNDE = True Then
asnchoice = "AB61:" & "AB" & forlen

ElseIf InbASNWI = True Then
asnchoice = "AN61:" & "AN" & forlen

Else
MsgBox ("No forecasting selection was made.  Please choose one.")
InbdAsn.Show
End If
```

```
Sheets("Forecasts").Select
Range(asnchoice).Select
Selection.copy
Sheets("Summary").Select
Range("C2").Select
Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone, SkipBlanks _
        :=False, Transpose:=False
Range("C2").Select


'Inbound Lines Evalutions by Forecasting Technique
InbLines.TextBox6 = Round(Sheets("Forecasts").Range("AX2").Value, 2)
InbLines.TextBox10 = Round(Sheets("Forecasts").Range("AX3").Value, 2)
InbLines.TextBox14 = Round(Sheets("Forecasts").Range("AX4").Value, 2)
InbLines.TextBox25 = Round(Sheets("Forecasts").Range("AX5").Value, 2)
InbLines.TextBox7 = Round(Sheets("Forecasts").Range("BC2").Value, 2)
InbLines.TextBox11 = Round(Sheets("Forecasts").Range("BC3").Value, 2)
InbLines.TextBox15 = Round(Sheets("Forecasts").Range("BC4").Value, 2)
InbLines.TextBox24 = Round(Sheets("Forecasts").Range("BC5").Value, 2)
InbLines.TextBox9 = Round(Sheets("Forecasts").Range("BJ2").Value, 2)
InbLines.TextBox12 = Round(Sheets("Forecasts").Range("BJ3").Value, 2)
InbLines.TextBox16 = Round(Sheets("Forecasts").Range("BJ4").Value, 2)
InbLines.TextBox18 = Round(Sheets("Forecasts").Range("BJ5").Value, 2)
InbLines.TextBox8 = Round(Sheets("Forecasts").Range("BV2").Value, 2)
InbLines.TextBox13 = Round(Sheets("Forecasts").Range("BV3").Value, 2)
InbLines.TextBox17 = Round(Sheets("Forecasts").Range("BV4").Value, 2)
InbLines.TextBox19 = Round(Sheets("Forecasts").Range("BV5").Value, 2)

InbLines.Show

End Sub
```

C. Historical Data and Forecasting Methods Graph

```
Private Sub CheckBox9_Click()
Application.ScreenUpdating = False
If CheckBox9 = True Then

    Dim vollen, len2 As Double
    Dim Com, comd, coma, comb, comc, comf, comg As String

''''''''''''''''''''''''''Clear Contents''''''''''''''''''''''''''''''''''''''''
Sheets("Graphdata").Visible = True
Sheets("Graphdata").Select
comg = "A3:AE200"
Range(comg).Select
```

```
Selection.ClearContents

''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''
    Do While IsEmpty(Sheets("Forecasts").Range("N" & 9 + vollen).Value) = 0
        vollen = vollen + 1
    Loop
  vollen = vollen + 8

    If vollen >= 60 Then
    vollen = 60
    Else
    vollen = vollen
    End If

    'Copy Date and Actual Data
    Sheets("Forecasts").Select
    Com = "N9:" & "O" & vollen

    Range(Com).Select

    Selection.copy
     Sheets("GraphData").Select
     Range("A3").Select
    Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone, SkipBlanks _
        :=False, Transpose:=False

    Range("E5").Select

  'Copy forecasted dates

    Sheets("Forecasts").Select
   Do While IsEmpty(Sheets("Forecasts").Range("N" & 61 + forlen).Value) = 0
        forlen = forlen + 1
    Loop

   forlen = forlen + 61

   comd = "N61:" & "N" & forlen
   Range(comd).Select
   Selection.copy
    Sheets("GraphData").Select

 'Graph Data last entry

  Do While IsEmpty(Sheets("GraphData").Range("A" & 3 + len1).Value) = 0
        len1 = len1 + 1
```

```
    Loop

   len1 = len1 + 3

  coma = "A" & len1

     Range(coma).Select
    Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone, SkipBlanks _
        :=False, Transpose:=False

'Copy Forecasts

Sheets("Forecasts").Select

'Moving Average

Dim mfor, mfor2 As String

comb = "P9:" & "P" & vollen
Range(comb).Select
Selection.copy
Sheets("Graphdata").Select
Range("C3").Select
    Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone, SkipBlanks _
        :=False, Transpose:=False

Sheets("Forecasts").Select
mfor = "P61:" & "P" & forlen
Range(mfor).Select
Selection.copy
Sheets("Graphdata").Select

mfor2 = "C" & len1

Range(mfor2).Select
    Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone, SkipBlanks _
        :=False, Transpose:=False



'Single Expo

Sheets("Forecasts").Select
comc = "U9:" & "U" & vollen
Range(comc).Select
Selection.copy
```

```
Sheets("Graphdata").Select
Range("D3").Select
   Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone, SkipBlanks _
      :=False, Transpose:=False

Sheets("Forecasts").Select
mfor = "U61:" & "U" & forlen
Range(mfor).Select
Selection.copy
Sheets("Graphdata").Select

mfor2 = "D" & len1

Range(mfor2).Select
   Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone, SkipBlanks _
      :=False, Transpose:=False

'Double Expo

Sheets("Forecasts").Select
come = "AB9:" & "AB" & vollen
Range(come).Select
Selection.copy
Sheets("Graphdata").Select
Range("E3").Select
   Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone, SkipBlanks _
      :=False, Transpose:=False

Sheets("Forecasts").Select
mfor = "AB61:" & "AB" & forlen
Range(mfor).Select
Selection.copy
Sheets("Graphdata").Select

mfor2 = "E" & len1

Range(mfor2).Select
   Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone, SkipBlanks _
      :=False, Transpose:=False

'Winters

Sheets("Forecasts").Select
comf = "AN9:" & "AN" & vollen
Range(comf).Select
Selection.copy
```

```
Sheets("Graphdata").Select
Range("F3").Select
    Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone, SkipBlanks _
        :=False, Transpose:=False

Sheets("Forecasts").Select
mfor = "AN61:" & "AN" & forlen
Range(mfor).Select
Selection.copy
Sheets("Graphdata").Select

mfor2 = "f" & len1


Range(mfor2).Select
    Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone, SkipBlanks _
        :=False, Transpose:=False


    ThisWorkbook.DialogSheets("dialog2").Show
Application.ScreenUpdating = True
Sheets("Forecasts").Select
Else


End If

End Sub
```

VITA

The author of this thesis was born December 28, 1984 and graduated from Walton Verona High School in 2003. He received his Bachelor's of Science Degree in Industrial Engineering in May of 2008 from the University of Louisville, J. B. Speed School of Engineering. During his cooperative internships he worked for UPS Supply Chain Solutions in Louisville, Kentucky. During the school semester rotations he worked as an intern at UPS Supply Chain Solutions. Currently he is an Industrial Engineer for UPS Supply Chain Solutions.