Title: A Case Study of (s, S) Policy for SHAZAN TOY Company using EXCEL

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Abstract: Analyzes the response of the (s, S) inventory control policy to factors such as demand and lead time. Evaluates this policy in a case study of a toy company, SHAZAN Toys

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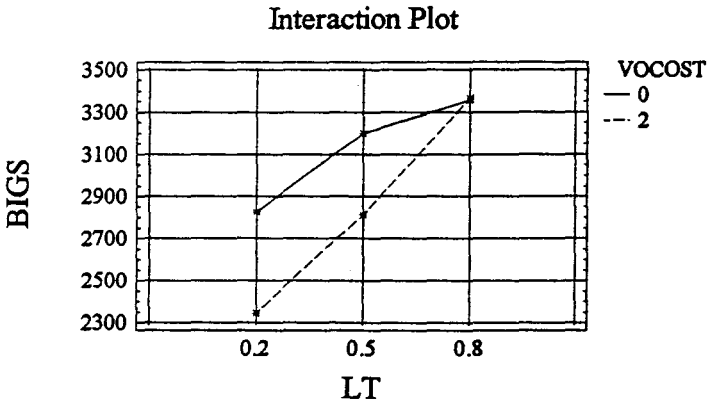

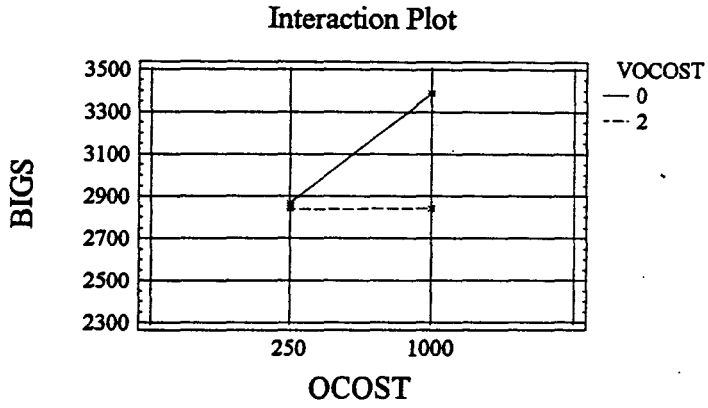

A Case Study of (s,S) Policy for SHAZAN TOY Company using EXCEL

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11 Mar 1997

1. Introduction

Inventory control is very important in any business, because inventory costs are often one of the largest portions of the budget. In this project, we are going to take a more in depth study of one the most common inventory control policies and how different factors, such as demand and lead time effect the policy. The policy we are going to look at is the ***(s,S)*** policy. This policy is know by several other names - the Max-Min policy and the Periodic Review Order Point, Order up to Level Policy. We will explain the details of several inventory policies, as well as why we chose the ***(s,S)*** policy to study, in the next section.

After we explain the policy we will be considering a case study of a toy retail company. We will use a combination of known analytical techniques and simulation to determine the appropriate (s,S) policy for our toy company - SHAZAN Toys.

2. Case Study: Application of (s,S) Policy

The SHAZAN Toy Distributing Company has hired us, two outstanding Industrial Engineering students at Oregon State University, to help them analyze their inventory situation at the warehouse for their toy catalog. SHAZAN's main slogan is "if you order from us, you will receive your toys faster than you can say SHAZAN," and their main customers are small town toy stores. So, one of the most important selling points of their catalogs is to deliver excellent toys quickly -- and it is this excellent service that has kept them in business all these years. They are particularly interested in how they can convert their current ***(s,Q)*** policy for many of the toys into a ***(s,S)*** policy. The main reason they are changing policies, is that a periodic review policy is much easier to manage with less clerks. The clerk only needs to consider how often she is going to review the inventory status and place the orders for new toys. They would like us to set up a computer program that will determine the optimal ***(s,S)*** policy do this for one chosen toy, train them on how to use it, and then they will find the optimal (s,S) policy for the other toys themselves. Here we will present a full analysis (including sensitivity analysis) for one chosen toy.

The SHAZAN Toy Catalog warehouse manager, Mr. Clown has chosen the Rolly Dolly Wagon (RDW) for us to use as our test case. He has roughly two years worth of weekly sales data on the RDW - one of their highest demanded and most expensive items to store. This data is shown in Appendix A. For the RDW weekly sales data, sales look more bimodal, although the underlying distribution appears to look normal. We feel that we could use the normal approximation for demand to at least get a range for the ***(s,S)*** values and then use simulation with bootstrap sampling from the original demand data to see if our approximation is reasonable. We chose to do a very simple Monte Carlo Simulation in Excel, so that the SHAZAN Warehouse Manager and his staff would be able to use the tool to find other optimal policies in the future. They want to use policies

that are even numbers of 100, because this is easier for the clerks. This means that if the optimal (s,S) policy is really (1213,2267), they would prefer to use (1200, 2200), (1200, 2300), (1300, 2200), or (1300,2300) - which ever policy is "most" optimal. This also made it much easier to use something simple, like Excel.

2.1 Problem Statement

The Rolly Dolly Wagon is a more expensive toy, and each order here costs $1000 to place, while storing the RDW for one week costs $0.50. Each time an order is placed and the SHAZAN Toy Company can not immediately fill the order, there is a associated lost sales or lost goodwill cost that has been estimated to be $25/wagon. There are no back orders. This special wagon sells for $89 under the (s,Q) policy they are using.

The weekly cost (associated with ordering, storing, and lost sales) for RDW is currently $1989.

3. Background and Literature Review

During a literature review in the area of Inventory Control could probably take one person a lifetime, because the field is so rich. We have learned some of the basic policies and then choose one that we are going to look at in some depth with a simulation model.

3.1 Common Inventory Policies

The Economic Order Quantity (EOQ) was developed by Harris in 1913, and it is still taught as one of the first lessons in most courses on inventory and production control. The reason for this is that gives an intuitive feel to the relationship between setup or ordering cost and inventory or holding costs. In reviewing the texts by Hopp & Spearman, Nahmias, Silver, Love, and, of course, Hadley and Whitin, we found that they all present some form of the derivation of EOQ early in the books. The assumptions that are required to use the EOQ model are, for the most part, unrealistic. The two assumptions that are the most unreasonable are the assumptions of constant, deterministic demand and instantaneous delivery (Hopp et al, 1996). For ost situations demand is random and lead time is positive, and often also random. Figure 1 shows how the inventory level looks over time; the constant slope is the demand rate. The quantity Q is ordered every Q/D time units.

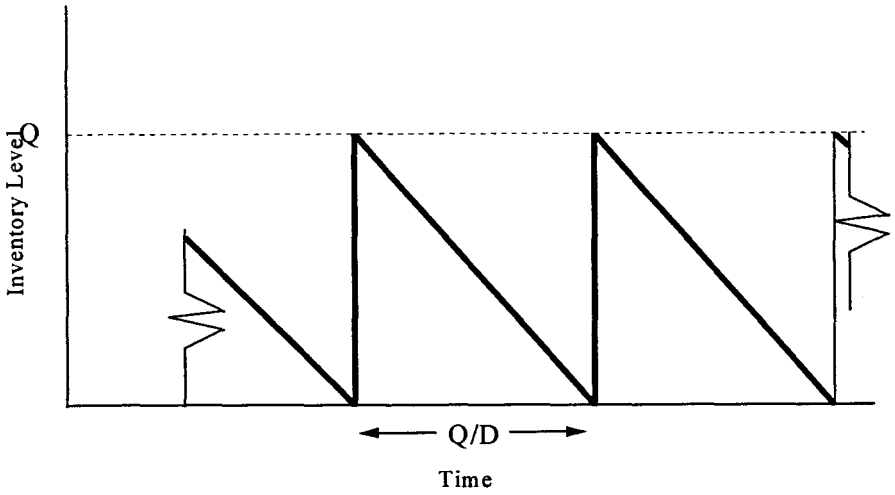


Figure 1: The EOQ Model

In dealing with production or purchasing environments, as mentioned before, these assumptions are not often reasonable because there will be demand variation and positive lead time. So statistical reorder point policies are often considered. Here we will present the concept of three different statistical reorder point policies that can be used. The references that we used are the ones listed in the previous paragraph. The information is common through all of these text books. In these models, lead time is assumed to be positive, constant, and deterministic.

The first model that we will present is the ***(s,Q)*** model (sometimes called ***(r,Q)***). This model is different from EOQ in that when the inventory level falls below the reorder point, ***s***, then the quantity ***Q*** is ordered. Figure 2 is a graphical representation of this. The advantage of this type of system is that it is easy to understand and therefore to implement. It is also easier for the supplier to plan because they will know the quantity amount that will be always be "demanded" from them. One disadvantage of this model is that the if the transaction that causes the inventory level to fall below ***s*** is very large, say larger than ***Q***, then the order if only ***Q*** will not even bring the inventory position (the sum of on hand quantity plus the sum of outstanding orders) above the reorder point. The other problem is that the system must be under continuous review. This means that as soon as the inventory level falls to the reorder point, the order must be placed; therefore, the order clerks need to be on "stand-by" ready to place orders, in other words, they need to be reactive. This environment requires more people, so they can frequently check the status of the inventory level (either automated or physically), and is not always possible.

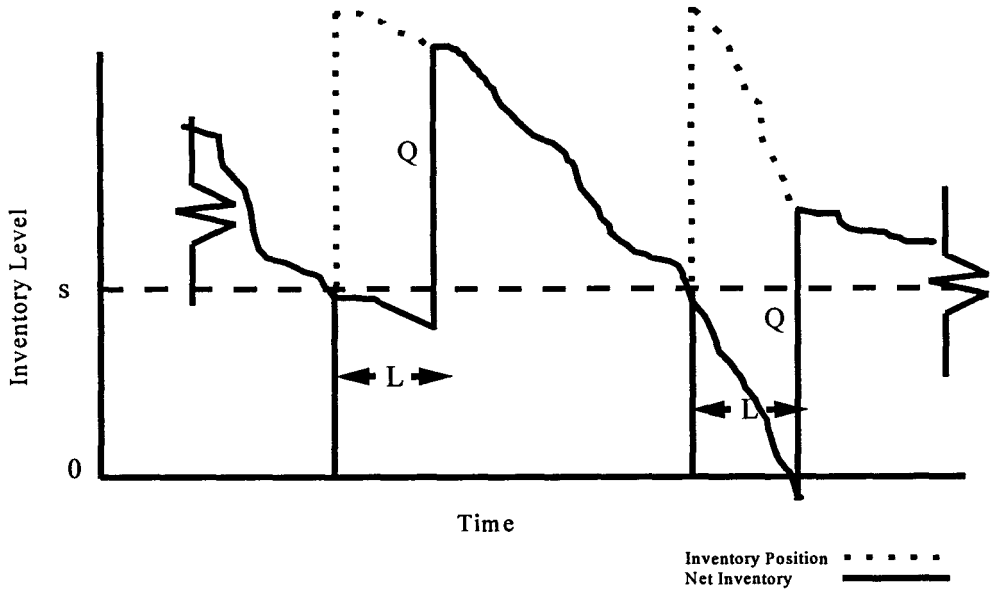


Figure 2: The (*s,Q*) system

Systems which do not require continuous review are attractive because often clerks have many duties and it allows them the ability to schedule all the ordering for a specific day of the month or week as opposed to continually reviewing and placing orders. One simple form of a period review policy is the ***(R,S)*** system. Here every ***R*** time units, the clerk checks the inventory position and places an order to bring the inventory position up to the level ***S***. This system is reasonable to manage because of the period review property, but one problem is that the holding costs and cumulative order costs are higher than in the continuous review case because every period an order is placed. Orders are placed even if the inventory level is only slightly below ***S***, this could be overkill. Figure 3 shows a graph of that represents the inventory level over time.

The final inventory control system we will discuss is the ***(s,S)*** inventory control system. Figure 4 represents this system. This is a hybrid of the two previously defined systems. The ***(s,S)*** system is similar to the ***(R,S)*** in that it is a periodic review system and orders are placed to bring the current inventory position up to level ***S***. However it differs in that an order is not necessarily placed every review period; an order is placed if, and only if, the inventory level is below ***s***, the reorder point. Referring to Figure 4, notice that at points A and D an order is placed, but in the last review period, no order is placed. This is because the inventory level is lot low enough.

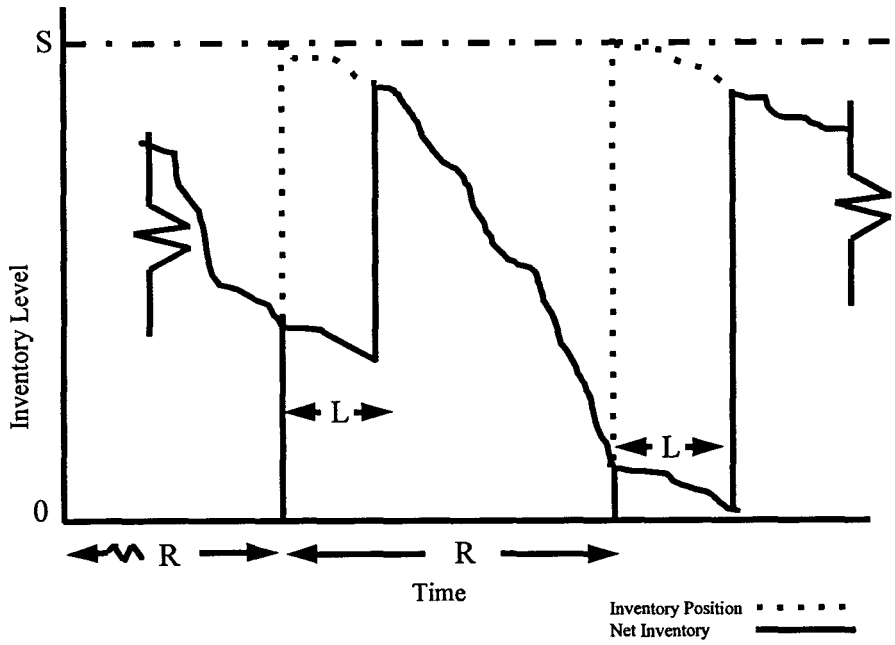


Figure 3: *(R,S)* System

The ***(s,S)*** system has been the focus of much research. Several papers in the area of inventory control theory (Arrow et al., Porteus 1971, Dvoretzy et al., and Ingelhardt) have proven that in many situations, the ***(s,S)*** policy is the optimal policy (least expensive) to use. Wagner et al. wrote a paper to show that there are times when it is not the optimal policy to use. But in general, ***(s,S)*** appears to be the best policy for companies to use; however, it is also the most complicated statistical reorder point policy to use. For these reasons, we have chosen to focus on this policy.

3.2 Determining Optimal (s,S) Policies

According to Nahmias, "determining optimal values of ***(s,S)*** is extremely difficult, and for that reason few real operating systems use optimal ***(s,S)*** policies. Because of this difficulty, many algorithms, heuristics, and approximations have been developed to determine these optimal (or approximately) optimal policies. Information on these techniques can be found in Porteus 1985, Freeland et al., Ehrhardt, and Federgruen. Even these techniques are "difficult" -- not easily implemented or solved. These techniques all involve assumptions, and if the situation you may be dealing with does not fit into the scenarios, then these algorithms and approximations are useless. Examples of these assumptions include stationarity of demand, one-period costs, discrete demand, full backlogging, and long run average cost criterion (Feregruen).

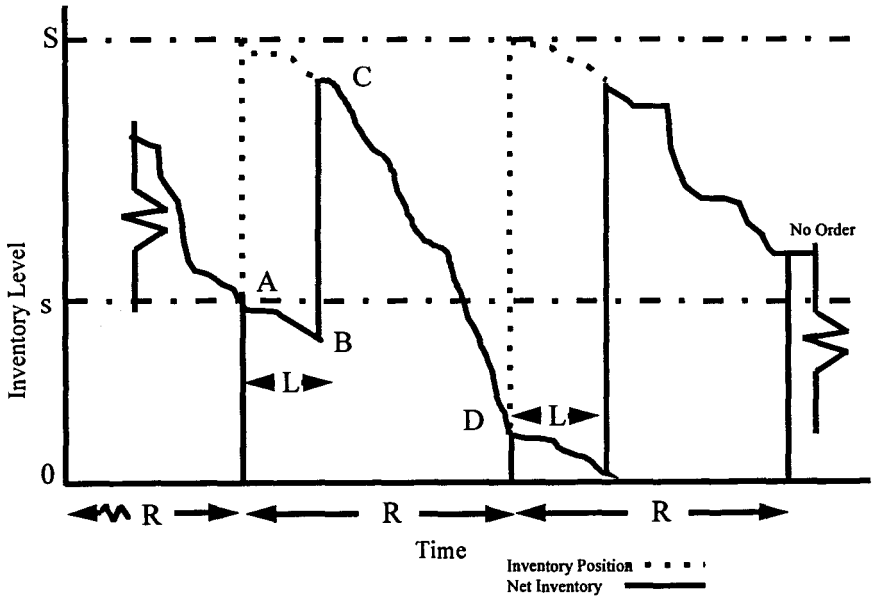


Figure 4: *(s,S)* System

We looked at other more easily solved methods for optimizing ***s*** and ***S***, and simulation seems to be a very popular method. Keaton uses a spreadsheet approach to determine optimal ***(Q,s)*** policies. Several other studies have used simulation techniques to determine other optimal inventory policy parameters , such as safety stock(Mentzer et al. and Zinn).

There are a variety of ways for analytically solving to find the optimal statistical reorder point for a given model. Consider the development of EOQ, as it is shown in most text books, a cost function developed and then the optimal Q is found by minimizing this cost function (with calculus). This method is the most common method to find optimal levels for a given model or policy.

In the development of the cost function, it is always necessary to make some assumptions. In ***(s,S)*** cost function development, allowing for full backlogging (backorders) is usually a key assumption. However in many situations, lost sales occur, instead of backordering. This means that the customers will go elsewhere to meet their demands. An example of the cost function for the ***(s,S)*** system, as fully developed in Hadley and Whitin, is

$$Cost = \frac{A}{R} P(1;\lambda R) + IC * D(S,R) + \pi E(S,R)$$

where

A	=	order cost
λ	=	demand/period
IC	=	invenory cost/period*item
π	=	lost sales cost/period*item
S	=	order-up-to-level
R	=	time period
E(S,R)	=	average number of lost sales/period

$$= \frac{1}{R}\sum_{z=0}^{S}\Psi(z)\sum_{u=z}^{\infty}(u-z)p(\mu;\lambda R)$$

D(S,R)	=	average units stored/period

$$= \frac{1}{R}\sum_{z=0}^{S}\Psi(z)\int_{0}^{R}\sum_{x=0}^{z}(z-x)p(x;\lambda t)dt$$

p(x; λ R)	=	the probability that x units are on hand after a time period R
$\Psi(z)$	=	the probability that z units are on hand after an order arrives

$$= \sum_{y=0}^{S}B(x,y)\Psi(S-y)$$

They also add the following in the text: "Unfortunately...it does not seem possible to solve for $\Psi(z)$ explicitly. Hence for periodic model review systems, it is not possible to formulate exact models for he lost sales case...." As you can see, this is not easily solved, so simulation appears to be our best tool.

3.3 Sensitivity Analysis Considerations.

We looked at what factors will most effect the values of (s,S), as well as the costs. There are many such factors. Clearly, the cost ratios have an effect, as demonstrated by the simple EOQ model. The distribution of the demand, as well as the lead time can also effect the appropriate level of ***s*** and ***S***. This is show in Zinn et al. We need to be able to chose "interesting" values in our sensitivity analysis. So we looked at the question, how high does the order cost need to be to "force" the system to not order every period. This is answered in Love with the following equation:

$$\text{Order Cost} > \frac{1.125*\text{Average\_demand}*\text{penalty\_cost}*\text{holding\_cost}}{\text{penalty\_cost} + \text{holding\_cost}}$$

using our information:

$$\text{Order Cost} > \frac{1.125*(1500)(25)(.50)}{25+.50} = 827.21$$

so we will need to set the order cost above $827.21 to order each week. Since our order cost is already above this level, in the sensitivity analysis, we will consider an order cost well below this threshold.

4. Assumptions

In order to use an (s,S) policy there are several assumptions that must be made, we have also made several other assumptions to simplify our study.

4.1 The SHAZAN toy company is currently using an optimal (s,Q) policy.

We make this assumption because in order to compare the average weekly costs to see if the (*s,S*) policy is better, we were interested in studying and simulating the (*s,S*) and not the (*s,Q*) policy. The (*s,Q*) is much more difficult to simulate, because it is a continuos as opposed to discrete event simulation. Although the holding costs should be lower in the (*s,Q*) policy because *s* will not have to be as high (to protect as long), orders are placed more often. This assumption is certainly one of our most questionable ones.

This is definitely an idea for a future project, to actually do the (*s,Q*) simulations and compare (*s,S*) and (*s,Q*), however doing a continuos time simulation in Excel would be a challenge, if not actually impossible.

4.2 Lead time of an order is a known constant.

We have studied the lead time pattern for the RDW and found that if the order is placed in the during the work week, it arrives in about 2.5 days (0.5 weeks). For example if the clerk placed an order on Friday afternoon for wagons, the will arrive on Wednesday morning. There were 5 weeks in the last two years that the order took 3.5 days to arrive in, and only 2 weeks where the shipment was earlier. This pattern makes us feel fairly certain that this assumption is reasonable.

A future project may want to consider the stochastic nature of the lead time, by assuming some different distributions (as we did for demand).

4.3 *Orders arrive in the order that they are placed.*

This assumption is fairly reasonable, considering that we will only place orders weekly and the lead time is less than one week. This assumption is essential for the use of an (*s*,*S*) policy.

4.4 *Demand in different periods are independent.*

This assumption allows us to simulate the demand with out considering any correlation in the time periods, and is a necessary assumption when using any statistical reorder point method.

4.5 *The demand distribution can be assumed to be normal.*

Here, we are considering the demand for each week and the demand over the week plus the lead time to be normally distributed. This assumption is made so that we can use Excel to generate demand to determine both the reorder-point (*s*) and the order up-to-level (*S*). Once we find this optimal policy with the normal demand we will see if using the actual demand data in the same simulation will give us the same (*s*,*S*) policy. We will look at this assumption in the sensitivity analysis as well, by also considering a uniform
demand.

This assumption is bad, but not horrible. If you look at the Chi-Squared Goodness of Fit Test (p-value = 0.026) included in Appendix A, as well as the histogram of demand, you can see that demand is not really normally distributed. Again, we will look at how bad this assumption is in the sensitivity analysis.

5. Simulation Approach

Because of the requirement that we train the managers at SHAZAN to use the simulation tool that we develop, we decide to use a simple Monte Carlo simulation in Excel. In explaining the setup of the simulation, we will refer to Figure 4 from our Background Section. An example of the initial simulation spreadsheet can be seen in Appendix B. (We also show the formulas used to develop the simulation in Excel.) We are going to use minimum cost as the measure for determining optimality.

The top of the sheet represents the scenario of costs that are used for the simulation. Each row represents one review period or week. The first column is simply the inventory level at A in Figure 4 (On-hand Begin is the On-hand quantity at the beginning of the review period. The second column, Demand, represents the total demand the review period. The next column is the generated demand from a normal distribution with the parameters, Dmean and Dstdev (listed at the top of the spread sheet). (The

second column is just the rounded number from the third column.) The third column, LTD, is the Demand that occurs over the lead time (Leadtime*Actual Demand), representing the total demand from A to B on Figure 4. The next column, Demand - LTD, represents the remainder of the demand that occurs from C to D on Figure 4. The On-hand arrival is the actual inventory level at B, when the delivery occurs. The Scheduled Receipt column is the amount that was ordered at point A; remember this amount is ordered to bring the inventory position up to level ***S***. The On-hand end column shows the inventory level, or quantity on-hand at the end of the review period, which becomes the On-hand Begin amount for the next review period. The cost columns are calculated next and summed for a weekly sales cost. We ran the simulation for seven years (364 weeks). We used the Cum Avg column to see if the simulation reached a steady state, which it did fairly early as shown by the first figure in Appendix B, which is five different runs (each seven years) with the same parameters and costs.

Notice that at the top of the spreadsheet, the reorder point, ***s***, and the order up to point, ***S***, are specified for the simulation run. We used the Excel "what if" feature to then by simultaneously checking a variety of (***s***,***S***) policies. This command generates a table that tries each pair of (***s***,***S***) policies. This allowed us to identify and chose the minimal policy over this range. An example of the output table is also show in Appendix B.

6. Simulation Results

The results of all 96 simulation experiments can be found in Appendix C. The results for our main test case of the Rolly Dolly Wagon (run 2,2,1,1,) are to use (***s***,***S***) of (2500,4400) with an average weekly cost of $1692. This is a savings of approximately $300, on average, per week (from the $1989 average cost) for switching to this new policy.

7. Sensitivity Analysis

The purpose of our sensitivity analysis was to see how "sensitive" our model was to the some the assumptions that were made, as well as to give the workers as SHAZAN an intuitive feel for how each factor effected the (***s***,***S***) policy that was chosen to be the closest to optimal.

In our sensitivity analysis we needed to consider several factors. These factors, their level, and the reasons that we chose them are explained in the next few paragraphs.

7.1 The Demand Distribution

Factor one for our experiment, is the demand distribution. As we said before, we are assuming that the demand is normally distributed, how ever bad this may be. Here we are interested mainly in the shape of the distribution, not the mean (1500). So for factor

one, we consider the normal distribution with three different coefficients of variation (*cv*), one less (0.1), one at (0.2), and one more (0.3) than the current *cv*; we also considered the uniform distribution instead of the normal distribution in this category with a low *cv* (around 0.077).

7.2 The Lead Time

As we said in the assumptions, we are assuming the lead time is a know constant. But what if gets shorter or longer? For facor two, we look at a lead time of 1 day (.2 week), the current level of 2.5 (0.5 week), and 4 days (.8 week).

7.3 The Order Cost

Based on the discussion in the literature review of the ratios of order costs that will "last more than one" review period, we consider on low order cost ($250/order) and one (current) higher one ($1000/order).

7.4 The Variable Order Cost

We added a variable order cost in because the SHAZAN company is currently dealing with a supplier that uses a variable order cost. Although the variable order cost is not currently on their contract, they think it may soon be, and they are interested in the possible effects. We set the level such that if the order was for over 2,000 wagons, then there would be a Variable Order Cost of $3.

7.5 The Experiment & Results

We decided to do a full factorial experiment with two replications with four levels for factor 1, three levels for factor 2, and two levels for both factors 3 and 4. This resulted in 96 simulation runs. We decided that we would test the effects of each of these factors on three different dependent variables, the optimal ***S***, the optimal ***s***, and the minimum cost.

The levels that we uses for each factor in the experiment as well as the experimental results of these 96 simulation runs are given in Appendix C, along with a complete Analysis of Variance. The Anova results are summarized and presented in Table 1. For more details see Appendix C for the actual Anova results.

Table of F - Ratios (p-value)			
Factor	S (order up to level) *	s (order point)	Average Weekly Cost
Demand Distribution	65.16 (>> 0.0001)	136.15 (<< 0.0001)	192. 88 (<< 0.0001)
Lead Time	100.31 (>> 0.0001)	93.81 (<< 0.0001)	13.16 (<< 0.0001)
Order Cost	33.88 (>>0.0001)	0.08	2375. 54 (<< 0.0001)
Variable Order Cost	10.69 (>> 0.0001)	0.59	4.04 (0.05)

Table 1 : ANOVA for Simulation Experiment

* Several Interactions also had a definite effect

For the Average Weekly Cost, as expected, the Order Cost has the biggest effect. It is interesting that our variable order cost had an effect, but it was not that large. This is probably because there where not many times when the variable order cost actually "kicked in." We set the level such that if the order was for over 2,000 wagons, then there would be a Variable Order Cost. The Demand Distribution also has a large effect on the cost. Lead Time and Demand Distribution are the most critical factors in determining the level for ***(s,S)***, as we would expect. The Order Cost and Variable Order Cost both effect the level of ***S***, this is probably a result of the ratio of inventory (or holding) cost to the Order Cost. We did not consider inventory cost as a factor. The level ***S*** needs to be set so that inventory costs are not too high, often approximately equal to the order cost. (See Appendix B for these columns in the spreadsheet.) The level ***S*** is also effected by several of the interactions. The plots for all of these interactions, as well as details to the levels of significance can be seen in Appendix C.

The overall effect of changing the demand distribution is that the uniform distribution has the lowest average weekly cost, as well as the lowest values for ***S*** and ***s***. Similarly for lead time lower Costs, ***S*** and ***s*** result from lower lead time. The plots in Appendix C show this very clearly.

7.6 The Normal Demand Assumption

As we said in the assumptions portion, the demand is not really normally distributed, so we are going to compare our simulated optimal value of (2500,4400) for the data in the problem statement which represents experiment (2,2,1,1) that used a Normal (1500,300) demand. We then redid this simulation sampling from the actual empirical demand distribution, and the optimal policy was found to be (2300,4300) -- not

terribly different, but not exactly the same either. We still feel that the effects demonstrated in the experiment, as well as the results, are valuable.

8. Lesson Learned & Recommendations

This exercise with the SHAZAN Toy company has taught us a lot about the different types of order policies that can be used. In particular we looked in depth at the ***(s,S)*** policy, and gained a lot of insight into how the levels ***s and S*** are set using a simple simulation model. Simulation is the best tool for determining the best levels for ***s and S***, although there are some numerical approximations to determine these levels. These approximations do not handle the cases with lost sales and lead times less than the review period.

Using Excel to do the simulation worked, we were always able to determine the***(s,S)*** policy; however these policies could not be determined to a "tighter" level like (1233,1870) using Excel. This is a problem, but for a rough estimate of the best policy, we are confident that our spread sheet approach works well, and most importantly, it is easy to understand.

We recommend that the SHAZAN Toy Company continue with the process of changing over to ***(s,S)*** policies for all of their toys, as it will definitely save them money and they can implement it with less employees. We have also recommend several options throughout the report to improve this case study (particularly in the area of some of the weaker assumptions). These would all be interesting follow-on projects for other teams.

9. References

Arrow, Kenneth J., T.Harris, and J.Marschak. "Optimal Inventory Policy." *Econometrica*, Vol. 19, No. 3, 1951 p.250-272

Dvoretzky, A., J.Kieffer, and J.Wolfowitz. "On the Optimal Character of the (s,S) Policy in Inventory Theory." *Econometrica*, Vol. 21, No. 4, 1953, p. 586-596.

Ehrhardt, Richard. "The Power Approximation for Computing (s,S) Inventory Policies." *Management Science*, Vol. 25, No. 8 August 1979, p.777-786.

Federgruen, Awi and Paul Zipkin. "An Efficient Algorithm for Coupling Optimal (s,S) Policies." *Operations Research*, Vol. 32, No.6, Nov-Dec 1984, p.1268-1285.

Freeland, James and Evan L. Porteus. "Evaluating the Effectiveness of a New Method for Computing Approximately Optimal (s,S) Inventory Policies." *Operations Research*, March-April 1980, p.353-364.

Hadley G. and T.M.Whitin. *Analysis of Inventory Systems*, Prentice-Hall, Inc. Englewood Cliffs, NJ. 1963.

Hopp, Wallace J. and Marik L. Spearman. *Factory Physics*, Irwin Press. Chicago, IL. 1996.

Ingelhart, Donald L. "Optimality of (s,S) Policies in the Infinite Horizon Dynamic Inventory Problem." *Management Science*, Vol. 9, 1963, p.259-267.

Keaton, Mark. "Determining Reorder Points When Lead Time is Random: A Spread Sheet Implementation." *Production and Inventory Management Journal*, First Quarter, 1995, p.20-26.

Love, Stephen. *Inventory Control*, McGraw-Hill, San Francisco, CA 1979.

Mentzer, John T. and R.Krishnan. "The Effect of the Assumption of Normality on Inventory Control/Customer Service." *Journal of Business Logistics*, Vol. 6, No. 1, 1985, p.101-120.

Nahmias, Steven. *Production and Operations Analysis*, 2nd ed. Irwin Press, Homewood. IL., 1993.

Porteus, Evan L. "Numerical Comparisons of Inventory Policies for Periodic Review Systems." *Operations Research*, Vol. 33, 1985, p.134-152.

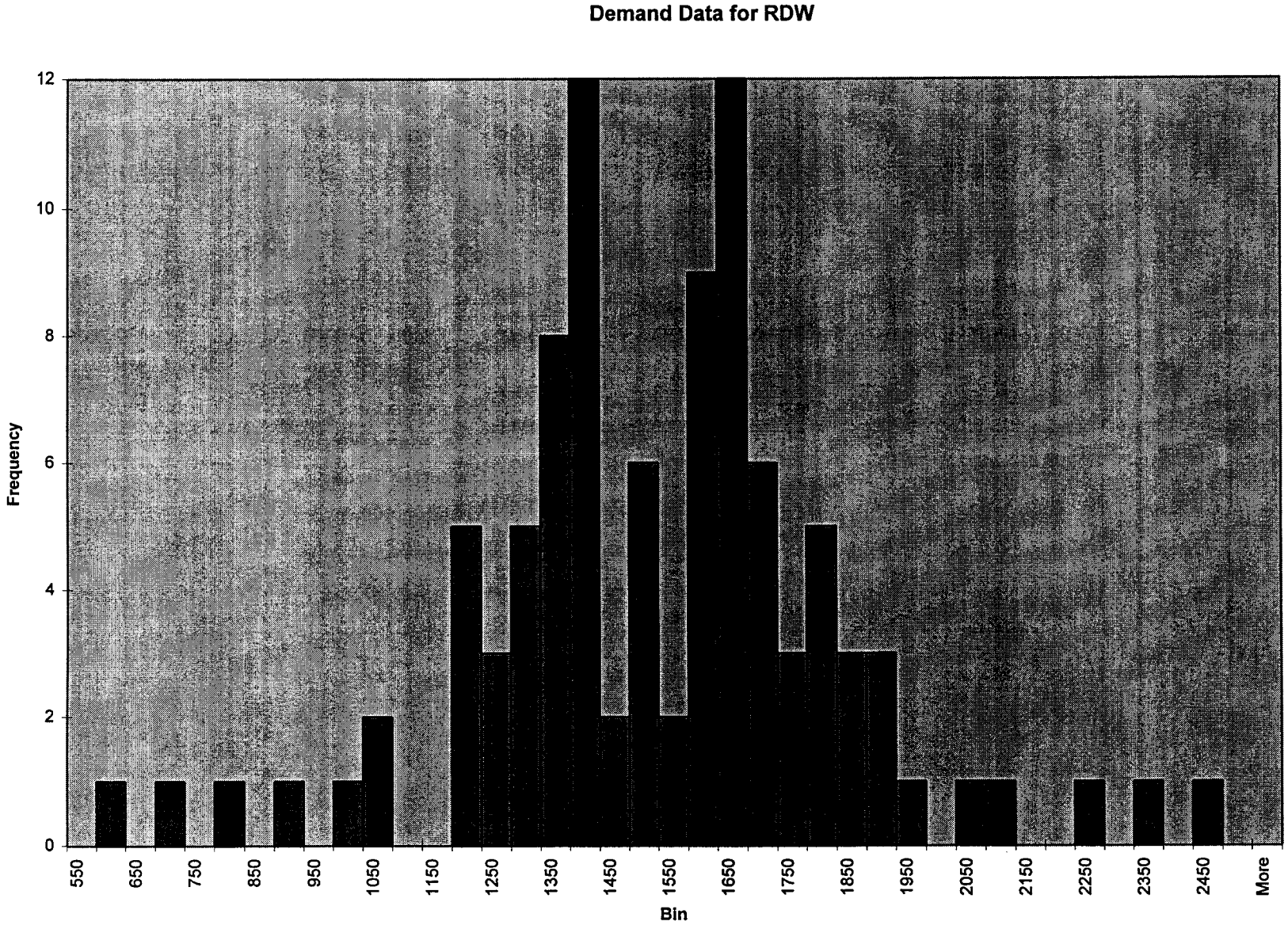
Porteus, Evan L. "On the Optimality of Generalized (s,S) Policies." *Management Science*, No. 7, March 1971, p.411-426.

Silver, Edward A. and Rein Peterson. *Decision Systems for Inventory Management and Production Planning (2nd edition)* John Miley&Sons. New York, NY. 1985.

Wagner, Harvey M.,M.O'Hagon, and B.Lundh. "An Experimental Study of Exactly and Approximately Optimal Inventory Policies." *Management Science*, Vol. 11, No. 7, May 1965, p.690-723.

Zinn, Walter and H.Mannorstein, "Comparing Two Alternative Methods of Determining Safety Stock Levels: The Demand and the Forecast Systems." *Journal of Business Logistics*, Vol. 11 N1, 1990, p.95-110.

Demand Histogram Chart 1



Demand	Normal distributed N(1500,90000)			or Uniform distributed		**Costs**	**$**
Mean	1500			minimum	1300	Fixed Order	$1,000
St Dev	300			maximum	1700	Var Order	$0
Lead time	0.5	week = (days)	2.5	Std	116	(over 1000)	2000
s	2500					Holding(per it	$0.50
S	4400					Lost Sales	$25
						Avg cost	**$1,690.1**
						SECost	**$34.00**

Week	On-Hand Begin	Demand	LTD	Demand-LTD	On hand Arrival	Sche Rec	On-Hand End	Order Amount End	Order Cost	Inventory Cost	Lost Sales Amount	L.Sales Cost	Total Cost	Cum Cost	Cum Avg
1	2500	1968	984	984	1516	1000	1532	2768	1000	1008	0	0	$2,008.00	$2,008.00	$2,008.00
2	1532	1563	782	781	750	3768	3737	0	0	1317.125	0	0	$1,317.13	$3,325.13	$1,662.56
3	3737	1402	701	701	3036	1000	3335	0	0	1768	0	0	$1,768.00	$5,093.13	$1,697.71
4	3335	1951	976	975	2359	0	1384	2916	1000	1179.625	0	0	$2,179.63	$7,272.75	$1,818.19
5	1384	1549	775	774	609	2916	2751	0	0	1033.625	0	0	$1,033.63	$8,306.38	$1,661.28
6	2751	1558	779	779	1972	0	1193	3107	1000	986	0	0	$1,986.00	$10,292.38	$1,715.40
7	1193	1114	557	557	636	3107	3186	0	0	1094.75	0	0	$1,094.75	$11,387.13	$1,626.73
8	3186	1605	803	802	2383	0	1581	2719	1000	1191.625	0	0	$2,191.63	$13,578.75	$1,697.34
9	1581	1446	723	723	858	2719	2854	0	0	1108.75	0	0	$1,108.75	$14,687.50	$1,631.94
10	2854	1110	555	555	2299	0	1744	2556	1000	1149.5	0	0	$2,149.50	$16,837.00	$1,683.70
11	1744	1354	677	677	1067	2556	2946	0	0	1172.5	0	0	$1,172.50	$18,009.50	$1,637.23
12	2946	1091	546	545	2400	0	1855	2445	1000	1200.125	0	0	$2,200.13	$20,209.63	$1,684.14
13	1855	1493	747	746	1108	2445	2807	0	0	1165.375	0	0	$1,165.38	$21,375.00	$1,644.23
14	2807	1566	783	783	2024	0	1241	3059	1000	1012	0	0	$2,012.00	$23,387.00	$1,670.50
15	1241	2103	1052	1051	189	3059	2197	2103	1000	859.375	0	0	$1,859.38	$25,246.38	$1,683.09
16	2197	1459	730	729	1467	2103	2841	0	0	1259.375	0	0	$1,259.38	$26,505.75	$1,656.61
17	2841	1137	569	568	2272	0	1704	2596	1000	1136.125	0	0	$2,136.13	$28,641.88	$1,684.82
18	1704	1503	752	751	952	2596	2797	0	0	1125.125	0	0	$1,125.13	$29,767.00	$1,653.72
19	2797	1066	533	533	2264	0	1731	2569	1000	1132	0	0	$2,132.00	$31,899.00	$1,678.89
20	1731	1187	594	593	1137	2569	3113	0	0	1210.875	0	0	$1,210.88	$33,109.88	$1,655.49
21	3113	1108	554	554	2559	0	2005	2295	1000	1279.5	0	0	$2,279.50	$35,389.38	$1,685.21
22	2005	1209	605	604	1400	2295	3091	0	0	1273.875	0	0	$1,273.88	$36,663.25	$1,666.51
23	3091	1748	874	874	2217	0	1343	2957	1000	1108.5	0	0	$2,108.50	$38,771.75	$1,685.73
24	1343	1226	613	613	730	2957	3074	0	0	1104.25	0	0	$1,104.25	$39,876.00	$1,661.50
25	3074	1548	774	774	2300	0	1526	2774	1000	1150	0	0	$2,150.00	$42,026.00	$1,681.04
26	1526	1326	663	663	863	2774	2974	0	0	1125	0	0	$1,125.00	$43,151.00	$1,659.65
27	2974	1374	687	687	2287	0	1600	2700	1000	1143.5	0	0	$2,143.50	$45,294.50	$1,677.57
28	1600	1300	650	650	950	2700	3000	0	0	1150	0	0	$1,150.00	$46,444.50	$1,658.73
29	3000	2025	1013	1012	1987	0	975	3325	1000	993.625	0	0	$1,993.63	$48,438.13	$1,670.28
30	975	1502	751	751	224	3325	2798	0	0	943.25	0	0	$943.25	$49,381.38	$1,646.05
31	2798	2001	1001	1000	1797	0	797	3503	1000	898.625	0	0	$1,898.63	$51,280.00	$1,654.19
32	797	1443	722	721	75	3503	2857	0	0	913.375	0	0	$913.38	$52,193.38	$1,631.04
33	2857	1579	790	789	2067	0	1278	3022	1000	1033.625	0	0	$2,033.63	$54,227.00	$1,643.24
34	1278	1612	806	806	472	3022	2688	0	0	991.5	0	0	$991.50	$55,218.50	$1,624.07
35	2688	1102	551	551	2137	0	1586	2714	1000	1068.5	0	0	$2,068.50	$57,287.00	$1,636.77
36	1586	1664	832	832	754	2714	2636	0	0	1055.5	0	0	$1,055.50	$58,342.50	$1,620.63
37	2636	1352	676	676	1960	0	1284	3016	1000	980	0	0	$1,980.00	$60,322.50	$1,630.34
38	1284	974	487	487	797	3016	3326	0	0	1152.5	0	0	$1,152.50	$61,475.00	$1,617.76
39	3326	1551	776	775	2550	0	1775	2525	1000	1275.125	0	0	$2,275.13	$63,750.13	$1,634.62
40	1775	1694	847	847	928	2525	2606	0	0	1095.25	0	0	$1,095.25	$64,845.38	$1,621.13
41	2606	1302	651	651	1955	0	1304	2996	1000	977.5	0	0	$1,977.50	$66,822.88	$1,629.83
42	1304	1490	745	745	559	2996	2810	0	0	1028.5	0	0	$1,028.50	$67,851.38	$1,615.51
43	2810	1801	901	900	1909	0	1009	3291	1000	954.625	0	0	$1,954.63	$69,806.00	$1,623.40
44	1009	1884	942	942	67	3291	2416	1884	1000	856.25	0	0	$1,856.25	$71,662.25	$1,628.69
45	2416	1004	502	502	1914	1884	3296	0	0	1428	0	0	$1,428.00	$73,090.25	$1,624.23
46	3296	2104	1052	1052	2244	0	1192	3108	1000	1122	0	0	$2,122.00	$75,212.25	$1,635.05
47	1192	1593	797	796	395	3108	2707	0	0	974.625	0	0	$974.63	$76,186.88	$1,621.00
48	2707	1604	802	802	1905	0	1103	3197	1000	952.5	0	0	$1,952.50	$78,139.38	$1,627.90

FIT Test

Bin	*requency*	*Z*	*UM DIST*	*PROB*	*PR(Bin)*	*Expected*		*Test Stat*
1050	7	-1.5	0.066807	0	0.066807	6.480301		0.041678
1250	8	-0.83333	0.202328	0.066807	0.135521	13.14555		2.014115
1300	5	-0.66667	0.252492	0.202328	0.050164	4.865922		0.003694
1350	8	-0.5	0.308538	0.252492	0.056045	5.436371		1.20893
1400	12	-0.33333	0.369441	0.308538	0.060904	5.907676		6.282745
1500	8	0	0.5	0.369441	0.130559	12.66418		1.717806
1600	11	0.333333	0.630559	0.5	0.130559	12.66418		0.218688
1650	12	0.5	0.691462	0.630559	0.060904	5.907676		6.282745
1700	6	0.666667	0.747508	0.691462	0.056045	5.436371		0.058436
1800	8	1	0.841345	0.747508	0.093837	9.102209		0.133469
1900	6	1.333333	0.908789	0.841345	0.067444	6.542066		0.044915
More	6		1	0.908789	0.091211	8.847494		0.916443
							TEST ST	**18.92366**
							pvalue	**0.02585**

RESULT = Fail to Reject the Null Hypothesis that the data is N(1500,300) at 0.05 significance level.
P-value is approximately 0.026.

Notice: Although we can not reject that the demand data is N(1500,300),
we have only moderate acceptance that it is (P-value is still small).

Table of Excel Formulas

Week	On-Hand Begin	Demand	LTD	Demand-LTD	On hand Arrival	Sche Rec	On-Hand End
1	2500	= CEILING(R12,1)	=CEILING(AI4*C12,1)	=C12-D12	=B12-D12	=1000	=IF(F12>0,F12)+G12-E12
=A12+1	=IF(H12>0,H12,0)	= CEILING(R13,1)	=CEILING(AI4*C13,1)	=C13-D13	=B13-D13	=1000+I12	=IF(F13>0,F13)+G13-E13
=A13+1	=IF(H13>0,H13,0)	= CEILING(R15,1)	=CEILING(AI4*C14,1)	=C14-D14	=B14-D14	=1000+I13	=IF(F14>0,F14)+G14-E14
=A14+1	=IF(H14>0,H14,0)	= CEILING(R14,1)	=CEILING(AI4*C15,1)	=C15-D15	=B15-D15	=I14	=IF(F15>0,F15)+G15-E15

Order Amount End	Order Cost
=IF(H12>AC$3,0,AD$3-IF(H12<0,0,H12))	=IF(I12>J$4,AI$2+AI$3*(I12-J$4),IF(I12=0,0,AI$2))
=IF(H13>AC$3,0,AD$3-IF(H13<0,0,H13))	=IF(I13>J$4,AI$2+AI$3*(I13-J$4),IF(I13=0,0,AI$2))
=IF(H14>AC$3,0,AD$3-IF(H14<0,0,H14))	=IF(I14>J$4,AI$2+AI$3*(I14-J$4),IF(I14=0,0,AI$2))
=IF(H15>AC$3,0,AD$3-IF(H15<0,0,H15))	=IF(I15>J$4,AI$2+AI$3*(I15-J$4),IF(I15=0,0,AI$2))

Inventory Cost
=((IF(B12>0,B12)+IF(F12>0,F12))/2*AI4+(IF(H12>0,H12)+IF(F12>0,F12)+G12)/2*(1-AI4))*J5
=((IF(B13>0,B13)+IF(F13>0,F13))/2*AI4+(IF(H13>0,H13)+IF(F13>0,F13)+G13)/2*(1-AI4))*J5
=((IF(B14>0,B14)+IF(F14>0,F14))/2*AI4+(IF(H14>0,H14)+IF(F14>0,F14)+G14)/2*(1-AI4))*J5
=((IF(B15>0,B15)+IF(F15>0,F15))/2*AI4+(IF(H15>0,H15)+IF(F15>0,F15)+G15)/2*(1-AI4))*J5

Lost Sales Amount	L.Sales Cost	Total Cost	Cum Cost	Cum Avg
=IF(F12<0,-F12,0)+IF(H12<0,-H12,0)	=L12*J$6	=M12+K12+J12	=N12	=O12/A12
=IF(F13<0,-F13,0)+IF(H13<0,-H13,0)	=L13*J$6	=M13+K13+J13	=O12+N13	=O13/A13
=IF(F14<0,-F14,0)+IF(H14<0,-H14,0)	=L14*J$6	=M14+K14+J14	=O13+N14	=O14/A14
=IF(F15<0,-F15,0)+IF(H15<0,-H15,0)	=L15*J$6	=M15+K15+J15	=O14+N15	=O15/A15

Appendix A
Demand Data

167	3376	1403	702	701	2674	0	1973	2327	1000	1337.125	0	0	$2,337.13	$282,308.50	$1,690.47
168	1973	1596	798	798	1175	2327	2704	0	0	1169.25	0	0	$1,169.25	$283,477.75	$1,687.37
169	2704	1247	624	623	2080	0	1457	2843	1000	1040.125	0	0	$2,040.13	$285,517.88	$1,689.45
170	1457	1825	913	912	544	2843	2475	1825	1000	982.875	0	0	$1,982.88	$287,500.75	$1,691.18
171	2475	1670	835	835	1640	1825	2630	0	0	1276.25	0	0	$1,276.25	$288,777.00	$1,688.75
172	2630	1177	589	588	2041	0	1453	2847	1000	1020.625	0	0	$2,020.63	$290,797.63	$1,690.68
173	1453	1149	575	574	878	2847	3151	0	0	1150.875	0	0	$1,150.88	$291,948.50	$1,687.56
174	3151	1214	607	607	2544	0	1937	2363	1000	1272	0	0	$2,272.00	$294,220.50	$1,690.92
175	1937	1142	571	571	1366	2363	3158	0	0	1273.75	0	0	$1,273.75	$295,494.25	$1,688.54
176	3158	1917	959	958	2199	0	1241	3059	1000	1099.625	0	0	$2,099.63	$297,593.88	$1,690.87
177	1241	1452	726	726	515	3059	2848	0	0	1022.25	0	0	$1,022.25	$298,616.13	$1,687.10
178	2848	1556	778	778	2070	0	1292	3008	1000	1035	0	0	$2,035.00	$300,651.13	$1,689.05
179	1292	911	456	455	836	3008	3389	0	0	1170.125	0	0	$1,170.13	$301,821.25	$1,686.15
180	3389	1262	631	631	2758	0	2127	2173	1000	1379	0	0	$2,379.00	$304,200.25	$1,690.00
181	2127	1544	772	772	1355	2173	2756	0	0	1220.75	0	0	$1,220.75	$305,421.00	$1,687.41
182	2756	1597	799	798	1957	0	1159	3141	1000	978.625	0	0	$1,978.63	$307,399.63	$1,689.01
183	1159	1882	941	941	218	3141	2418	1882	1000	894.25	0	0	$1,894.25	$309,293.88	$1,690.13
184	2418	1798	899	899	1519	1882	2502	0	0	1230	0	0	$1,230.00	$310,523.88	$1,687.63
185	2502	1430	715	715	1787	0	1072	3228	1000	893.5	0	0	$1,893.50	$312,417.38	$1,688.74
186	1072	1202	601	601	471	3228	3098	0	0	1042.5	0	0	$1,042.50	$313,459.88	$1,685.27
187	3098	1374	687	687	2411	0	1724	2576	1000	1205.5	0	0	$2,205.50	$315,665.38	$1,688.05
188	1724	1802	901	901	823	2576	2498	1802	1000	1055.5	0	0	$2,055.50	$317,720.88	$1,690.00
189	2498	1774	887	887	1611	1802	2526	0	0	1256	0	0	$1,256.00	$318,976.88	$1,687.71
190	2526	1800	900	900	1626	0	726	3574	1000	813	0	0	$1,813.00	$320,789.88	$1,688.37
191	726	1837	919	918	-193	3574	2656	0	0	869.5	193	4825	$5,694.50	$326,484.38	$1,709.34
192	2656	1544	772	772	1884	0	1112	3188	1000	942	0	0	$1,942.00	$328,426.38	$1,710.55
193	1112	1829	915	914	197	3188	2471	1829	1000	895.625	0	0	$1,895.63	$330,322.00	$1,711.51
194	2471	1625	813	812	1658	1829	2675	0	0	1286.375	0	0	$1,286.38	$331,608.38	$1,709.32
195	2675	1093	547	546	2128	0	1582	2718	1000	1064.125	0	0	$2,064.13	$333,672.50	$1,711.14
196	1582	1757	879	878	703	2718	2543	0	0	1031.125	0	0	$1,031.13	$334,703.63	$1,707.67
197	2543	1898	949	949	1594	0	645	3655	1000	797	0	0	$1,797.00	$336,500.63	$1,708.13
198	645	1792	896	896	-251	3655	2759	0	0	882.375	251	6275	$7,157.38	$343,658.00	$1,735.65
199	2759	1199	600	599	2159	0	1560	2740	1000	1079.625	0	0	$2,079.63	$345,737.63	$1,737.38
200	1560	1656	828	828	732	2740	2644	0	0	1051	0	0	$1,051.00	$346,788.63	$1,733.94
201	2644	1940	970	970	1674	0	704	3596	1000	837	0	0	$1,837.00	$348,625.63	$1,734.46
202	704	1439	720	719	-16	3596	2877	0	0	897.125	16	400	$1,297.13	$349,922.75	$1,732.29
203	2877	1707	854	853	2023	0	1170	3130	1000	1011.625	0	0	$2,011.63	$351,934.38	$1,733.67
204	1170	1442	721	721	449	3130	2858	0	0	1007	0	0	$1,007.00	$352,941.38	$1,730.10
205	2858	729	365	364	2493	0	2129	2171	1000	1246.625	0	0	$2,246.63	$355,188.00	$1,732.62
206	2129	2077	1039	1038	1090	2171	2223	2077	1000	1087.875	0	0	$2,087.88	$357,275.88	$1,734.35
207	2223	812	406	406	1817	2077	3488	0	0	1427.75	0	0	$1,427.75	$358,703.63	$1,732.87
208	3488	1652	826	826	2662	0	1836	2464	1000	1331	0	0	$2,331.00	$361,034.63	$1,735.74
209	1836	1351	676	675	1160	2464	2949	0	0	1196.125	0	0	$1,196.13	$362,230.75	$1,733.16
210	2949	1826	913	913	2036	0	1123	3177	1000	1018	0	0	$2,018.00	$364,248.75	$1,734.52
211	1123	1388	694	694	429	3177	2912	0	0	1008.75	0	0	$1,008.75	$365,257.50	$1,731.08
212	2912	1620	810	810	2102	0	1292	3008	1000	1051	0	0	$2,051.00	$367,308.50	$1,732.59
213	1292	2202	1101	1101	191	3008	2098	2202	1000	847.5	0	0	$1,847.50	$369,156.00	$1,733.13
214	2098	1724	862	862	1236	2202	2576	0	0	1168.5	0	0	$1,168.50	$370,324.50	$1,730.49
215	2576	1240	620	620	1956	0	1336	2964	1000	978	0	0	$1,978.00	$372,302.50	$1,731.64
216	1336	1610	805	805	531	2964	2690	0	0	1006.5	0	0	$1,006.50	$373,309.00	$1,728.28
217	2690	1445	723	722	1967	0	1245	3055	1000	983.625	0	0	$1,983.63	$375,292.63	$1,729.46
218	1245	1539	770	769	475	3055	2761	0	0	1001.375	0	0	$1,001.38	$376,294.00	$1,726.12
219	2761	1415	708	707	2053	0	1346	2954	1000	1026.625	0	0	$2,026.63	$378,320.63	$1,727.49
220	1346	1516	758	758	588	2954	2784	0	0	1032.5	0	0	$1,032.50	$379,353.13	$1,724.33
221	2784	1668	834	834	1950	0	1116	3184	1000	975	0	0	$1,975.00	$381,328.13	$1,725.47
222	1116	1567	784	783	332	3184	2733	0	0	962.125	0	0	$962.13	$382,290.25	$1,722.03
223	2733	1547	774	773	1959	0	1186	3114	1000	979.625	0	0	$1,979.63	$384,269.88	$1,723.18
224	1186	1027	514	513	672	3114	3273	0	0	1114.625	0	0	$1,114.63	$385,384.50	$1,720.47
225	3273	998	499	499	2774	0	2275	2025	1000	1387	0	0	$2,387.00	$387,771.50	$1,723.43

Week	*Demand*
1	1351
2	2245
3	1643
4	888
5	1345
6	1366
7	1678
8	1392
9	1398
10	1626
11	1577
12	768
13	1643
14	1589
15	1620
16	1593
17	1613
18	1897
19	1617
20	1638
21	1572
22	1370
23	1618
24	1261
25	1400
26	1948
27	1816
28	1672
29	1245
30	1651
31	1479
32	1818
33	1900
34	1382
35	1774
36	1697
37	1286
38	1573
39	1709
40	1789
41	1293
42	1612
43	1554
44	1380
45	1321
46	1414
47	1288
48	1749

Average	*1503.6*
St Dev	*311.8*

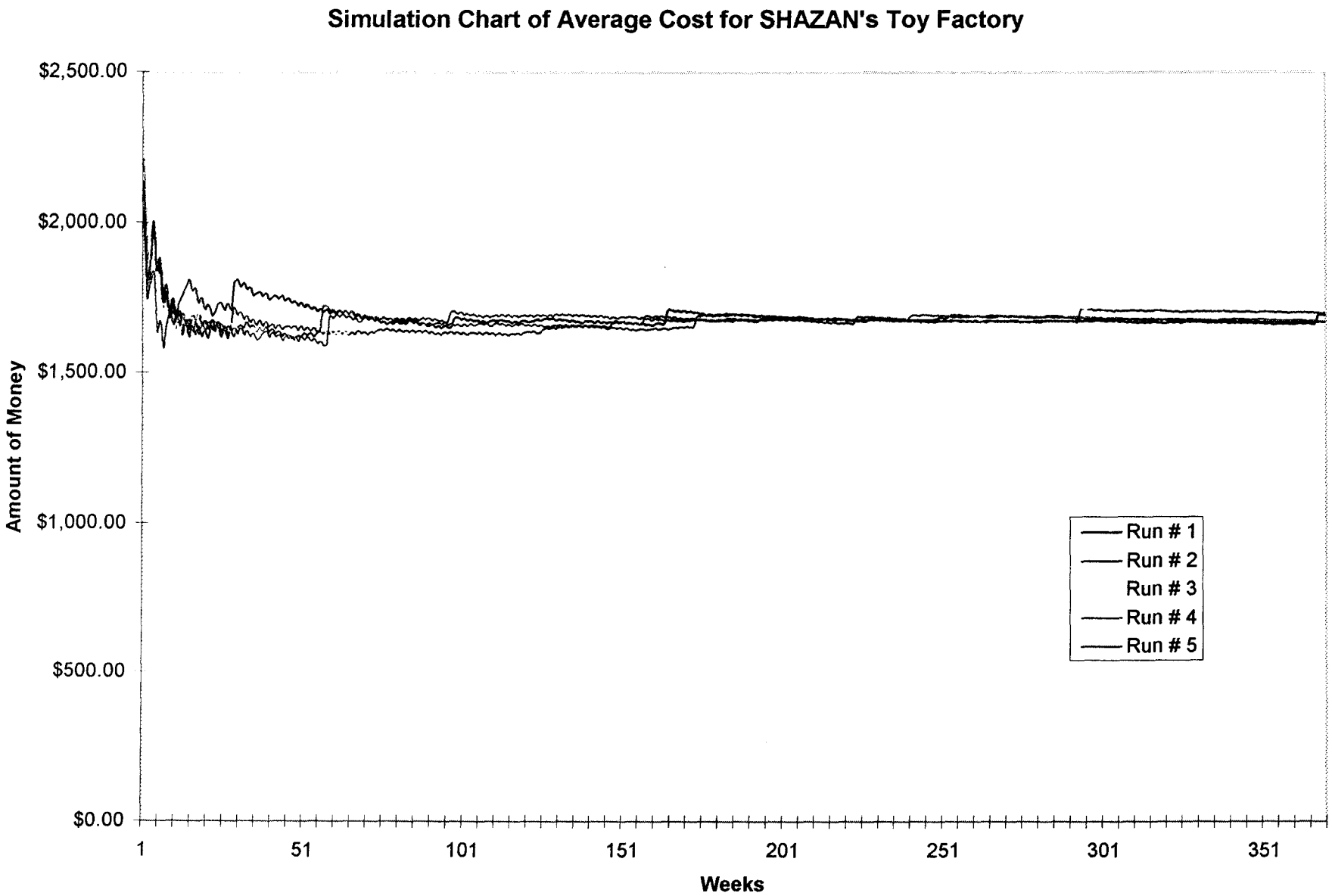
108	2753	1982	991	991	1762	0	771	3529	1000	881	0	0	$1,881.00	$181,389.00	$1,679.53
109	771	1277	639	638	132	3529	3023	0	0	948.375	0	0	$948.38	$182,337.38	$1,672.82
110	3023	893	447	446	2576	0	2130	2170	1000	1288.125	0	0	$2,288.13	$184,625.50	$1,678.41
111	2130	1157	579	578	1551	2170	3143	0	0	1318.125	0	0	$1,318.13	$185,943.63	$1,675.17
112	3143	1741	871	870	2272	0	1402	2898	1000	1136.125	0	0	$2,136.13	$188,079.75	$1,679.28
113	1402	1337	669	668	733	2898	2963	0	0	1091.125	0	0	$1,091.13	$189,170.88	$1,674.08
114	2963	1613	807	806	2156	0	1350	2950	1000	1078.125	0	0	$2,078.13	$191,249.00	$1,677.62
115	1350	1461	731	730	619	2950	2839	0	0	1047.125	0	0	$1,047.13	$192,296.13	$1,672.14
116	2839	1363	682	681	2157	0	1476	2824	1000	1078.625	0	0	$2,078.63	$194,374.75	$1,675.64
117	1476	1344	672	672	804	2824	2956	0	0	1108	0	0	$1,108.00	$195,482.75	$1,670.79
118	2956	1626	813	813	2143	0	1330	2970	1000	1071.5	0	0	$2,071.50	$197,554.25	$1,674.19
119	1330	1466	733	733	597	2970	2834	0	0	1041	0	0	$1,041.00	$198,595.25	$1,668.87
120	2834	1503	752	751	2082	0	1331	2969	1000	1041.125	0	0	$2,041.13	$200,636.38	$1,671.97
121	1331	1041	521	520	810	2969	3259	0	0	1147.375	0	0	$1,147.38	$201,783.75	$1,667.63
122	3259	1700	850	850	2409	0	1559	2741	1000	1204.5	0	0	$2,204.50	$203,988.25	$1,672.03
123	1559	1465	733	732	826	2741	2835	0	0	1098.375	0	0	$1,098.38	$205,086.63	$1,667.37
124	2835	1859	930	929	1905	0	976	3324	1000	952.625	0	0	$1,952.63	$207,039.25	$1,669.67
125	976	1554	777	777	199	3324	2746	0	0	930.5	0	0	$930.50	$207,969.75	$1,663.76
126	2746	1319	660	659	2086	0	1427	2873	1000	1043.125	0	0	$2,043.13	$210,012.88	$1,666.77
127	1427	1412	706	706	721	2873	2888	0	0	1078.75	0	0	$1,078.75	$211,091.63	$1,662.14
128	2888	1579	790	789	2098	0	1309	2991	1000	1049.125	0	0	$2,049.13	$213,140.75	$1,665.16
129	1309	1880	940	940	369	2991	2420	1880	1000	932.25	0	0	$1,932.25	$215,073.00	$1,667.23
130	2420	1530	765	765	1655	1880	2770	0	0	1297.5	0	0	$1,297.50	$216,370.50	$1,664.39
131	2770	2020	1010	1010	1760	0	750	3550	1000	880	0	0	$1,880.00	$218,250.50	$1,666.03
132	750	1236	618	618	132	3550	3064	0	0	953.5	0	0	$953.50	$219,204.00	$1,660.64
133	3064	1472	736	736	2328	0	1592	2708	1000	1164	0	0	$2,164.00	$221,368.00	$1,664.42
134	1592	1885	943	942	649	2708	2415	1885	1000	1001.625	0	0	$2,001.63	$223,369.63	$1,666.94
135	2415	1159	580	579	1835	1885	3141	0	0	1388.875	0	0	$1,388.88	$224,758.50	$1,664.88
136	3141	1411	706	705	2435	0	1730	2570	1000	1217.625	0	0	$2,217.63	$226,976.13	$1,668.94
137	1730	811	406	405	1324	2570	3489	0	0	1304.625	0	0	$1,304.63	$228,280.75	$1,666.28
138	3489	1936	968	968	2521	0	1553	2747	1000	1260.5	0	0	$2,260.50	$230,541.25	$1,670.59
139	1553	1811	906	905	647	2747	2489	1811	1000	1010.375	0	0	$2,010.38	$232,551.63	$1,673.03
140	2489	1911	956	955	1533	1811	2389	1911	1000	1219.375	0	0	$2,219.38	$234,771.00	$1,676.94
141	2389	1843	922	921	1467	1911	2457	1843	1000	1211.375	0	0	$2,211.38	$236,982.38	$1,680.73
142	2457	1559	780	779	1677	1843	2741	0	0	1299.375	0	0	$1,299.38	$238,281.75	$1,678.04
143	2741	1827	914	913	1827	0	914	3386	1000	913.625	0	0	$1,913.63	$240,195.38	$1,679.69
144	914	1918	959	959	-45	3386	2427	1873	1000	840.875	45	1125	$2,965.88	$243,161.25	$1,688.62
145	2427	1546	773	773	1654	1873	2754	0	0	1295.25	0	0	$1,295.25	$244,456.50	$1,685.91
146	2754	1556	778	778	1976	0	1198	3102	1000	988	0	0	$1,988.00	$246,444.50	$1,687.98
147	1198	923	462	461	736	3102	3377	0	0	1143.625	0	0	$1,143.63	$247,588.13	$1,684.27
148	3377	1684	842	842	2535	0	1693	2607	1000	1267.5	0	0	$2,267.50	$249,855.63	$1,688.21
149	1693	1890	945	945	748	2607	2410	1890	1000	1025.75	0	0	$2,025.75	$251,881.38	$1,690.48
150	2410	1505	753	752	1657	1890	2795	0	0	1301.125	0	0	$1,301.13	$253,182.50	$1,687.88
151	2795	1491	746	745	2049	0	1304	2996	1000	1024.625	0	0	$2,024.63	$255,207.13	$1,690.11
152	1304	1836	918	918	386	2996	2464	1836	1000	942	0	0	$1,942.00	$257,149.13	$1,691.77
153	2464	1482	741	741	1723	1836	2818	0	0	1320.5	0	0	$1,320.50	$258,469.63	$1,689.34
154	2818	1361	681	680	2137	0	1457	2843	1000	1068.625	0	0	$2,068.63	$260,538.25	$1,691.81
155	1457	1626	813	813	644	2843	2674	0	0	1032.75	0	0	$1,032.75	$261,571.00	$1,687.55
156	2674	1398	699	699	1975	0	1276	3024	1000	987.5	0	0	$1,987.50	$263,558.50	$1,689.48
157	1276	1256	628	628	648	3024	3044	0	0	1080	0	0	$1,080.00	$264,638.50	$1,685.60
158	3044	955	478	477	2566	0	2089	2211	1000	1283.125	0	0	$2,283.13	$266,921.63	$1,689.38
159	2089	1978	989	989	1100	2211	2322	1978	1000	1102.75	0	0	$2,102.75	$269,024.38	$1,691.98
160	2322	1555	778	777	1544	1978	2745	0	0	1266.625	0	0	$1,266.63	$270,291.00	$1,689.32
161	2745	1300	650	650	2095	0	1445	2855	1000	1047.5	0	0	$2,047.50	$272,338.50	$1,691.54
162	1445	1195	598	597	847	2855	3105	0	0	1137.375	0	0	$1,137.38	$273,475.88	$1,688.12
163	3105	1667	834	833	2271	0	1438	2862	1000	1135.625	0	0	$2,135.63	$275,611.50	$1,690.87
164	1438	1468	734	734	704	2862	2832	0	0	1067.5	0	0	$1,067.50	$276,679.00	$1,687.07
165	2832	1351	676	675	2156	0	1481	2819	1000	1078.125	0	0	$2,078.13	$278,757.13	$1,689.44
166	1481	924	462	462	1019	2819	3376	0	0	1214.25	0	0	$1,214.25	$279,971.38	$1,686.57

49	1593
50	1788
51	1843
52	1335
53	1703
54	1598
55	1891
56	1467
57	1613
58	1336
59	2044
60	1488
61	1333
62	1477
63	1752
64	1194
65	1369
66	1309
67	1513
68	1787
69	1466
70	2100
71	972
72	1178
73	1160
74	1351
75	2345
76	1560
77	1359
78	1039
79	1652
80	1154
81	1423
82	554
83	1244
84	1161
85	1339
86	1486
87	1279
88	1333
89	1681
90	1243
91	678
92	1526
93	2414
94	1016
95	1637
96	1615
97	1395

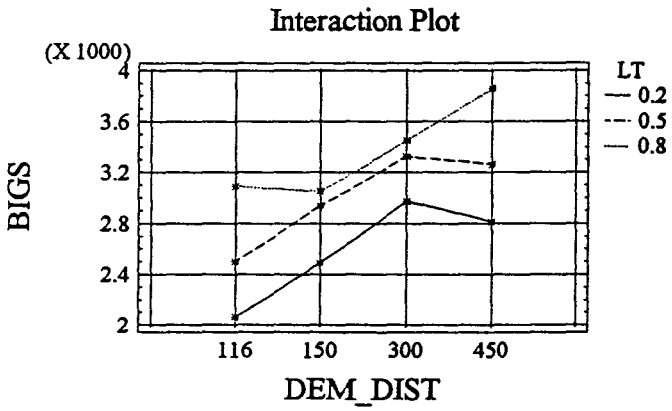
49	1103	1563	782	781	321	3197	2737	0	0	959.875	0	0	$959.88	$79,099.25	$1,614.27
50	2737	1795	898	897	1839	0	942	3358	1000	919.625	0	0	$1,919.63	$81,018.88	$1,620.38
51	942	1601	801	800	141	3358	2699	0	0	910.125	0	0	$910.13	$81,929.00	$1,606.45
52	2699	1707	854	853	1845	0	992	3308	1000	922.625	0	0	$1,922.63	$83,851.63	$1,612.53
53	992	1445	723	722	269	3308	2855	0	0	961.625	0	0	$961.63	$84,813.25	$1,600.25
54	2855	1568	784	784	2071	0	1287	3013	1000	1035.5	0	0	$2,035.50	$86,848.75	$1,608.31
55	1287	1653	827	826	460	3013	2647	0	0	983.375	0	0	$983.38	$87,832.13	$1,596.95
56	2647	1153	577	576	2070	0	1494	2806	1000	1035.125	0	0	$2,035.13	$89,867.25	$1,604.77
57	1494	1518	759	759	735	2806	2782	0	0	1069	0	0	$1,069.00	$90,936.25	$1,595.37
58	2782	1913	957	956	1825	0	869	3431	1000	912.625	0	0	$1,912.63	$92,848.88	$1,600.84
59	869	1281	641	640	228	3431	3019	0	0	971.875	0	0	$971.88	$93,820.75	$1,590.18
60	3019	1399	700	699	2319	0	1620	2680	1000	1159.625	0	0	$2,159.63	$95,980.38	$1,599.67
61	1620	1633	817	816	803	2680	2667	0	0	1071.625	0	0	$1,071.63	$97,052.00	$1,591.02
62	2667	1786	893	893	1774	0	881	3419	1000	887	0	0	$1,887.00	$98,939.00	$1,595.79
63	881	1930	965	965	-84	3419	2454	1846	1000	844.25	84	2100	$3,944.25	$102,883.25	$1,633.07
64	2454	1164	582	582	1872	1846	3136	0	0	1397.5	0	0	$1,397.50	$104,280.75	$1,629.39
65	3136	1251	626	625	2510	0	1885	2415	1000	1255.125	0	0	$2,255.13	$106,535.88	$1,639.01
66	1885	1362	681	681	1204	2415	2938	0	0	1205.75	0	0	$1,205.75	$107,741.63	$1,632.45
67	2938	1507	754	753	2184	0	1431	2869	1000	1092.125	0	0	$2,092.13	$109,833.75	$1,639.31
68	1431	1958	979	979	452	2869	2342	1958	1000	943.25	0	0	$1,943.25	$111,777.00	$1,643.78
69	2342	1714	857	857	1485	1958	2586	0	0	1232	0	0	$1,232.00	$113,009.00	$1,637.81
70	2586	1168	584	584	2002	0	1418	2882	1000	1001	0	0	$2,001.00	$115,010.00	$1,643.00
71	1418	1503	752	751	666	2882	2797	0	0	1053.625	0	0	$1,053.63	$116,063.63	$1,634.70
72	2797	1475	738	737	2059	0	1322	2978	1000	1029.625	0	0	$2,029.63	$118,093.25	$1,640.18
73	1322	1105	553	552	769	2978	3195	0	0	1129.125	0	0	$1,129.13	$119,222.38	$1,633.18
74	3195	1637	819	818	2376	0	1558	2742	1000	1188.125	0	0	$2,188.13	$121,410.50	$1,640.68
75	1558	1172	586	586	972	2742	3128	0	0	1171.5	0	0	$1,171.50	$122,582.00	$1,634.43
76	3128	1172	586	586	2542	0	1956	2344	1000	1271	0	0	$2,271.00	$124,853.00	$1,642.80
77	1956	1334	667	667	1289	2344	2966	0	0	1230.5	0	0	$1,230.50	$126,083.50	$1,637.45
78	2966	1196	598	598	2368	0	1770	2530	1000	1184	0	0	$2,184.00	$128,267.50	$1,644.46
79	1770	1972	986	986	784	2530	2328	1972	1000	1024.5	0	0	$2,024.50	$130,292.00	$1,649.27
80	2328	1351	676	675	1652	1972	2949	0	0	1319.125	0	0	$1,319.13	$131,611.13	$1,645.14
81	2949	1292	646	646	2303	0	1657	2643	1000	1151.5	0	0	$2,151.50	$133,762.63	$1,651.39
82	1657	1847	924	923	733	2643	2453	1847	1000	1027.375	0	0	$2,027.38	$135,790.00	$1,655.98
83	2453	1912	956	956	1497	1847	2388	1912	1000	1210.25	0	0	$2,210.25	$138,000.25	$1,662.65
84	2388	2036	1018	1018	1370	1912	2264	2036	1000	1163	0	0	$2,163.00	$140,163.25	$1,668.61
85	2264	1773	887	886	1377	2036	2527	0	0	1197.625	0	0	$1,197.63	$141,360.88	$1,663.07
86	2527	1739	870	869	1657	0	788	3512	1000	828.625	0	0	$1,828.63	$143,189.50	$1,664.99
87	788	1936	968	968	-180	3512	2544	0	0	855.5	180	4500	$5,355.50	$148,545.00	$1,707.41
88	2544	1559	780	779	1764	0	985	3315	1000	882.125	0	0	$1,882.13	$150,427.13	$1,709.40
89	985	1589	795	794	190	3315	2711	0	0	923.875	0	0	$923.88	$151,351.00	$1,700.57
90	2711	1709	855	854	1856	0	1002	3298	1000	928.125	0	0	$1,928.13	$153,279.13	$1,703.10
91	1002	1132	566	566	436	3298	3168	0	0	1042.5	0	0	$1,042.50	$154,321.63	$1,695.84
92	3168	1320	660	660	2508	0	1848	2452	1000	1254	0	0	$2,254.00	$156,575.63	$1,701.91
93	1848	1353	677	676	1171	2452	2947	0	0	1198.625	0	0	$1,198.63	$157,774.25	$1,696.50
94	2947	1717	859	858	2088	0	1230	3070	1000	1044.125	0	0	$2,044.13	$159,818.38	$1,700.20
95	1230	1643	822	821	408	3070	2657	0	0	971.625	0	0	$971.63	$160,790.00	$1,692.53
96	2657	1498	749	749	1908	0	1159	3141	1000	954	0	0	$1,954.00	$162,744.00	$1,695.25
97	1159	1791	896	895	263	3141	2509	0	0	916.875	0	0	$916.88	$163,660.88	$1,687.23
98	2509	1111	556	555	1953	0	1398	2902	1000	976.625	0	0	$1,976.63	$165,637.50	$1,690.18
99	1398	1788	894	894	504	2902	2512	0	0	977.5	0	0	$977.50	$166,615.00	$1,682.98
100	2512	1251	626	625	1886	0	1261	3039	1000	943.125	0	0	$1,943.13	$168,558.13	$1,685.58
101	1261	1343	672	671	589	3039	2957	0	0	1054.375	0	0	$1,054.38	$169,612.50	$1,679.33
102	2957	1513	757	756	2200	0	1444	2856	1000	1100.125	0	0	$2,100.13	$171,712.63	$1,683.46
103	1444	1339	670	669	774	2856	2961	0	0	1101.125	0	0	$1,101.13	$172,813.75	$1,677.80
104	2961	1193	597	596	2364	0	1768	2532	1000	1182.125	0	0	$2,182.13	$174,995.88	$1,682.65
105	1768	1550	775	775	993	2532	2750	0	0	1129.5	0	0	$1,129.50	$176,125.38	$1,677.38
106	2750	736	368	368	2382	0	2014	2286	1000	1191	0	0	$2,191.00	$178,316.38	$1,682.23
107	2014	1547	774	773	1240	2286	2753	0	0	1191.625	0	0	$1,191.63	$179,508.00	$1,677.64

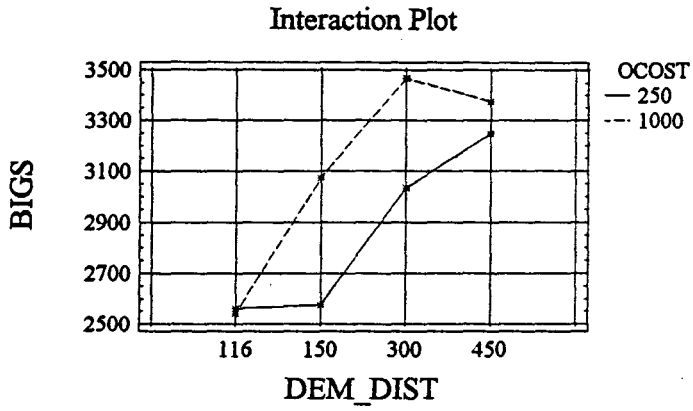
Appendix B
Simulation Experiment Setup & Examples

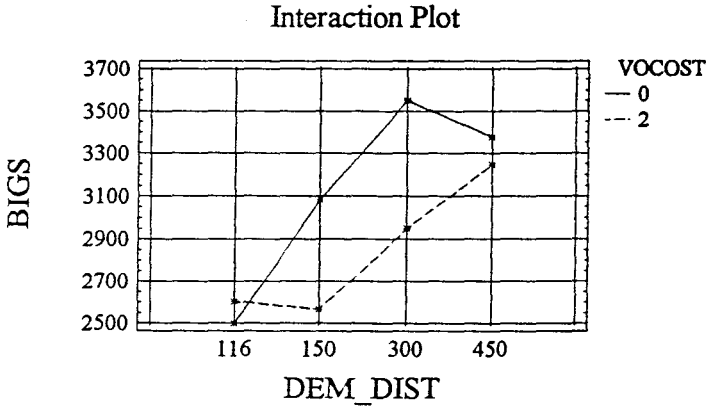
	A	B	C	D	E	F	G	H	I	J
1									**Costs**	$
2		**Demand**	Normal distributed N(1500,90000)			**or** Uniform distributed			Fixed Order	$1,000
3		Mean	1500			minimum	1300		Var Order	$0
4		St Dev	300			maximum	1700		(over 2000)	2000
5		Lead time	0.5	week = (days)	2.5	Std	116		Holding(per item)	$0.50
6		s	2500						Lost Sales	$25
7		S	4400						**Avg cost**	**$1,690.12**
8									**SECost**	**$34.00**

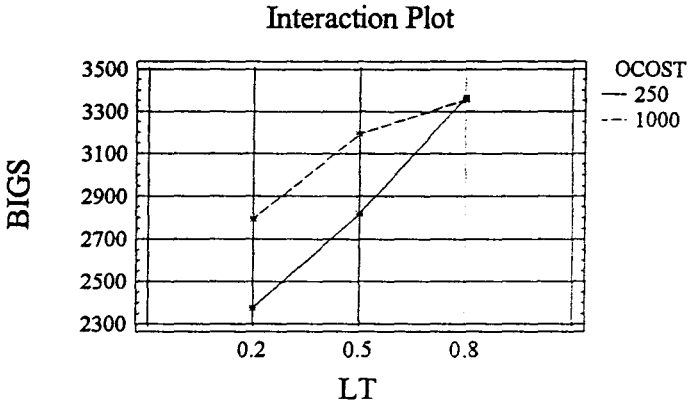

Simulation Chart of Average Cost for SHAZAN's Toy Factory
$2,500.00
$2,000.00
$1,500.00
$1,000.00
$500.00
$0.00
Amount of Money
1
51
101
151
201
251
301
351
Weeks
Run # 1
Run # 2
Run # 3
Run # 4
Run # 5

Diane Nelson

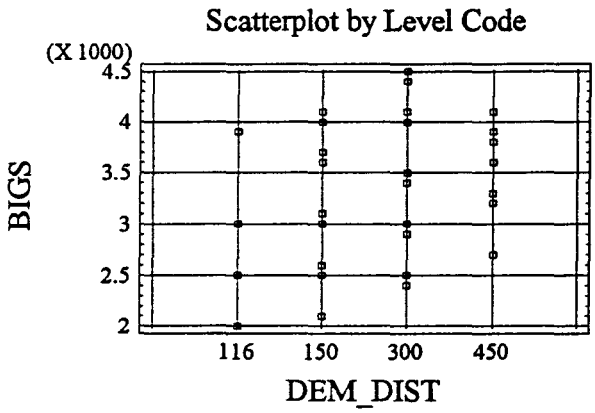


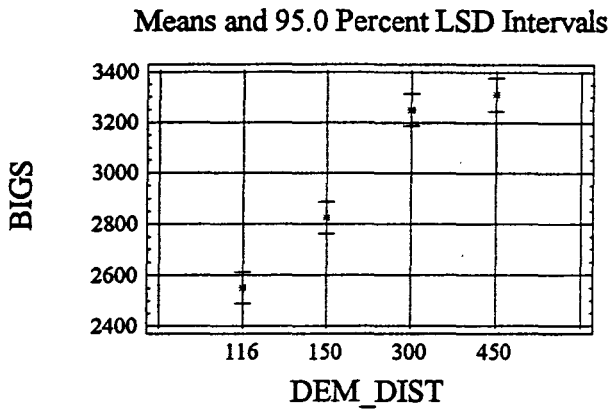


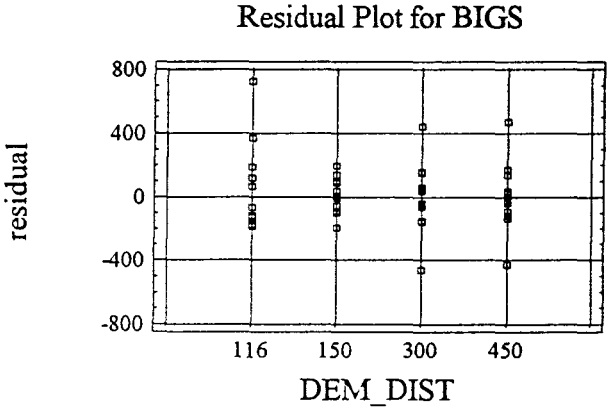




Diane Nelson







Diane Nelson

Table of Least Squares Means for BIGS
with 95.0 Percent Confidence Intervals

Level		Count	Mean	Stnd. Error	Lower Limit	Upper Limit
GRAND MEAN		96	2984.23			
DEM_DIST						
116		25	2551.02	43.901	2463.0	2639.04
150		24	2825.0	44.5511	2735.68	2914.32
300		24	3250.0	44.5511	3160.68	3339.32
450		23	3310.92	46.1708	3218.35	3403.48
LT						
0.2		32	2584.38	38.5824	2507.02	2661.73
0.5		32	3006.25	38.5824	2928.9	3083.6
0.8		32	3362.08	39.1984	3283.49	3440.67
OCOST						
250		48	2853.89	31.8386	2790.05	2917.72
1000		48	3114.58	31.5024	3051.42	3177.74
VOCOST						
0		48	3127.08	31.5024	3063.92	3190.24
2		48	2841.39	31.8386	2777.55	2905.22
DEM_DIST by LT						
116	0.2	8	2062.5	77.1648	1907.79	2217.21
116	0.5	8	2500.0	77.1648	2345.29	2654.71
116	0.8	9	3090.56	73.7354	2942.73	3238.39
150	0.2	8	2487.5	77.1648	2332.79	2642.21
150	0.5	8	2937.5	77.1648	2782.79	3092.21
150	0.8	8	3050.0	77.1648	2895.29	3204.71
300	0.2	8	2975.0	77.1648	2820.29	3129.71
300	0.5	8	3325.0	77.1648	3170.29	3479.71
300	0.8	8	3450.0	77.1648	3295.29	3604.71
450	0.2	8	2812.5	77.1648	2657.79	2967.21
450	0.5	8	3262.5	77.1648	3107.79	3417.21
450	0.8	7	3857.75	85.3047	3686.73	4028.78
DEM_DIST by OCOST						
116	250	13	2560.37	61.1523	2437.77	2682.98
116	1000	12	2541.67	63.0048	2415.35	2667.98
150	250	12	2575.0	63.0048	2448.68	2701.32
150	1000	12	3075.0	63.0048	2948.68	3201.32
300	250	12	3033.33	63.0048	2907.02	3159.65
300	1000	12	3466.67	63.0048	3340.35	3592.98
450	250	11	3246.83	67.5083	3111.49	3382.18
450	1000	12	3375.0	63.0048	3248.68	3501.32
DEM_DIST by VOCOST						
116	0	12	2500.0	63.0048	2373.68	2626.32
116	2	13	2602.04	61.1523	2479.44	2724.64
150	0	12	3083.33	63.0048	2957.02	3209.65
150	2	12	2566.67	63.0048	2440.35	2692.98
300	0	12	3550.0	63.0048	3423.68	3676.32
300	2	12	2950.0	63.0048	2823.68	3076.32
450	0	12	3375.0	63.0048	3248.68	3501.32
450	2	11	3246.83	67.5083	3111.49	3382.18
LT by OCOST						
0.2	250	16	2375.0	54.5637	2265.61	2484.39
0.2	1000	16	2793.75	54.5637	2684.36	2903.14
0.5	250	16	2818.75	54.5637	2709.36	2928.14
0.5	1000	16	3193.75	54.5637	3084.36	3303.14
0.8	250	16	3367.91	56.2927	3255.04	3480.77
0.8	1000	16	3356.25	54.5637	3246.86	3465.64
LT by VOCOST						
0.2	0	16	2825.0	54.5637	2715.61	2934.39
0.2	2	16	2343.75	54.5637	2234.36	2453.14
0.5	0	16	3200.0	54.5637	3090.61	3309.39
0.5	2	16	2812.5	54.5637	2703.11	2921.89
0.8	0	16	3356.25	54.5637	3246.86	3465.64
0.8	2	16	3367.91	56.2927	3255.04	3480.77
OCOST by VOCOST						
250	0	24	2866.67	44.5511	2777.35	2955.99
250	2	24	2841.1	45.4971	2749.89	2932.32
1000	0	24	3387.5	44.5511	3298.18	3476.82
1000	2	24	2841.67	44.5511	2752.35	2930.99

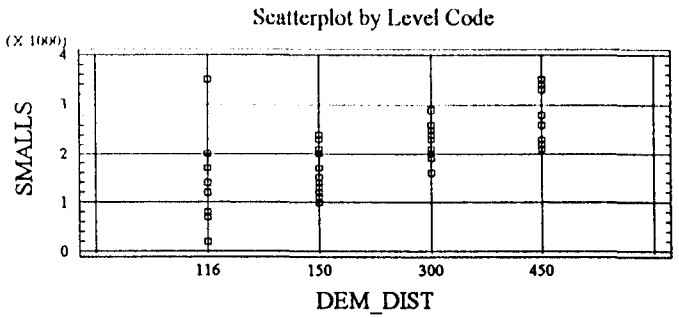
Diane Nelson

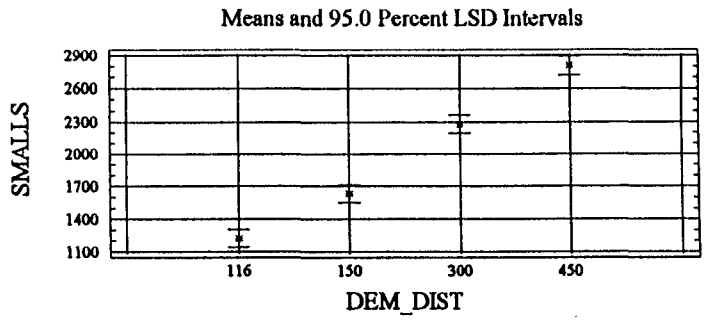
Analysis of Variance for BIGS - Type III Sums of Squares

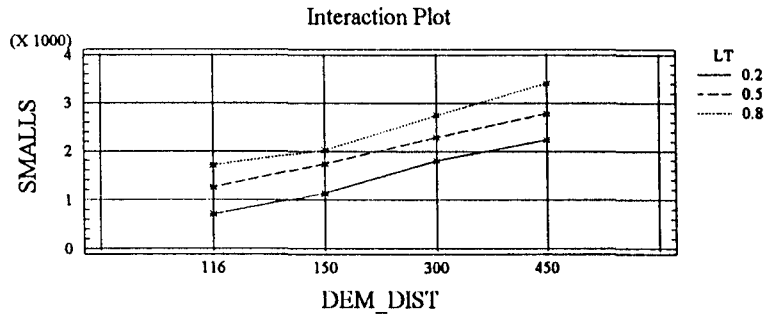
Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
MAIN EFFECTS					
A:DEM_DIST	9.31241E6	3	3.10414E6	65.16	0.0000
B:LT	9.55644E6	2	4.77822E6	100.31	0.0000
C:OCOST	1.61381E6	1	1.61381E6	33.88	0.0000
D:VOCOST	1.93817E6	1	1.93817E6	40.69	0.0000
INTERACTIONS					
AB	1.3203E6	6	220050.0	4.62	0.0007
AC	1.10336E6	3	367788.0	7.72	0.0002
AD	1.98113E6	3	660377.0	13.86	0.0000
BC	879073.0	2	439536.0	9.23	0.0004
BD	1.07389E6	2	536947.0	11.27	0.0001
CD	1.60684E6	1	1.60684E6	33.73	0.0000
ABC	564869.0	6	94144.8	1.98	0.0852
ABD	922587.0	6	153765.0	3.23	0.0088
ACD	1.05041E6	3	350137.0	7.35	0.0003
BCD	524335.0	2	262168.0	5.50	0.0067
RESIDUAL	2.5723E6	54	47635.2		
TOTAL (CORRECTED)	3.59583E7	95			

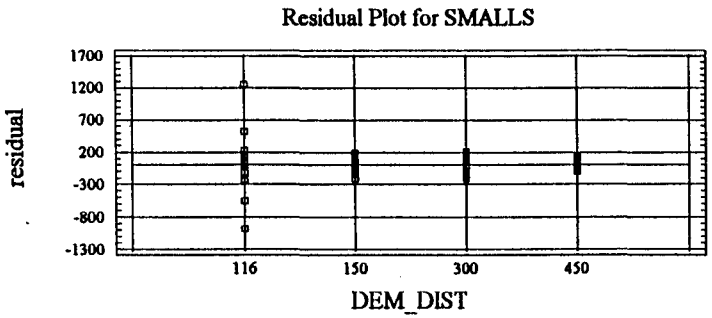
All F-ratios are based on the residual mean square error.

Diane Nelson









Diane Nelson

Table of Least Squares Means for SMALLS
with 95.0 Percent Confidence Intervals

Level		Count	Mean	Stnd. Error	Lower Limit	Upper Limit
GRAND MEAN		96	1985.54			
DEM_DIST						
116		25	1223.0	58.3858	1105.94	1340.06
150		24	1633.33	59.2504	1514.54	1752.12
300		24	2279.17	59.2504	2160.38	2397.96
450		23	2806.64	61.4045	2683.53	2929.75
LT						
0.2		32	1471.88	51.3123	1369.0	1574.75
0.5		32	2012.5	51.3123	1909.62	2115.38
0.8		32	2472.23	52.1316	2367.71	2576.75
OCOST						
250		48	1993.99	42.3435	1909.09	2078.88
1000		48	1977.08	41.8964	1893.09	2061.08
VOCOST						
0		48	2008.33	41.8964	1924.34	2092.33
2		48	1962.74	42.3435	1877.84	2047.63
DEM_DIST by LT						
116	0.2	8	712.5	102.625	506.749	918.251
116	0.5	8	1250.0	102.625	1044.25	1455.75
116	0.8	9	1706.5	98.0638	1509.9	1903.11
150	0.2	8	1137.5	102.625	931.749	1343.25
150	0.5	8	1737.5	102.625	1531.75	1943.25
150	0.8	8	2025.0	102.625	1819.25	2230.75
300	0.2	8	1800.0	102.625	1594.25	2005.75
300	0.5	8	2287.5	102.625	2081.75	2493.25
300	0.8	8	2750.0	102.625	2544.25	2955.75
450	0.2	8	2237.5	102.625	2031.75	2443.25
450	0.5	8	2775.0	102.625	2569.25	2980.75
450	0.8	7	3407.42	113.45	3179.96	3634.87
DEM_DIST by OCOST						
116	250	13	1346.0	81.329	1182.95	1509.06
116	1000	12	1100.0	83.7927	932.005	1267.99
150	250	12	1550.0	83.7927	1382.01	1717.99
150	1000	12	1716.67	83.7927	1548.67	1884.66
300	250	12	2250.0	83.7927	2082.01	2417.99
300	1000	12	2308.33	83.7927	2140.34	2476.33
450	250	11	2829.94	89.7822	2649.94	3009.95
450	1000	12	2783.33	83.7927	2615.34	2951.33
DEM_DIST by VOCOST						
116	0	12	1200.0	83.7927	1032.01	1367.99
116	2	13	1246.0	81.329	1082.95	1409.06
150	0	12	1733.33	83.7927	1565.34	1901.33
150	2	12	1533.33	83.7927	1365.34	1701.33
300	0	12	2308.33	83.7927	2140.34	2476.33
300	2	12	2250.0	83.7927	2082.01	2417.99
450	0	12	2791.67	83.7927	2623.67	2959.66
450	2	11	2821.61	89.7822	2641.61	3001.61
LT by OCOST						
0.2	250	16	1443.75	72.5666	1298.26	1589.24
0.2	1000	16	1500.0	72.5666	1354.51	1645.49
0.5	250	16	1962.5	72.5666	1817.01	2107.99
0.5	1000	16	2062.5	72.5666	1917.01	2207.99
0.8	250	16	2575.71	74.866	2425.61	2725.81
0.8	1000	16	2368.75	72.5666	2223.26	2514.24
LT by VOCOST						
0.2	0	16	1493.75	72.5666	1348.26	1639.24
0.2	2	16	1450.0	72.5666	1304.51	1595.49
0.5	0	16	2062.5	72.5666	1917.01	2207.99
0.5	2	16	1962.5	72.5666	1817.01	2107.99
0.8	0	16	2468.75	72.5666	2323.26	2614.24
0.8	2	16	2475.71	74.866	2325.61	2625.81
OCOST by VOCOST						
250	0	24	1962.5	59.2504	1843.71	2081.29
250	2	24	2025.47	60.5085	1904.16	2146.79
1000	0	24	2054.17	59.2504	1935.38	2172.96
1000	2	24	1900.0	59.2504	1781.21	2018.79

Diane Nelson

Analysis of Variance for SMALLS - Type III Sums of Squares

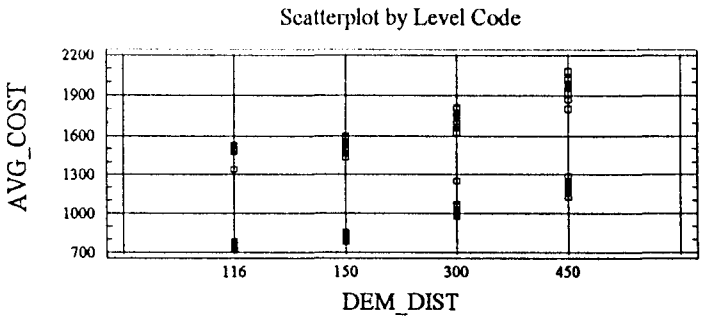
Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
MAIN EFFECTS					
A:DEM_DIST	3.44144E7	3	1.14715E7	136.15	0.0000
B:LT	1.58074E7	2	7.90371E6	93.81	0.0000
C:OCOST	6784.77	1	6784.77	0.08	0.7777
D:VOCOST	49367.0	1	49367.0	0.59	0.4473
INTERACTIONS					
AB	272344.0	6	45390.7	0.54	0.7764
AC	565443.0	3	188481.0	2.24	0.0944
AD	227817.0	3	75939.0	0.90	0.4466
BC	432011.0	2	216005.0	2.56	0.0864
BD	45107.0	2	22553.5	0.27	0.7662
CD	279897.0	1	279897.0	3.32	0.0739
ABC	525933.0	6	87655.5	1.04	0.4098
ABD	217371.0	6	36228.5	0.43	0.8557
ACD	269482.0	3	89827.5	1.07	0.3712
BCD	51213.5	2	25606.7	0.30	0.7392
RESIDUAL	4.54975E6	54	84254.6		
TOTAL (CORRECTED)	5.66296E7	95			

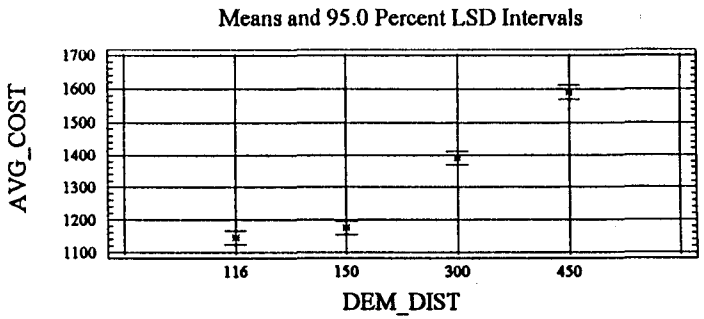
All F-ratios are based on the residual mean square error.

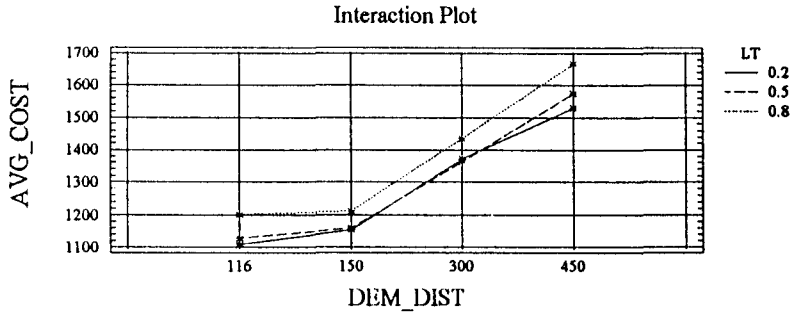
The StatAdvisor

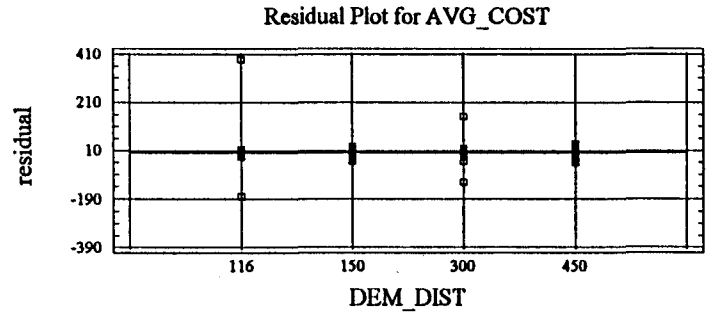
The ANOVA table decomposes the variability of SMALLS into contributions due to various factors. Since Type III sums of squares (the default) have been chosen, the contribution of each factor is measured having removed the effects of all other factors. The P-values test the statistical significance of each of the factors. Since 2 P-values are less than 0.05, these factors have a statistically significant effect on SMALLS at the 95.0% confidence level.

Diane Nelson









Diane Nelson

Table of Least Squares Means for AVG_COST
with 95.0 Percent Confidence Intervals

Level		Count	Mean	Stnd. Error	Lower Limit	Upper Limit
GRAND MEAN		96	1325.39			
DEM_DIST						
116		25	1145.46	14.4804	1116.43	1174.49
150		24	1175.75	14.6948	1146.29	1205.21
300		24	1390.25	14.6948	1360.79	1419.71
450		23	1590.11	15.229	1559.58	1620.64
LT						
0.2		32	1291.19	12.7261	1265.67	1316.7
0.5		32	1306.47	12.7261	1280.95	1331.98
0.8		32	1378.52	12.9293	1352.6	1404.44
OCOST						
250		48	965.367	10.5017	944.313	986.422
1000		48	1685.42	10.3908	1664.58	1706.25
VOCOST						
0		48	1310.54	10.3908	1289.71	1331.37
2		48	1340.24	10.5017	1319.19	1361.3
DEM_DIST by LT						
116	0.2	8	1108.25	25.4521	1057.22	1159.28
116	0.5	8	1127.0	25.4521	1075.97	1178.03
116	0.8	9	1201.13	24.321	1152.37	1249.89
150	0.2	8	1154.63	25.4521	1103.6	1205.65
150	0.5	8	1160.75	25.4521	1109.72	1211.78
150	0.8	8	1211.88	25.4521	1160.85	1262.9
300	0.2	8	1372.0	25.4521	1320.97	1423.03
300	0.5	8	1364.12	25.4521	1313.1	1415.15
300	0.8	8	1434.62	25.4521	1383.6	1485.65
450	0.2	8	1529.88	25.4521	1478.85	1580.9
450	0.5	8	1574.0	25.4521	1522.97	1625.03
450	0.8	7	1666.45	28.137	1610.04	1722.86
DEM_DIST by OCOST						
116	250	13	785.918	20.1705	745.478	826.357
116	1000	12	1505.0	20.7816	1463.34	1546.66
150	250	12	815.5	20.7816	773.835	857.165
150	1000	12	1536.0	20.7816	1494.34	1577.66
300	250	12	1040.5	20.7816	998.835	1082.16
300	1000	12	1740.0	20.7816	1698.34	1781.66
450	250	11	1219.55	22.267	1174.91	1264.19
450	1000	12	1960.67	20.7816	1919.0	2002.33
DEM_DIST by VOCOST						
116	0	12	1130.75	20.7816	1089.09	1172.41
116	2	13	1160.17	20.1705	1119.73	1200.61
150	0	12	1163.58	20.7816	1121.92	1205.25
150	2	12	1187.92	20.7816	1146.25	1229.58
300	0	12	1383.58	20.7816	1341.92	1425.25
300	2	12	1396.92	20.7816	1355.25	1438.58
450	0	12	1564.25	20.7816	1522.59	1605.91
450	2	11	1615.97	22.267	1571.32	1660.61
LT by OCOST						
0.2	250	16	938.437	17.9974	902.355	974.52
0.2	1000	16	1643.94	17.9974	1607.85	1680.02
0.5	250	16	944.312	17.9974	908.23	980.395
0.5	1000	16	1668.63	17.9974	1632.54	1704.71
0.8	250	16	1013.35	18.5676	976.126	1050.58
0.8	1000	16	1743.69	17.9974	1707.6	1779.77
LT by VOCOST						
0.2	0	16	1278.56	17.9974	1242.48	1314.65
0.2	2	16	1303.81	17.9974	1267.73	1339.9
0.5	0	16	1289.69	17.9974	1253.6	1325.77
0.5	2	16	1323.25	17.9974	1287.17	1359.33
0.8	0	16	1363.38	17.9974	1327.29	1399.46
0.8	2	16	1393.66	18.5676	1356.44	1430.89
OCOST by VOCOST						
250	0	24	957.292	14.6948	927.83	986.753
250	2	24	973.443	15.0068	943.356	1003.53
1000	0	24	1663.79	14.6948	1634.33	1693.25
1000	2	24	1707.04	14.6948	1677.58	1736.5

Diane Nelson

Analysis of Variance for AVG_COST - Type III Sums of Squares

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
MAIN EFFECTS					
A:DEM_DIST	2.99876E6	3	999586.0	192.88	0.0000
B:LT	136372.0	2	68186.0	13.16	0.0000
C:OCOST	1.23112E7	1	1.23112E7	2375.54	0.0000
D:VOCOST	20946.1	1	20946.1	4.04	0.0494
INTERACTIONS					
AB	15939.0	6	2656.51	0.51	0.7962
AC	5016.38	3	1672.13	0.32	0.8090
AD	4485.18	3	1495.06	0.29	0.8335
BC	2658.71	2	1329.35	0.26	0.7747
BD	280.46	2	140.23	0.03	0.9733
CD	4359.35	1	4359.35	0.84	0.3631
ABC	29773.1	6	4962.19	0.96	0.4626
ABD	20395.3	6	3399.22	0.66	0.6852
ACD	22283.2	3	7427.72	1.43	0.2432
BCD	17763.1	2	8881.53	1.71	0.1898
RESIDUAL	279854.0	54	5182.48		
TOTAL (CORRECTED)	1.62403E7	95			

All F-ratios are based on the residual mean square error.

The StatAdvisor

The ANOVA table decomposes the variability of AVG_COST into contributions due to various factors. Since Type III sums of squares (the default) have been chosen, the contribution of each factor is measured having removed the effects of all other factors. The P-values test the statistical significance of each of the factors. Since 4 P-values are less than 0.05, these factors have a statistically significant effect on AVG_COST at the 95.0% confidence level.

Appendix C
Experimental Results
& Analysis of Variance

Appendix C

Notation

Alternative\Attribut	Std (Normal)	LT	OC	VOC
1	*150*	*0.2*	*1000*	*0*
2	*300*	*0.5*	*250*	*2*
3	*450*	*0.8*		
4	*116(Uniform)*			

Remark :
(Std,LT,FOC,VOC)
4,3,2,1
Std (Uniform) = 116
Lead Time = 0.8 week
Fixed Order Cost = $ 250
Variable Order Cost = $ 0

Scenario	First Replication				Second Replication			
(Std,LT,FOC,VOC)	s	S	SECost	Min Cost	s	S	SECost	Min Cost
1,1,1,1	1400	3600	16.91	1419.13	1300	3700	16.77	1462.73
1,1,1,2	1100	2100	6.71	1536.17	1000	2100	22.31	1557.32
1,1,2,1	1100	2100	6.71	786.17	1000	2100	22.32	807.18
1,1,2,2	1200	2100	8.71	790.27	1000	2100	22.31	807.32
1,2,1,1	2300	4000	29.02	1432.99	2400	4100	33.77	1495.61
1,2,1,2	1500	2500	12.38	1531.10	1500	2600	22.11	1578.48
1,2,2,1	1700	2600	8.55	811.54	1500	2600	22.11	828.34
1,2,2,2	1500	2500	12.38	781.10	1500	2600	22.11	828.48
1,3,1,1	2000	3000	13.11	1554.07	2000	3100	22.27	1602.29
1,3,1,2	2100	3000	23.88	1589.96	2000	3100	22.26	1602.43
1,3,2,1	2100	3000	23.88	839.96	2000	3100	22.27	852.29
1,3,2,2	2000	3000	13.11	804.07	2000	3100	22.26	852.43
2,1,1,1	2000	4100	21.36	1663.96	1900	4000	22.21	1626.97
2,1,1,2	1600	2500	15.69	1734.45	1900	2400	22.34	1740.71
2,1,2,1	1600	2500	15.22	977.81	1900	4000	18.77	1250.93
2,1,2,2	1600	2500	15.21	990.68	1900	2400	22.34	990.71
2,2,1,1	2500	4400	46.84	1692.21	2300	4500	44.69	1669.39
2,2,1,2	2100	3000	19.90	1763.79	2400	2900	17.86	1757.02
2,2,2,1	2100	3000	19.52	1007.44	2400	2900	17.11	996.78
2,2,2,2	2100	3000	19.52	1020.02	2400	2900	17.86	1007.02
2,3,1,1	2600	3500	28.83	1803.52	2900	3400	31.01	1802.22
2,3,1,2	2600	3500	28.92	1815.43	2900	3400	31.11	1810.66
2,3,2,1	2600	3500	28.56	1059.76	2900	3400	31.01	1052.22
2,3,2,2	2600	3500	28.65	1071.67	2900	3400	31.11	1060.66
3,1,1,1	2300	2700	27.00	1872.16	2100	3800	25.21	1799.74
3,1,1,2	2300	2700	27.29	1919.96	2200	2700	40.40	1956.13
3,1,2,1	2300	2700	26.77	1128.39	2200	2700	36.48	1161.67
3,1,2,2	2300	2700	27.03	1176.20	2200	2700	39.78	1224.82
3,2,1,1	2600	3300	35.11	1910.78	2800	3300	20.26	1917.60
3,2,1,2	2800	3200	31.95	1959.28	2800	3300	23.17	1981.88
3,2,2,1	2800	3200	30.98	1169.03	2800	3300	19.29	1186.30
3,2,2,2	2800	3200	31.72	1215.52	2800	3300	22.17	1250.58
3,3,1,1	3300	4100	31.20	2080.31	3400	3900	31.85	2018.53
3,3,1,2	3400	3800	35.95	2032.03	3400	3900	35.65	2079.12
3,3,2,1	3400	3800	34.86	1243.15	3500	3900	29.64	1282.53
3,3,2,2	3400	3800	35.74	1288.27	3500	3900	33.09	1341.47
4,1,1,1	700	2000	3.03	1482.05	700	2000	2.58	1482.22
4,1,1,2	700	2000	2.62	1478.67	1400	2500	3.76	1499.59
4,1,2,1	700	2000	3.03	732.05	700	2000	2.58	732.22
4,1,2,2	700	2000	2.62	728.67	700	2000	2.58	732.22
4,2,1,1	1200	2500	3.59	1505.11	1200	2500	2.57	1504.88
4,2,1,2	1200	2500	2.08	1499.35	1400	2500	3.76	1499.59
4,2,2,1	1200	2500	3.59	755.11	1200	2500	2.57	754.88
4,2,2,2	1200	2500	2.08	749.35	1400	2500	3.76	749.59
4,3,1,1	1700	3000	4.53	1531.37	1700	3000	3.36	1530.94
4,3,1,2	2000	3000	2.68	1523.63	1700	3000	4.70	1526.12
4,3,2,1	1700	3000	4.53	781.37	1700	3000	3.36	780.94
4,3,2,2	2000	3000	2.68	773.63	1700	3000	4.70	776.12

Run#1

s	S	SECost	MIN Cost
2500	4400	$46.84	1692.214

Std =	300
LT =	0.5
FOC =	1000
VOC =	0

Scenario
2,2,1,1

Avg cost

$1,692.21	S 4200	4300	4350	4375	4400	4425	4450	4500	4600
s 2200	1975.74	1789.57	1788.34	1761.81	1745.47	1796.43	1804.94	1820.20	1840.84
2300	1781.16	1829.02	1775.50	1759.95	1748.22	1764.16	1753.14	1713.87	1793.26
2400	1772.44	1713.24	1751.39	1756.03	1762.63	1737.35	1728.14	1709.72	1699.25
2450	1794.79	1747.04	1701.69	1702.83	1735.98	1737.04	1742.54	1709.72	1709.31
2475	1804.24	1737.45	1716.77	1698.26	1700.30	1730.54	1729.64	1709.72	1709.31
2500	1810.54	1715.98	1725.06	1706.22	1692.21	1700.28	1726.75	1724.12	1694.95
2525	1787.79	1722.25	1730.83	1719.61	1705.70	1696.17	1701.92	1714.84	1694.95
2550	1776.12	1736.86	1711.24	1727.19	1717.32	1707.86	1701.44	1719.19	1694.95
2600	1820.51	1739.85	1731.99	1718.20	1714.36	1728.53	1721.29	1711.96	1710.95
2700	1900.78	1815.47	1771.58	1747.70	1757.94	1744.82	1747.52	1741.24	1737.46
2800	1998.78	1899.99	1847.38	1825.79	1840.98	1827.32	1806.67	1791.98	1769.67
2900	2129.20	2022.02	1966.51	1949.42	1936.01	1897.26	1889.71	1882.11	1827.64
3000	2192.24	2179.20	2099.29	2072.77	2058.03	2030.50	2008.85	1984.37	1928.83
3100	2236.94	2242.24	2226.93	2234.90	2229.20	2163.40	2146.81	2106.40	2034.37
3200	2292.05	2286.94	2289.63	2297.51	2292.24	2282.38	2276.93	2279.20	2156.40

Note *The minimum cost is $1,692.21 at s = 2500, S = 4400 and SECost = 46.84.*

The varied decision variables for this table are Std (Standard deviation of the data), LT (Lead Time), FOC (Fixed Order Cost), and VOC (Variable Order Cost). The value of each variable is altered along with what the scenario is. For instance, the scenario 2,2,1,1 represents std, LT, FOC, and VOC being 300, 0.5, 1000, and 0, respectively. (see Appendix C)
The content of this table is the average cost of the factory in long run (370 weeks or 7 years).

First, Std and LT are selected by scenario. Next, S and s have been arbitrarily varied, in this case, in scale of 100 units. Then, start running the simulation. It will result in the minimum cost roughly found in somewhere on the table. Thus, those values of S and s that generate the certain minimum cost will be focused and fixed. To find more precise value, the table will be rescaled more tighter, from the scale of 100 units to 50 and to 25 units. It is ensured that the minimum cost found is generated from the optimal solution of S and s.

344	1191	1970	985	985	206	3109	2330	1970	1000	880.25	0	0	$1,880.25	$582,019.25	$1,691.92
345	2330	1388	694	694	1636	1970	2912	0	0	1310.5	0	0	$1,310.50	$583,329.75	$1,690.81
346	2912	1630	815	815	2097	0	1282	3018	1000	1048.5	0	0	$2,048.50	$585,378.25	$1,691.84
347	1282	1697	849	848	433	3018	2603	0	0	971.125	0	0	$971.13	$586,349.38	$1,689.77
348	2603	1730	865	865	1738	0	873	3427	1000	869	0	0	$1,869.00	$588,218.38	$1,690.28
349	873	1540	770	770	103	3427	2760	0	0	908.25	0	0	$908.25	$589,126.63	$1,688.04
350	2760	1213	607	606	2153	0	1547	2753	1000	1076.625	0	0	$2,076.63	$591,203.25	$1,689.15
351	1547	1227	614	613	933	2753	3073	0	0	1154.875	0	0	$1,154.88	$592,358.13	$1,687.63
352	3073	1064	532	532	2541	0	2009	2291	1000	1270.5	0	0	$2,270.50	$594,628.63	$1,689.29
353	2009	1544	772	772	1237	2291	2756	0	0	1191.25	0	0	$1,191.25	$595,819.88	$1,687.88
354	2756	1189	595	594	2161	0	1567	2733	1000	1080.625	0	0	$2,080.63	$597,900.50	$1,688.98
355	1567	1292	646	646	921	2733	3008	0	0	1143.75	0	0	$1,143.75	$599,044.25	$1,687.45
356	3008	1244	622	622	2386	0	1764	2536	1000	1193	0	0	$2,193.00	$601,237.25	$1,688.87
357	1764	1256	628	628	1136	2536	3044	0	0	1202	0	0	$1,202.00	$602,439.25	$1,687.50
358	3044	1627	814	813	2230	0	1417	2883	1000	1115.125	0	0	$2,115.13	$604,554.38	$1,688.70
359	1417	1239	620	619	797	2883	3061	0	0	1119.375	0	0	$1,119.38	$605,673.75	$1,687.11
360	3061	1650	825	825	2236	0	1411	2889	1000	1118	0	0	$2,118.00	$607,791.75	$1,688.31
361	1411	1949	975	974	436	2889	2351	1949	1000	940.375	0	0	$1,940.38	$609,732.13	$1,689.01
362	2351	1985	993	992	1358	1949	2315	1985	1000	1166.375	0	0	$2,166.38	$611,898.50	$1,690.33
363	2315	1137	569	568	1746	1985	3163	0	0	1369.375	0	0	$1,369.38	$613,267.88	$1,689.44
364	3163	1479	740	739	2423	0	1684	2616	1000	1211.625	0	0	$2,211.63	$615,479.50	$1,690.88
365	1684	1467	734	733	950	2616	2833	0	0	1129.125	0	0	$1,129.13	$616,608.63	$1,689.34
366	2833	1170	585	585	2248	0	1663	2637	1000	1124	0	0	$2,124.00	$618,732.63	$1,690.53
367	1663	1625	813	812	850	2637	2675	0	0	1084.375	0	0	$1,084.38	$619,817.00	$1,688.87
368	2675	1470	735	735	1940	0	1205	3095	1000	970	0	0	$1,970.00	$621,787.00	$1,689.64
369	1205	1569	785	784	420	3095	2731	0	0	983.875	0	0	$983.88	$622,770.88	$1,687.73
370	2731	1261	631	630	2100	0	1470	2830	1000	1050.125	0	0	$2,050.13	$624,821.00	$1,688.71

285	1575	1547	774	773	801	2725	2753	0	0	1081.875	0	0	$1,081.88	$484,519.88	$1,700.07
286	2753	1244	622	622	2131	0	1509	2791	1000	1065.5	0	0	$2,065.50	$486,585.38	$1,701.35
287	1509	1546	773	773	736	2791	2754	0	0	1065.75	0	0	$1,065.75	$487,651.13	$1,699.13
288	2754	1085	543	542	2211	0	1669	2631	1000	1105.625	0	0	$2,105.63	$489,756.75	$1,700.54
289	1669	1631	816	815	853	2631	2669	0	0	1084.375	0	0	$1,084.38	$490,841.13	$1,698.41
290	2669	1424	712	712	1957	0	1245	3055	1000	978.5	0	0	$1,978.50	$492,819.63	$1,699.38
291	1245	1536	768	768	477	3055	2764	0	0	1002.25	0	0	$1,002.25	$493,821.88	$1,696.98
292	2764	1748	874	874	1890	0	1016	3284	1000	945	0	0	$1,945.00	$495,766.88	$1,697.83
293	1016	1429	715	714	301	3284	2871	0	0	971.625	0	0	$971.63	$496,738.50	$1,695.35
294	2871	1643	822	821	2049	0	1228	3072	1000	1024.625	0	0	$2,024.63	$498,763.13	$1,696.47
295	1228	1036	518	518	710	3072	3264	0	0	1123	0	0	$1,123.00	$499,886.13	$1,694.53
296	3264	1530	765	765	2499	0	1734	2566	1000	1249.5	0	0	$2,249.50	$502,135.63	$1,696.40
297	1734	1734	867	867	867	2566	2566	0	0	1075	0	0	$1,075.00	$503,210.63	$1,694.31
298	2566	1444	722	722	1844	0	1122	3178	1000	922	0	0	$1,922.00	$505,132.63	$1,695.08
299	1122	1465	733	732	389	3178	2835	0	0	989.125	0	0	$989.13	$506,121.75	$1,692.71
300	2835	1194	597	597	2238	0	1641	2659	1000	1119	0	0	$2,119.00	$508,240.75	$1,694.14
301	1641	1566	783	783	858	2659	2734	0	0	1093.75	0	0	$1,093.75	$509,334.50	$1,692.14
302	2734	1449	725	724	2009	0	1285	3015	1000	1004.625	0	0	$2,004.63	$511,339.13	$1,693.18
303	1285	1583	792	791	493	3015	2717	0	0	1000.375	0	0	$1,000.38	$512,339.50	$1,690.89
304	2717	1789	895	894	1822	0	928	3372	1000	911.125	0	0	$1,911.13	$514,250.63	$1,691.61
305	928	1242	621	621	307	3372	3058	0	0	996.5	0	0	$996.50	$515,247.13	$1,689.33
306	3058	1742	871	871	2187	0	1316	2984	1000	1093.5	0	0	$2,093.50	$517,340.63	$1,690.66
307	1316	1509	755	754	561	2984	2791	0	0	1026.625	0	0	$1,026.63	$518,367.25	$1,688.49
308	2791	1761	881	880	1910	0	1030	3270	1000	955.125	0	0	$1,955.13	$520,322.38	$1,689.36
309	1030	921	461	460	569	3270	3379	0	0	1102.125	0	0	$1,102.13	$521,424.50	$1,687.46
310	3379	1605	803	802	2576	0	1774	2526	1000	1288.125	0	0	$2,288.13	$523,712.63	$1,689.40
311	1774	1016	508	508	1266	2526	3284	0	0	1264.5	0	0	$1,264.50	$524,977.13	$1,688.03
312	3284	2042	1021	1021	2263	0	1242	3058	1000	1131.5	0	0	$2,131.50	$527,108.63	$1,689.45
313	1242	1803	902	901	340	3058	2497	1803	1000	934.625	0	0	$1,934.63	$529,043.25	$1,690.23
314	2497	1138	569	569	1928	1803	3162	0	0	1414.75	0	0	$1,414.75	$530,458.00	$1,689.36
315	3162	1615	808	807	2354	0	1547	2753	1000	1177.125	0	0	$2,177.13	$532,635.13	$1,690.91
316	1547	1165	583	582	964	2753	3135	0	0	1170.375	0	0	$1,170.38	$533,805.50	$1,689.26
317	3135	1534	767	767	2368	0	1601	2699	1000	1184	0	0	$2,184.00	$535,989.50	$1,690.82
318	1601	2008	1004	1004	597	2699	2292	2008	1000	973.25	0	0	$1,973.25	$537,962.75	$1,691.71
319	2292	1446	723	723	1569	2008	2854	0	0	1286.5	0	0	$1,286.50	$539,249.25	$1,690.44
320	2854	1110	555	555	2299	0	1744	2556	1000	1149.5	0	0	$2,149.50	$541,398.75	$1,691.87
321	1744	1426	713	713	1031	2556	2874	0	0	1154.5	0	0	$1,154.50	$542,553.25	$1,690.20
322	2874	1558	779	779	2095	0	1316	2984	1000	1047.5	0	0	$2,047.50	$544,600.75	$1,691.31
323	1316	1376	688	688	628	2984	2924	0	0	1060	0	0	$1,060.00	$545,660.75	$1,689.35
324	2924	1416	708	708	2216	0	1508	2792	1000	1108	0	0	$2,108.00	$547,768.75	$1,690.64
325	1508	1178	589	589	919	2792	3122	0	0	1157.5	0	0	$1,157.50	$548,926.25	$1,689.00
326	3122	1047	524	523	2598	0	2075	2225	1000	1299.125	0	0	$2,299.13	$551,225.38	$1,690.88
327	2075	1916	958	958	1117	2225	2384	1916	1000	1114.75	0	0	$2,114.75	$553,340.13	$1,692.17
328	2384	1360	680	680	1704	1916	2940	0	0	1331	0	0	$1,331.00	$554,671.13	$1,691.07
329	2940	1659	830	829	2110	0	1281	3019	1000	1055.125	0	0	$2,055.13	$556,726.25	$1,692.18
330	1281	1381	691	690	590	3019	2919	0	0	1049.875	0	0	$1,049.88	$557,776.13	$1,690.23
331	2919	1187	594	593	2325	0	1732	2568	1000	1162.625	0	0	$2,162.63	$559,938.75	$1,691.66
332	1732	1202	601	601	1131	2568	3098	0	0	1207.5	0	0	$1,207.50	$561,146.25	$1,690.20
333	3098	2010	1005	1005	2093	0	1088	3212	1000	1046.5	0	0	$2,046.50	$563,192.75	$1,691.27
334	1088	1887	944	943	144	3212	2413	1887	1000	875.125	0	0	$1,875.13	$565,067.88	$1,691.82
335	2413	1297	649	648	1764	1887	3003	0	0	1353.875	0	0	$1,353.88	$566,421.75	$1,690.81
336	3003	1994	997	997	2006	0	1009	3291	1000	1003	0	0	$2,003.00	$568,424.75	$1,691.74
337	1009	780	390	390	619	3291	3520	0	0	1132.25	0	0	$1,132.25	$569,557.00	$1,690.08
338	3520	1350	675	675	2845	0	2170	2130	1000	1422.5	0	0	$2,422.50	$571,979.50	$1,692.25
339	2170	2128	1064	1064	1106	2130	2172	2128	1000	1085.5	0	0	$2,085.50	$574,065.00	$1,693.41
340	2172	1465	733	732	1439	2128	2835	0	0	1251.625	0	0	$1,251.63	$575,316.63	$1,692.11
341	2835	2086	1043	1043	1792	0	749	3551	1000	896	0	0	$1,896.00	$577,212.63	$1,692.71
342	749	1417	709	708	40	3551	2883	0	0	907.875	0	0	$907.88	$578,120.50	$1,690.41
343	2883	1692	846	846	2037	0	1191	3109	1000	1018.5	0	0	$2,018.50	$580,139.00	$1,691.37

226	2275	1179	590	589	1685	2025	3121	0	0	1348.875	0	0	$1,348.88	$389,120.38	$1,721.77
227	3121	1776	888	888	2233	0	1345	2955	1000	1116.5	0	0	$2,116.50	$391,236.88	$1,723.51
228	1345	1661	831	830	514	2955	2639	0	0	995.875	0	0	$995.88	$392,232.75	$1,720.32
229	2639	1704	852	852	1787	0	935	3365	1000	893.5	0	0	$1,893.50	$394,126.25	$1,721.08
230	935	1546	773	773	162	3365	2754	0	0	922.25	0	0	$922.25	$395,048.50	$1,717.60
231	2754	1810	905	905	1849	0	944	3356	1000	924.5	0	0	$1,924.50	$396,973.00	$1,718.50
232	944	717	359	358	585	3356	3583	0	0	1131.625	0	0	$1,131.63	$398,104.63	$1,715.97
233	3583	1374	687	687	2896	0	2209	2091	1000	1448	0	0	$2,448.00	$400,552.63	$1,719.11
234	2209	1862	931	931	1278	2091	2438	1862	1000	1161.75	0	0	$2,161.75	$402,714.38	$1,721.00
235	2438	1223	612	611	1826	1862	3077	0	0	1378.625	0	0	$1,378.63	$404,093.00	$1,719.54
236	3077	1532	766	766	2311	0	1545	2755	1000	1155.5	0	0	$2,155.50	$406,248.50	$1,721.39
237	1545	1448	724	724	821	2755	2852	0	0	1099.25	0	0	$1,099.25	$407,347.75	$1,718.77
238	2852	1432	716	716	2136	0	1420	2880	1000	1068	0	0	$2,068.00	$409,415.75	$1,720.23
239	1420	1840	920	920	500	2880	2460	1840	1000	970	0	0	$1,970.00	$411,385.75	$1,721.28
240	2460	1468	734	734	1726	1840	2832	0	0	1323	0	0	$1,323.00	$412,708.75	$1,719.62
241	2832	1335	668	667	2164	0	1497	2803	1000	1082.125	0	0	$2,082.13	$414,790.88	$1,721.12
242	1497	2103	1052	1051	445	2803	2197	2103	1000	923.375	0	0	$1,923.38	$416,714.25	$1,721.96
243	2197	1612	806	806	1391	2103	2688	0	0	1221.25	0	0	$1,221.25	$417,935.50	$1,719.90
244	2688	1312	656	656	2032	0	1376	2924	1000	1016	0	0	$2,016.00	$419,951.50	$1,721.11
245	1376	2251	1126	1125	250	2924	2049	2251	1000	856.125	0	0	$1,856.13	$421,807.63	$1,721.66
246	2049	1422	711	711	1338	2251	2878	0	0	1231.75	0	0	$1,231.75	$423,039.38	$1,719.67
247	2878	1506	753	753	2125	0	1372	2928	1000	1062.5	0	0	$2,062.50	$425,101.88	$1,721.06
248	1372	1721	861	860	511	2928	2579	0	0	987.625	0	0	$987.63	$426,089.50	$1,718.10
249	2579	1802	901	901	1678	0	777	3523	1000	839	0	0	$1,839.00	$427,928.50	$1,718.59
250	777	1589	795	794	-18	3523	2729	0	0	878.625	18	450	$1,328.63	$429,257.13	$1,717.03
251	2729	1236	618	618	2111	0	1493	2807	1000	1055.5	0	0	$2,055.50	$431,312.63	$1,718.38
252	1493	1821	911	910	582	2807	2479	1821	1000	992.875	0	0	$1,992.88	$433,305.50	$1,719.47
253	2479	1678	839	839	1640	1821	2622	0	0	1275.25	0	0	$1,275.25	$434,580.75	$1,717.71
254	2622	1293	647	646	1975	0	1329	2971	1000	987.625	0	0	$1,987.63	$436,568.38	$1,718.77
255	1329	1786	893	893	436	2971	2514	0	0	960.75	0	0	$960.75	$437,529.13	$1,715.80
256	2514	1174	587	587	1927	0	1340	2960	1000	963.5	0	0	$1,963.50	$439,492.63	$1,716.77
257	1340	1227	614	613	726	2960	3073	0	0	1103.125	0	0	$1,103.13	$440,595.75	$1,714.38
258	3073	1319	660	659	2413	0	1754	2546	1000	1206.625	0	0	$2,206.63	$442,802.38	$1,716.29
259	1754	1708	854	854	900	2546	2592	0	0	1086.5	0	0	$1,086.50	$443,888.88	$1,713.86
260	2592	1031	516	515	2076	0	1561	2739	1000	1038.125	0	0	$2,038.13	$445,927.00	$1,715.10
261	1561	1406	703	703	858	2739	2894	0	0	1113.75	0	0	$1,113.75	$447,040.75	$1,712.80
262	2894	1527	764	763	2130	0	1367	2933	1000	1065.125	0	0	$2,065.13	$449,105.88	$1,714.14
263	1367	1533	767	766	600	2933	2767	0	0	1033.375	0	0	$1,033.38	$450,139.25	$1,711.56
264	2767	1698	849	849	1918	0	1069	3231	1000	959	0	0	$1,959.00	$452,098.25	$1,712.49
265	1069	1292	646	646	423	3231	3008	0	0	1019.25	0	0	$1,019.25	$453,117.50	$1,709.88
266	3008	1850	925	925	2083	0	1158	3142	1000	1041.5	0	0	$2,041.50	$455,159.00	$1,711.12
267	1158	1627	814	813	344	3142	2673	0	0	957.625	0	0	$957.63	$456,116.63	$1,708.30
268	2673	1655	828	827	1845	0	1018	3282	1000	922.625	0	0	$1,922.63	$458,039.25	$1,709.10
269	1018	1080	540	540	478	3282	3220	0	0	1059.5	0	0	$1,059.50	$459,098.75	$1,706.69
270	3220	1732	866	866	2354	0	1488	2812	1000	1177	0	0	$2,177.00	$461,275.75	$1,708.43
271	1488	1412	706	706	782	2812	2888	0	0	1094	0	0	$1,094.00	$462,369.75	$1,706.16
272	2888	1608	804	804	2084	0	1280	3020	1000	1042	0	0	$2,042.00	$464,411.75	$1,707.40
273	1280	1191	596	595	684	3020	3109	0	0	1097.125	0	0	$1,097.13	$465,508.88	$1,705.16
274	3109	1539	770	769	2339	0	1570	2730	1000	1169.625	0	0	$2,169.63	$467,678.50	$1,706.86
275	1570	1505	753	752	817	2730	2795	0	0	1091.125	0	0	$1,091.13	$468,769.63	$1,704.62
276	2795	1566	783	783	2012	0	1229	3071	1000	1006	0	0	$2,006.00	$470,775.63	$1,705.71
277	1229	1364	682	682	547	3071	2936	0	0	1041.25	0	0	$1,041.25	$471,816.88	$1,703.31
278	2936	1343	672	671	2264	0	1593	2707	1000	1132.125	0	0	$2,132.13	$473,949.00	$1,704.85
279	1593	1526	763	763	830	2707	2774	0	0	1091.75	0	0	$1,091.75	$475,040.75	$1,702.66
280	2774	1825	913	912	1861	0	949	3351	1000	930.625	0	0	$1,930.63	$476,971.38	$1,703.47
281	949	1177	589	588	360	3351	3123	0	0	1017.875	0	0	$1,017.88	$477,989.25	$1,701.03
282	3123	1631	816	815	2307	0	1492	2808	1000	1153.625	0	0	$2,153.63	$480,142.88	$1,702.63
283	1492	1243	622	621	870	2808	3057	0	0	1137.125	0	0	$1,137.13	$481,280.00	$1,700.64
284	3057	1482	741	741	2316	0	1575	2725	1000	1158	0	0	$2,158.00	$483,438.00	$1,702.25