Ethan Cox
2/9/18
TIM 125

Midterm

Problem 1: Planning

Create a plan and time-schedule for on the problems below. Also, using an appropriate table (see Problem 6 below), track how well you execute your schedule, and make notes on obstacles and problems that prevent effective execution.

Step 1: Define the problem.

SP1: Create a plan and time-schedule for the remaining problem.

Step 2: Plan how to solve the problem.

Assumptions: I am a student going through the process of planning how to solve a set of problems. I am starting the midterm on Friday and will work on it till Monday, so I have four days to plan how to do the problems. Problems 2 through 6 are to be done in order. I will also assume that each problem will take me about the time estimated on the exam, or about 9 total hours.

Available information: The SCM textbook, lecture notes, and information on the internet.

SP1: Create a plan and time-schedule for the remaining problem.

Step 1: Determine the set of problems and the time it will take to complete them.

Step 2: How many days will I work on the problems.

Step 3: Split the problems up into an equal number of hours per day.

Step 3: Execute the plan.

SP1: Create a plan and time-schedule for the remaining problem.

Step 1: Determine the set of problems and the time it will take to complete them.

Problem	Expected hours to complete
2	1
3	5
4	1.5
5	0.5
6	0.5
Extra Credit	2
Total hours	10.5

Step 2: How many days will I work on the problems.

I will work on the problems for four days.

Step 3: Split the problems up into an equal number of hours per day.

I will perform problem 2 on Friday, problem 3 on Saturday, problems 3 through 6 on Sunday, and the extra credit on Monday.

Date	Problem's to do, Expected Hours
2/9	2, 1 hour
2/10	3, 5 hours
2/11	4,5,6; 2.5 hours
2/12	Extra Credit, 2 hours

Step 4: Check your work.

I am confident my work is correct.

Step 5: Learn and Generalize.

Planning how to solve a set of problems is important for understanding how the problems relate to each other, and how to solve them efficiently. Failing to create a plan will lead to sloppiness and decrease the overall quality of your work.

Problem 2: Supply Chain Strategy for SPC

What should SPC's competitive strategy be? What should SPC's supply chain strategy be to align with its competitive strategy? Where does SPC lie in the zone of strategic fit between IDU and responsiveness? What should SPC's high-level SC strategy be for each of the supply chain drivers?

Step 1: Define the problem.

SP1: What should SPC's competitive strategy be?

SP2: What should SPC's supply chain strategy be to align with its competitive strategy?

SP3: Where does SPC lie in the zone of strategic fit between IDU and responsiveness?

SP4: What should SPC's high-level SC strategy be for each of the supply chain drivers?

Step 2: Plan how to solve the problem.

Assumptions: I am an engineer at SPC working to determine our competitive strategy and various aspects of our high level supply chain strategy.

Available information: The SCM textbook, lecture notes, and information on the internet.

SP1: What should SPC's competitive strategy be?

Step 1: Perform a Porter's Five Forces Analysis of the packaging industry.

Step 2: Determine what SPC's competitive strategy should be to best compete within the industry.

SP2: What should SPC's supply chain strategy be to align with its competitive strategy?

Step 1: Understand SPC's customer needs, and the IDU for the products.

Step 2: Find the balance between responsiveness and efficiency and determine SPC's SC strategy.

SP3: Where does SPC lie in the zone of strategic fit between IDU and responsiveness?

Step 1: Combine the efficiency/responsiveness graph and the IDU graph.

SP4: What should SPC's high-level SC strategy be for each of the supply chain drivers?

Step 1: Determine the high-level SC strategy for SPC's facilities (#, location, function, capacity). Do the facilities need to be responsive or efficient?

Step 2: Determine the high-level SC strategy for SPC's transportation (modes of transportation, what routes to take). Does the transportation need to responsive or efficient?

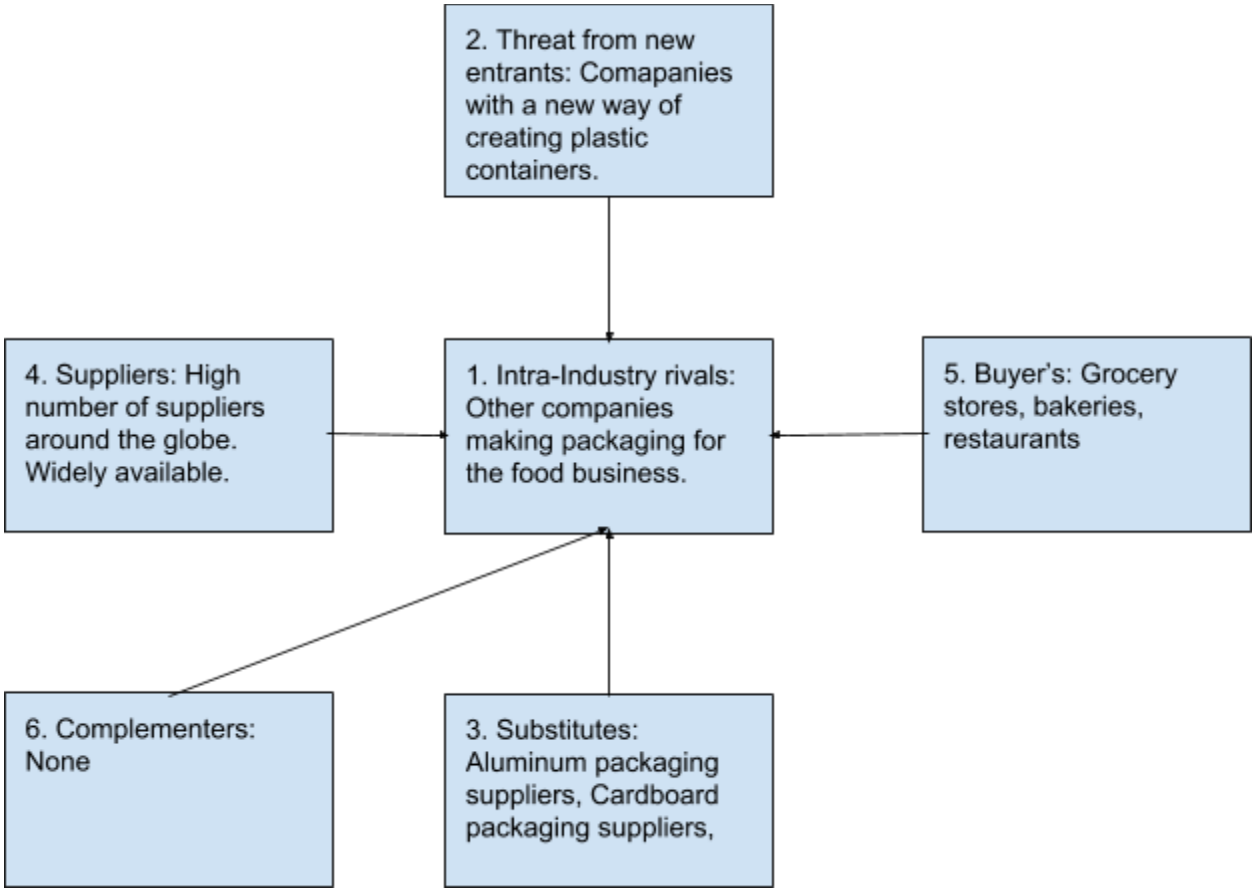
Step 3: Determine the high-level SC strategy for SPC's inventory (cycle inventory, safety inventory). Does SPC need higher or lower levels of inventory?

SP4: Determine the high-level SC strategy for SPC's information. What type of information systems or information tech should SPC use to make their SC more efficient and/or responsive.

Step 3: Execute the plan.

SP1: What should SPC's competitive strategy be?

Step 1: Perform a Porter's Five Forces Analysis of the packaging industry.



Force	Description	Strength
1	Intra-Industry competition: Large number of competitors, quality is largely the same as this is an established technology, and low switching costs mean this is a strong force.	High
2	Threat from new entrants: Relatively low barriers to entry. Established technology and highly competitive industry will discourage many potential new entrants. Could enter if they believe they have a new technology that will give them an advantage.	Medium
3	Threat from substitutes: There aren't many substitutes for plastic containers in the foodservice industry. Styrofoam, aluminum, and cardboard containers could be potential substitutes but they largely serve different purposes than plastic containers.	Low
4	Large number of polystyrene suppliers offering a standardized service. Widely available raw material means suppliers generally offer nothing special, at least in terms of the product they sell.	Low
5	Large number of small buyers decreases any individual buyer's bargaining power. Low switching costs increase buyer's bargaining power. Large number of firms in plastic packaging industry to purchase from increases buyer's bargaining power.	High
6	There aren't any complementors in the industry.	Low

Step 2: Determine what SPC's competitive strategy should be to best compete within the industry.

Given that the plastic packaging business uses a fairly standardized technology, and has a significant number of competitors, it will be difficult for SPC to differentiate themselves well enough to gain a competitive advantage. While SPC offers recyclable containers, so do many other packaging companies. There also isn't much SPC could do to target a niche part of the market, as all the customers largely want the same type of product. Caterers want plastic containers that they can use for packaging and serving food. Grocery stores, bakeries, and restaurants all want plastic containers to perform a similar set of tasks. Thus, pursuing a niche competitive strategy is not a good idea for SPC. SPC should pursue a cost leadership competitive strategy as it will give them the best chance to compete successfully within the plastic packaging business.

SPC's Competitive Strategy	Cost Leadership

SP2: What should SPC's supply chain strategy be to align with its competitive strategy?

Step 1: Understand SPC's customer needs, and the IDU for the products.

SPC's customers need affordable, sturdy, and recyclable food storage containers that they can use to package, store, serve, and sell food. SPC is a mature company with a well defined product line, so they have a low IDU.

Step 2: Find the balance between responsiveness and efficiency and determine SPC's SC strategy.

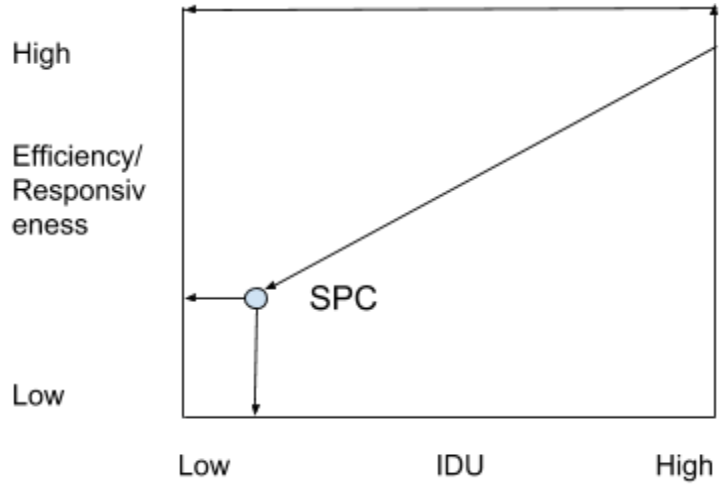
SPC has a small product line comprised of standardized products, and lower service levels for their customers. SPC does however have to deal with spikes in demand for black container during the spring and clear containers in the fall. If SPC did not have to deal with spikes in demand they could focus on making their supply as efficient as possible, to meet their needs as a low cost provider. Cyclical spikes in demand mean that SPC has to ensure that the SC is somewhat responsive to meet these change in demand without generating excess inventory throughout the year, incurring massive holding costs. Fortunately, these spikes in demand are cyclical and SPC can plan for them. Thus, SPC should still focus on having an efficient, but still somewhat responsive SC.

SPC's IDU	SPC's responsiveness/efficiency needs
SPC has a low IDU as they are a mature company.	SPC needs an efficient, but somewhat responsive supply chain. They have a standardized set of products, but must be able to respond to seasonal changes in demand.

SP3: Where does SPC lie in the zone of strategic fit between IDU and responsiveness?

Step 1: Combine the efficiency/responsiveness graph and the IDU graph.

We use the efficiency/responsiveness spectrum as the x-axis and the IDU spectrum as the y-axis of our graph to obtain ourzone of strategic fit.



As we can see, SPC's zone of strategic fit is with an efficient but somewhat responsive SC, and a low IDU. This gives them the ability to succeed as a low cost provider while still handling seasonal increases in demand.

SP4: What should SPC's high-level SC strategy be for each of the supply chain drivers?

Step 1: Determine the high-level SC strategy for SPC's facilities (#, location, function, capacity). Do the facilities need to be responsive or efficient?

Step 2: Determine the high-level SC strategy for SPC's transportation (modes of transportation, what routes to take). Does the transportation need to responsive or efficient?

Step 3: Determine the high-level SC strategy for SPC's inventory (cycle inventory, safety inventory). Does SPC need higher or lower levels of inventory?

Step 4: Determine the high-level SC strategy for SPC's information. What type of information systems or information tech should SPC use to make their SC more efficient and/or responsive.

Step 5: Determine the high-level SC strategy for SPC's sourcing. Will they produce inputs in house or outsource?

Step 6: Determine the high-level SC strategy for SPC's pricing. Should they use everyday low pricing or menu pricing?

SC Driver	High-level Strategy
Facilities	Efficient supply chains have fewer facilities, and since SPC does not need to be super responsive to customer needs, SPC can have fewer facilities. SPC's customers will likely be concentrated in metropolitan areas, so it makes since to distribution warehouses centers near those locations, but closer to major highways. Manufacturing plants should be located slightly further from these warehouses as land will be cheaper and there will likely be less regulation. SPC should maintain fewer larger facilities as they will be more efficient, but still able to handle seasonal increases in demand.
Transportation	SPC will transport the material by land as it is more cheaper and more efficient than transporting by air or sea. SPC will transport along major highways as this will help decrease route times and inventory loss due to accidents.
Inventory	SPC will maintain lower inventory levels in order to be more efficient and avoid holding costs as cutting costs is extremely important for a low cost provider. Therefore, SPC will not hold large amounts of safety inventory, but they will hold seasonal inventory. During periods when we are capable of producing more than is demanded we will build up this seasonal inventory, which will work since SPC has relatively low percent holding costs. This inventory strategy will allow SPC to gain a competitive advantage as a low cost provider.

Information	Demand forecasting will be extremely important for SPC since they won't hold large amounts of safety or seasonal inventory. This will be the primary role of the information system. We will also develop supplier relationship management technology as obtaining input materials at good prices will be key to maintaining a competitive advantage.
Sourcing	SPC will purchase raw materials from outside suppliers as the raw materials we use as inputs are widely available at cheap prices. SPC will negotiate directly with suppliers as this will allow SPC to get better prices.
Pricing	SPC will use everyday low prices as they don't offer any products that should be sold at higher prices. This should give us relatively stable demand except for the period where seasonal trends occur, helping us be more efficient. SPC will use fixed pricing and offer one delivery method to customers as it allows them to be more efficient.

SP4: Check Your Work.

I am confident my work is correct.

SP5: Learn and Generalize.

It is important for a company to align their supply chain strategy with their competitive strategy in order to maximize supply chain profit and overall company profit. If a company wants to excel as a low cost provider it is important for them to have an efficient supply chain. On the other hand, companies like Dell who offer personalized products, need a more responsive supply chain since they experience changes in demand fairly often. Companies also need to understand what level of demand uncertainty they have, so they can appropriately plan for changes in demand. Companies need to match their supply chain strategy with their competitive strategy to maximize their competitive advantages and maximize their overall profitability.

Problem 3: Demand Forecasting for SPC

Which forecasting method should Julie Williams use for black plastic? Which forecasting method should she use for clear plastic? What is the demand forecast for each quarter of 2007 for black plastic and for clear plastic?

Step 1: Define the problem.

SP1: Which forecasting method should Julie Williams use for black plastic?

SP2: Which forecasting method should she use for clear plastic?

SP3: What is the demand forecast for each quarter of 2007 for black plastic and for clear plastic?

Step 2: Plan how to solve the problem.

Assumptions: I am an engineer at SPC deciding what demand forecasting methods to use for both black plastic and clear plastic in all quarter of 2007. Whichever forecasting method

gives me the smallest error throughout the forecast is the one I will use for each type of plastic. In each of my forecasts, I will let the smoothing constants be as follows: alpha(a) = 0.06, beta(b) = 0.06, and gamma(g) = 0.06. The five forecasting methods I will use for both black and clear plastic are static, four-week moving average, simple exponential smoothing, Holt's method, and Winter's method.

Available information: The SCM textbook, lecture notes, and information on the internet.

SP1: Which forecasting method should Julie Williams use for black plastic?

Step 1: Forecast demand using the static forecasting method and perform an error analysis.

Step 2: Forecast demand using the four-week moving average method and perform an error analysis.

Step 3: Forecast demand using the simple exponential smoothing method and perform an error analysis.

Step 4: Forecast demand using Holt's method and perform an error analysis.

Step 5: Forecast demand using Winter's method and perform an error analysis.

Step 6: Which forecasting method gives us the smallest error.

SP2: Which forecasting method should she use for clear plastic?

Step 1: Forecast demand using the static forecasting method and perform an error analysis.

Step 2: Forecast demand using the four-week moving average method and perform an error analysis.

Step 3: Forecast demand using the simple exponential smoothing method and perform an error analysis.

Step 4: Forecast demand using Holt's method and perform an error analysis.

Step 5: Forecast demand using Winter's method and perform an error analysis.

Step 6: Which forecasting method gives us the smallest error.

SP3: What is the demand forecast for each quarter of 2007 for black plastic and for clear plastic?

Step 1: Which forecasting method am I going to use for black plastic.

Step 2: Forecast demand for black plastic during each quarter of 2007 using that method.

Step 3: Which forecasting method am I going to use for clear plastic.

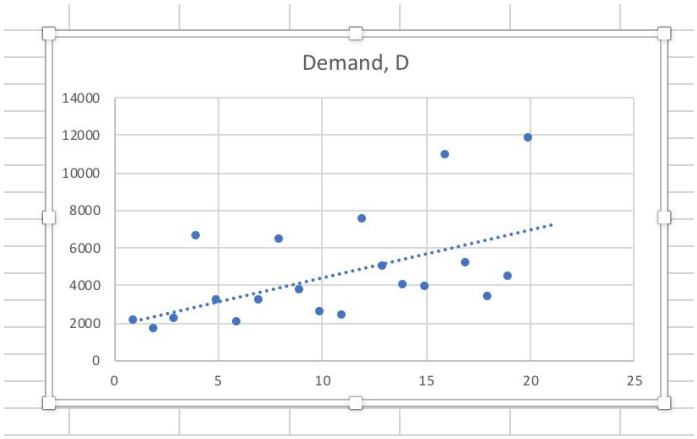
Step 4: Forecast demand for clear plastic during each quarter of 2007 using that method.

Step 3: Execute the plan.

SP1: Which forecasting method should Julie Williams use for black plastic?

Step 1: Forecast demand using the static forecasting method and perform an error analysis.

There are three factors at play in static forecasting; level, trend, and seasonality. The first thing to do is to graph the given demand for black plastic, showing a regression line.



The next step in performing a static forecast is to deseasonalize the given demand. The periodicity in this case is 4 since each year is broken up into four quarters, which means I will use the formula for deseasonalizing data where periodicity is even. The first value we calculate is the deseasonalized demand for period three. D3 = (D1 + 2D2 + 2D3 + 2D4 + D5)/8 = 3,217.125. This process continues up until period 18, as shown in excel.

	A	B	C	D	E
1	Year, Y	Period, P	Demand, D		
2	2002	1	2025		
3		2	1563		
4		3	2170	3217.125	
5		4	6542	3404.875	
6	2003	5	3162	3568.375	
7		6	1928	3662.25	
8		7	3113	3706.5	
9		8	6350	3844.875	
10	2004	9	3708	3814.5	
11		10	2489	3848.625	
12		11	2309	4137.375	
13		12	7427	4473.25	
14	2005	13	4941	4851.75	
15		14	3943	5474	
16		15	3883	5917.25	
17		16	10831	5857.875	
18	2006	17	5083	5840.125	
19		18	3326	6019	
20		19	4358		
21		20	11787		
22					

The data shown is then regressed in excel to obtain the initial level and trend.

	A	B	C	D	E	F	G	H	I
1	SUMMARY OUTPUT								
2									
3	*Regression Statistics*								
4	Multiple R	0.95563604							
5	R Square	0.91324025							
6	Adjusted R S	0.90704312							
7	Standard Err	310.127824							
8	Observations	16							
9									
10	ANOVA								
11		*df*	*SS*	*MS*	*F*	*Significance F*			
12	Regression	1	14173471.2	14173471.2	147.36514	8.0634E-09			
13	Residual	14	1346509.74	96179.267					
14	Total	15	15519980.9						
15									
16		*Coefficients*	*tandard Erro*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
17	Intercept	2333.54118	192.869764	12.0990513	8.4161E-09	1919.87667	2747.20568	1919.87667	2747.20568
18	X Variable 1	204.173162	16.8190427	12.1394045	8.0634E-09	168.099903	240.246421	168.099903	240.246421
19									
20									
21									

The regresion gives me an initial level, L0 = 2,333 and the initial trend, T0 = 204. Deseasonalized demand for any period t is given by Dt = 2,333 + 204t. Using this formula I fill in the deseasonalized demand for periods 1 and 2 and periods 19 and 20. D1 = 2,537 and D2 = 2,741. D19 = 6,209 and D20 = 6,413.

The next step is to obtain the seasonal factor for each period, which is given by the seasonalized demand divided by the deseasonalized demand. Filling in the excel sheet gives:

	Year, Y	Period, t	Demand, D	Deseasonaliz	Seasonal Factor, S
2	2002	1	2025	2537	0.80
3		2	1563	2741	0.57
4		3	2170	2945	0.74
5		4	6542	3149	2.08
6	2003	5	3162	3353	0.94
7		6	1928	3557	0.54
8		7	3113	3761	0.83
9		8	6350	3965	1.60
10	2004	9	3708	4169	0.89
11		10	2489	4373	0.57
12		11	2309	4577	0.50
13		12	7427	4781	1.55
14	2005	13	4941	4985	0.99
15		14	3943	5189	0.76
16		15	3883	5393	0.72
17		16	10831	5597	1.94
18	2006	17	5083	5801	0.88
19		18	3326	6005	0.55
20		19	4358	6209	0.70
21		20	11787	6413	1.84
22					

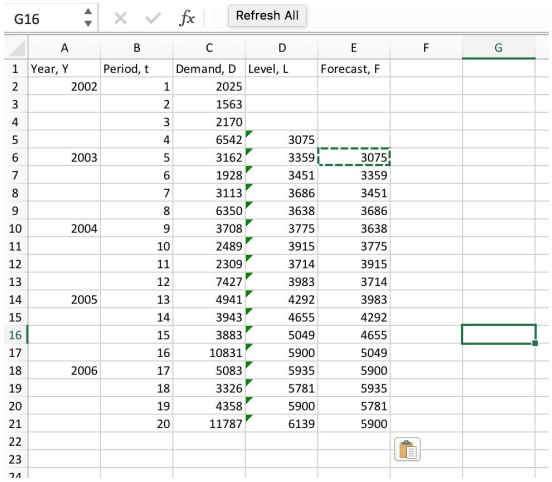
We can now calculate our forecast for the periods of data we have. The forecast is given by multiplying the deseasonalized data during a period by the seasonal factor for the period. I will also perform an error analysis of the forecast. I will once again do this in excel, giving me:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	Year, Y	Period, t	Demand, D	Deseasonaliz	Seasonal Fac	Average Sea	Forecast, F	Error, E	Absolute Err	MSE	MAD	% Error	MAPE	TS
2	2002	1	2,025	2,537	0.80	0.90	2,282.31	257	257	66,208	257	13	13	1.00
3		2	1,563	2,741	0.57	0.60	1,641.96	79	79	36,221	168	5	9	2.00
4		3	2,170	2,945	0.74	0.70	2,056.15	-114	114	28,468	150	5	8	1.48
5		4	6,542	3,149	2.08	1.80	5,671.71	-870	870	210,704	330	13	9	-1.96
6	2003	5	3,162	3,353	0.94	0.90	3,016.39	-146	146	172,803	293	5	8	-2.71
7		6	1,928	3,557	0.54	0.60	2,130.77	203	203	150,856	278	11	9	-2.12
8		7	3,113	3,761	0.83	0.70	2,625.87	-487	487	163,204	308	16	10	-3.50
9		8	6,350	3,965	1.60	1.80	7,141.42	791	791	221,096	368	12	10	-0.78
10	2004	9	3,708	4,169	0.89	0.90	3,750.47	42	42	196,730	332	1	9	-0.73
11		10	2,489	4,373	0.57	0.60	2,619.59	131	131	178,763	312	5	9	-0.36
12		11	2,309	4,577	0.50	0.70	3,195.59	887	887	233,969	364	38	11	2.12
13		12	7,427	4,781	1.55	1.80	8,611.12	1,184	1,184	331,318	433	16	12	4.52
14	2005	13	4,941	4,985	0.99	0.90	4,484.55	-456	456	321,858	434	9	12	3.45
15		14	3,943	5,189	0.76	0.60	3,108.40	-835	835	348,622	463	21	12	1.44
16		15	3,883	5,393	0.72	0.70	3,765.30	-118	118	326,304	440	3	12	1.25
17		16	10,831	5,597	1.94	1.80	10,080.83	-750	750	341,082	459	7	11	-0.44
18	2006	17	5,083	5,801	0.88	0.90	5,218.63	136	136	322,101	440	3	11	-0.15
19		18	3,326	6,005	0.55	0.60	3,597.21	271	271	308,293	431	8	11	0.48
20		19	4,358	6,209	0.70	0.70	4,335.02	-23	23	292,095	409	1	10	0.45
21		20	11,787	6,413	1.84	1.80	11,550.54	-236	236	280,285	401	2	10	-0.14
22														
23														
24														

Step 2: Forecast demand using the four-week moving average method and perform an error analysis.

I use the adaptive forecasting framework:

1. Initialize: First we calculate the estimates for the initial level, since the four-week moving average method has only level in the forecast. In this case the initial level is in period 4, and it is calculated as (D1 + D2 + D3 + D4)/4. L0 = 3,075.
2. Forecast: We now repeat the process of calculating the remaining levels throughout the operational periods. Using the level, we calculate the forecast for each period from 5 through 20. Ft+1 = Lt, so if t = 4 F5 = L4, and so forth. This can be seen in excel.



	A	B	C	D	E	F	G
1	Year, Y	Period, t	Demand, D	Level, L	Forecast, F		
2	2002	1	2025				
3		2	1563				
4		3	2170				
5		4	6542	3075			
6	2003	5	3162	3359	3075		
7		6	1928	3451	3359		
8		7	3113	3686	3451		
9		8	6350	3638	3686		
10	2004	9	3708	3775	3638		
11		10	2489	3915	3775		
12		11	2309	3714	3915		
13		12	7427	3983	3714		
14	2005	13	4941	4292	3983		
15		14	3943	4655	4292		
16		15	3883	5049	4655		
17		16	10831	5900	5049		
18	2006	17	5083	5935	5900		
19		18	3326	5781	5935		
20		19	4358	5900	5781		
21		20	11787	6139	5900		
22							
23							

3. Estimate error: Using excel I will calculate the Error, Absolute Error, MSE, MAD, % Error, MAPE, and TS. The excel sheet showing this is given:

	A	B	C	D	E	F	G	H	I	J	K	L
1	Year, Y	Period, t	Demand, D	Level, L	Forecast, F	Error, E	Absolute Err	MSE	MAD	% Error	MAPE	TS
2	2002	1	2025									
3		2	1563									
4		3	2170									
5		4	6542	3075								
6	2003	5	3162	3359	3075	-87	87	7569	87	3	3	-1.00
7		6	1928	3451	3359	1431	1431	1028023	759	74	38	1.77
8		7	3113	3686	3451	338	338	723317	619	11	29	2.72
9		8	6350	3638	3686	-2664	2664	2316379	1130	42	32	-0.87
10	2004	9	3708	3775	3638	-70	70	1854076	918	2	26	-1.15
11		10	2489	3915	3775	1286	1286	1820589	979	52	31	0.24
12		11	2309	3714	3915	1606	1606	1928967	1069	70	36	1.72
13		12	7427	3983	3714	-3713	3713	3411142	1399	50	38	-1.34
14	2005	13	4941	4292	3983	-958	958	3134047	1350	19	36	-2.10
15		14	3943	4655	4292	349	349	2832788	1250	9	33	-1.99
16		15	3883	5049	4655	772	772	2629442	1207	20	32	-1.42
17		16	10831	5900	5049	-5783	5783	5196764	1588	53	34	-4.72
18	2006	17	5083	5935	5900	817	817	4848295	1529	16	32	-4.37
19		18	3326	5781	5935	2609	2609	4988194	1606	78	36	-2.53
20		19	4358	5900	5781	1423	1423	4790596	1594	33	35	-1.66
21		20	11787	6139	5900	-5888	5888	6657600	1862	50	36	-4.58
22												
23												

Step 3: Forecast demand using the simple exponential smoothing method and perform an error analysis.

Again I use the adaptive forecasting framework:

1. Initialize: Simple exponential smoothing has only level as part of the forecast. The initial level, L0 = (D1 + D2 + … + Dn)/n = 4,547. The initial forecast, F1 = L0 = 4,547.
2. Forecast: We calculate level as, Lt = aDt+1 + (1-a)Lt = 0.06*Dt+1 + 0.94*Lt. The forecast for Ft+1 = Lt. Using excel the complete forecast is:

	A	B	C	D	E	F
1	Year, Y	Period, t	Demand, D	Level, L	Forecast, F	
2		0		4547		
3	2002	1	2025	4395.586	4547	
4		2	1563	4225.63084	4396	
5		3	2170	4102.29299	4226	
6		4	6542	4248.67541	4102	
7	2003	5	3162	4183.47489	4249	
8		6	1928	4048.14639	4183	
9		7	3113	3992.03761	4048	
10		8	6350	4133.51535	3992	
11	2004	9	3708	4107.98443	4134	
12		10	2489	4010.84537	4108	
13		11	2309	3908.73464	4011	
14		12	7427	4119.83056	3909	
15	2005	13	4941	4169.10073	4120	
16		14	3943	4155.53469	4169	
17		15	3883	4139.18261	4156	
18		16	10831	4540.69165	4139	
19	2006	17	5083	4573.23015	4541	
20		18	3326	4498.39634	4573	
21		19	4358	4489.97256	4498	
22		20	11787	4927.79421	4490	
23						
24						

3. Estimate error: Using excel I will calculate the Error, Absolute Error, MSE, MAD, % Error, MAPE, and TS. The excel sheet showing this is given:

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Year, Y	Period, t	Demand, D	Level, L	Forecast, F	Error, E	Absolute Err	MSE	MAD	% Error	MAPE	TS	
2		0		4547									
3	2002	1	2,025	4,396	4,547	2,522	2,522	6,359,980	2,522	125	125	1.00	
4		2	1,563	4,226	4,396	2,833	2,833	7,191,762	2,677	181	153	2.00	
5		3	2,170	4,102	4,226	2,056	2,056	6,203,047	2,470	95	133	3.00	
6		4	6,542	4,249	4,102	-2,440	2,440	6,140,328	2,462	37	109	2.02	
7	2003	5	3,162	4,183	4,249	1,087	1,087	5,148,435	2,187	34	94	2.77	
8		6	1,928	4,048	4,183	2,255	2,255	5,138,224	2,199	117	98	3.78	
9		7	3,113	3,992	4,048	935	935	4,529,120	2,018	30	88	4.58	
10		8	6,350	4,134	3,992	-2,358	2,358	4,657,978	2,061	37	82	3.34	
11	2004	9	3,708	4,108	4,134	426	426	4,160,543	1,879	11	74	3.89	
12		10	2,489	4,011	4,108	1,619	1,619	4,006,600	1,853	65	73	4.82	
13		11	2,309	3,909	4,011	1,702	1,702	3,905,662	1,839	74	73	5.78	
14		12	7,427	4,120	3,909	-3,518	3,518	4,611,706	1,979	47	71	3.60	
15	2005	13	4,941	4,169	4,120	-821	821	4,308,830	1,890	17	67	3.33	
16		14	3,943	4,156	4,169	226	226	4,004,708	1,771	6	63	3.68	
17		15	3,883	4,139	4,156	273	273	3,742,679	1,671	7	59	4.07	
18		16	10,831	4,541	4,139	-6,692	6,692	6,307,538	1,985	62	59	0.05	
19	2006	17	5,083	4,573	4,541	-542	542	5,953,806	1,900	11	56	-0.23	
20		18	3,326	4,498	4,573	1,247	1,247	5,709,460	1,864	37	55	0.43	
21		19	4,358	4,490	4,498	140	140	5,410,000	1,773	3	52	0.54	
22		20	11,787	4,928	4,490	-7,297	7,297	7,801,830	2,049	62	53	-3.10	
23													
24													

Name Bo

Step 4: Forecast demand using Holt's method and perform an error analysis. Again I use the adaptive forecasting framework:

1. Initialize: Holt's method involves using both level and trend in the demand forecast. To obtain both the initial level and trend we run a linear regression on the data. Doing so results in the regression equation: Dt = 1,836 + 258t. The initial level, L0 = 1,836 and the initial trend, T0 = 258.

2. Forecast: At any time t, the forecast Ft+1 = Lt + Tt, the Level Lt+1 = aDt+1 +(1-a)(Lt + Tt) = 0.06*Dt+1 + 0.94(Lt + Tt), and the Trend Tt+1 = b(Lt+1 - Lt) + (1-b)Tt = 0.06(Lt+1 - Lt) + 0.94*Tt. The complete forecast in excel is as such:

	A	B	C	D	E	F
1	Year, Y	Period, t	Demand, D	Level, L	Trend, T	Forecast, F
2		0		1836	258	
3	2002	1	2,025	2,090	258	1,836
4		2	1,563	2,301	255	4,115
5		3	2,170	2,532	254	3,864
6		4	6,542	3,011	267	4,702
7	2003	5	3,162	3,271	267	9,553
8		6	1,928	3,441	261	6,433
9		7	3,113	3,667	259	5,369
10		8	6,350	4,071	267	6,780
11	2004	9	3,708	4,301	265	10,421
12		10	2,489	4,441	258	8,009
13		11	2,309	4,556	249	6,930
14		12	7,427	4,962	259	6,865
15	2005	13	4,941	5,204	258	12,389
16		14	3,943	5,370	252	10,145
17		15	3,883	5,518	246	9,313
18		16	10,831	6,068	264	9,401
19	2006	17	5,083	6,257	260	16,899
20		18	3,326	6,325	248	11,340
21		19	4,358	6,440	240	9,651
22		20	11,787	6,987	258	10,798
23						

3. Estimate error: Using excel I will calculate the Error, Absolute Error, MSE, MAD, % Error, MAPE, and TS. The excel sheet showing this is given:

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Year, Y	Period, t	Demand, D	Level, L	Trend, T	Forecast, F	Error, E	Absolute Err	MSE	MAD	% Error	MAPE	TS
2		0		1836	258								
3	2002	1	2,025	2,090	258	1,836	-189	189	35,721	-189	9	9.33	-1.00
4		2	1,563	2,301	255	4,115	2,552	2,552	3,273,855	1,181	163	86.30	2.32
5		3	2,170	2,532	254	3,864	1,694	1,694	3,138,590	1,352	78	83.55	3.28
6		4	6,542	3,011	267	4,702	-1,840	1,840	3,200,035	554	28	69.69	11.32
7	2003	5	3,162	3,271	267	9,553	6,391	6,391	10,729,621	1,722	202	96.18	7.36
8		6	1,928	3,441	261	6,433	4,505	4,505	12,324,342	2,186	234	119.09	7.86
9		7	3,113	3,667	259	5,369	2,256	2,256	11,291,036	2,196	72	112.44	8.85
10		8	6,350	4,071	267	6,780	430	430	9,902,754	1,975	7	99.23	10.05
11	2004	9	3,708	4,301	265	10,421	6,713	6,713	13,809,680	2,501	181	108.32	10.62
12		10	2,489	4,441	258	8,009	5,520	5,520	15,475,395	2,803	222	119.66	11.45
13		11	2,309	4,556	249	6,930	4,621	4,621	16,009,989	2,969	200	126.98	12.37
14		12	7,427	4,962	259	6,865	-562	562	14,702,185	2,674	8	117.03	13.94
15	2005	13	4,941	5,204	258	12,389	7,448	7,448	17,838,381	3,041	151	119.62	14.70
16		14	3,943	5,370	252	10,145	6,202	6,202	19,311,495	3,267	157	122.31	15.59
17		15	3,883	5,518	246	9,313	5,430	5,430	19,989,875	3,411	140	123.48	16.52
18		16	10,831	6,068	264	9,401	-1,430	1,430	18,868,327	3,109	13	116.59	18.59
19	2006	17	5,083	6,257	260	16,899	11,816	11,816	25,970,923	3,621	232	123.40	19.22
20		18	3,326	6,325	248	11,340	8,014	8,014	28,096,010	3,865	241	129.93	20.08
21		19	4,358	6,440	240	9,651	5,293	5,293	28,091,804	3,940	121	129.49	21.04
22		20	11,787	6,987	258	10,798	-989	989	26,736,101	3,694	8	123.43	22.71
23													
24													

Step 5: Forecast demand using Winter's method and perform an error analysis. Again we use the adaptive forecasting framework:

1. Initialize: Winter's method uses level, trend, and seasonality in the forecast. We obtain the initial level, trend, and seasonality the same as we did in the static method. Since we have a periodicity of four, the initial seasonality values are S1 through S4 from the static forecasting method. I will not recalculate these values, but L0 = 2,333, T0 = 204, and S1 = 0.90, S2 = 0.60, S3 = 0.70, S4 = 1.80.

2. Forecast: At any time t, Ft+1 = (Lt + Tt)St+1, Lt+1 = a(Dt+1/St+1) + (1-a)(Lt + Tt), Tt+1 = b(Lt+1 - Lt) + (1-b)Tt, and St+p+1 = g(Dt+1/Lt+1) + (1-g)St+1 where p = 4. Completing the forecast in excel looks as such:

	A	B	C	D	E	F	G
1	Year, Y	Period, t	Demand, D	Level, L	Trend, T	Seasonality,	Forecast, F
2		0		2,333	204		
3	2002	1	2,025	2,520	203	0.9	2,283
4		2	1,563	2,716	203	0.6	1,634
5		3	2,170	2,929	203	0.7	2,043
6		4	6,542	3,162	205	1.8	5,638
7	2003	5	3,162	3,378	206	0.89	3,011
8		6	1,928	3,561	204	0.60	2,145
9		7	3,113	3,806	207	0.70	2,645
10		8	6,350	3,981	205	1.82	7,287
11	2004	9	3,708	4,183	205	0.90	3,754
12		10	2,489	4,376	204	0.60	2,611
13		11	2,309	4,500	199	0.71	3,249
14		12	7,427	4,664	197	1.80	8,472
15	2005	13	4,941	4,901	199	0.90	4,356
16		14	3,943	5,193	205	0.59	3,027
17		15	3,883	5,408	206	0.70	3,765
18		16	10,831	5,640	207	1.79	10,049
19	2006	17	5,083	5,834	206	0.90	5,279
20		18	3,326	6,008	204	0.60	3,645
21		19	4,358	6,214	205	0.70	4,342
22		20	11,787	6,427	205	1.80	11,541
23							

3. Estimate errors: Estimate error: Using excel I will calculate the Error, Absolute Error, MSE, MAD, % Error, MAPE, and TS. The excel sheet showing this is given:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	Year, Y	Period, t	Demand, D	Level, L	Trend, T	Seasonality,	Forecast, F	Error, E	Absolute Err	MSE	MAD	% Error	MAPE	TS
2		0		2,333	204									
3	2002	1	2,025	2,520	203	0.9	2,283	258	258	66,719	258	13	12.76	1.00
4		2	1,563	2,716	203	0.6	1,634	71	71	35,855	164	5	8.64	2.00
5		3	2,170	2,929	203	0.7	2,043	-127	127	29,300	152	6	7.71	1.33
6		4	6,542	3,162	205	1.8	5,638	-904	904	226,193	340	14	9.24	-2.07
7	2003	5	3,162	3,378	206	0.89	3,011	-151	151	185,499	302	5	8.34	-2.82
8		6	1,928	3,561	204	0.60	2,145	217	217	162,406	288	11	8.83	-2.21
9		7	3,113	3,806	207	0.70	2,645	-468	468	170,458	314	15	9.71	-3.52
10		8	6,350	3,981	205	1.82	7,287	937	937	258,911	392	15	10.34	-0.43
11	2004	9	3,708	4,183	205	0.90	3,754	46	46	230,378	353	1	9.33	-0.34
12		10	2,489	4,376	204	0.60	2,611	122	122	208,835	330	5	8.89	0.00
13		11	2,309	4,500	199	0.71	3,249	940	940	270,112	385	41	11.78	2.44
14		12	7,427	4,664	197	1.80	8,472	1,045	1,045	338,589	440	14	11.97	4.51
15	2005	13	4,941	4,901	199	0.90	4,356	-585	585	338,828	452	12	11.96	3.10
16		14	3,943	5,193	205	0.59	3,027	-916	916	374,558	485	23	12.77	1.00
17		15	3,883	5,408	206	0.70	3,765	-118	118	350,509	460	3	12.12	0.80
18		16	10,831	5,640	207	1.79	10,049	-782	782	366,823	480	7	11.81	-0.86
19	2006	17	5,083	5,834	206	0.90	5,279	196	196	347,496	464	4	11.34	-0.47
20		18	3,326	6,008	204	0.60	3,645	319	319	333,845	456	10	11.24	0.22
21		19	4,358	6,214	205	0.70	4,342	-16	16	316,288	432	0	10.67	0.19
22		20	11,787	6,427	205	1.80	11,541	-246	246	303,497	423	2	10.24	-0.38
23														
24														
25														

Step 6: Which forecasting method gives us the smallest error.

I am going to judge the forecasting methods by on the average % error they have. Whichever method resulted in the smallest forecasting error is the method to proceed forward with forecasting demand for the next year (2007).

Forecasting Method	% Error
Static	10%
Moving average	36.34%

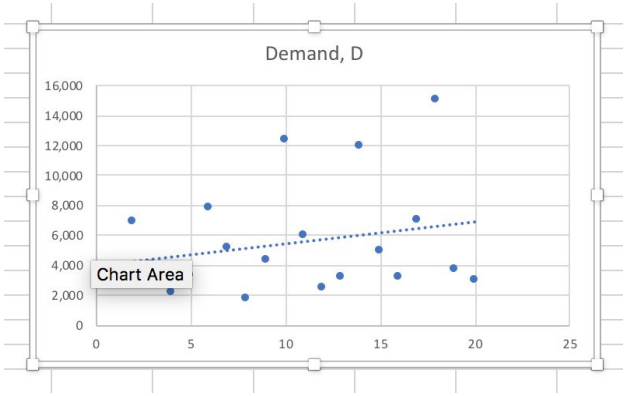
Simple exponential smoothing	53%
Holt's method	123%
Winter's method	10%

Winter's method for demand forecasting and static forecasting gives us the smallest % error, and I will use Winters method to project demand in 2007.

SP2: Which forecasting method should she use for clear plastic?

Step 1: Forecast demand using the static forecasting method and perform an error analysis.

There are three factors at play in static forecasting; level, trend, and seasonality. The first thing to do is to graph the given demand for black plastic, showing a regression line.



The next step in performing a static forecast is to deseasonalize the given demand. The periodicity in this case is 4 since each year is broken up into four quarters, which means I will use the formula for deseasonalizing data where periodicity is even. The first value we calculate is the deseasonalized demand for period three. D3 = (D1 + 2D2 + 2D3 + 2D4 + D5)/8 = 4,024. This process continues up until period 18, as shown in excel.

	A	B	C	D	E
1	Year, Y	Period, t	Demand, D	Deseasonalized Demand	
2	2002	1	2,880		
3		2	6,892		
4		3	3,978	4024.75	
5		4	2,145	4190.75	
6	2003	5	3,288	4449.25	
7		6	7,812	4544.25	
8		7	5,126	4618.125	
9		8	1,757	5302.125	
10	2004	9	4,267	5970	
11		10	12,305	6164.5	
12		11	5,976	6111.5	
13		12	2,463	5915.5	
14	2005	13	3,137	5726.625	
15		14	11,867	5676.625	
16		15	4,903	6238	
17		16	3,136	7098.25	
18	2006	17	6,955	7332.375	
19		18	14,931	7164.5	
20		19	3,712		
21		20	2,984		
22					

To perform the forecast we need to calculate the initial level and trend. This is done running a regression on the deseasonalized demand in excel:

	A	B	C	D	E	F	G	H	I
1	SUMMARY OUTPUT								
2									
3	*Regression Statistics*								
4	Multiple R	0.9357795							
5	R Square	0.87568327							
6	Adjusted R S	0.8668035							
7	Standard Err	386.749973							
8	Observations	16							
9									
10	ANOVA								
11		*df*	*SS*	*MS*	*F*	*Significance F*			
12	Regression	1	14750478.1	14750478.1	98.6155758	1.0183E-07			
13	Residual	14	2094057.58	149575.541					
14	Total	15	16844535.7						
15									
16		*Coefficients*	*tandard Erro*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
17	Intercept	3470.92463	240.521393	14.4308354	8.4813E-10	2955.05755	3986.79171	2955.05755	3986.79171
18	X Variable 1	208.287684	20.9744622	9.93053754	1.0183E-07	163.301937	253.273431	163.301937	253.273431
19									

The regresion gives me an initial level, L0 = 3,471 and the initial trend, T0 = 208. Deseasonalized demand for any period t is given by Dt = 3,471 + 208t. Using this formula for regressed deseasonalized demand we fill in the next column of the excel sheet:

	A	B	C	D	E
1	Year, Y	Period, t	Demand, D	Deseasonaliz	Regressed, R
2	2002	1	2,880		3,679
3		2	6,892		3,887
4		3	3,978	4,025	4,095
5		4	2,145	4,191	4,303
6	2003	5	3,288	4,449	4,511
7		6	7,812	4,544	4,719
8		7	5,126	4,618	4,927
9		8	1,757	5,302	5,135
10	2004	9	4,267	5,970	5,343
11		10	12,305	6,165	5,551
12		11	5,976	6,112	5,759
13		12	2,463	5,916	5,967
14	2005	13	3,137	5,727	6,175
15		14	11,867	5,677	6,383
16		15	4,903	6,238	6,591
17		16	3,136	7,098	6,799
18	2006	17	6,955	7,332	7,007
19		18	14,931	7,165	7,215
20		19	3,712		7,423
21		20	2,984		7,631
22					
23					
24					

The next step is to obtain the seasonal factor for each period, which is given by the seasonalized demand divided by the regressed deseasonalized demand. Filling in the excel sheet gives:

	A	B	C	D	E	F
1	Year, Y	Period, t	Demand, D	Deseasonaliz	Regressed, R	Seasonal Fac
2	2002	1	2,880		3,679	0.78
3		2	6,892		3,887	1.77
4		3	3,978	4,025	4,095	0.97
5		4	2,145	4,191	4,303	0.50
6	2003	5	3,288	4,449	4,511	0.73
7		6	7,812	4,544	4,719	1.66
8		7	5,126	4,618	4,927	1.04
9		8	1,757	5,302	5,135	0.34
10	2004	9	4,267	5,970	5,343	0.80
11		10	12,305	6,165	5,551	2.22
12		11	5,976	6,112	5,759	1.04
13		12	2,463	5,916	5,967	0.41
14	2005	13	3,137	5,727	6,175	0.51
15		14	11,867	5,677	6,383	1.86
16		15	4,903	6,238	6,591	0.74
17		16	3,136	7,098	6,799	0.46
18	2006	17	6,955	7,332	7,007	0.99
19		18	14,931	7,165	7,215	2.07
20		19	3,712		7,423	0.50
21		20	2,984		7,631	0.39
22						
23						

Next I calculate the average seasonal factor. There are four seasons, so I get the data during that season from each of the five years of data given, add them up and divide the sum by five.
S1 = (0.78 + 0.73 + 0.80 + 0.51 + 0.99)/5 = 0.76
S2 = (1.77 + 1.66 + 2.22 + 1.86 + 2.07)/5 = 1.91
S3 = (0.97 + 1.04 + 1.04 + 0.74 + 0.50)/5 = 0.86
S4 = (0.50 + 0.34 + 0.41 + 0.46 + 0.39)/5 = 0.42

	A	B	C	D	E	F	G
1	Year, Y	Period, t	Demand, D	Deseasonaliz	Regressed, R	Seasonal Fac	Average Sea
2	2002	1	2,880		3,679	0.78	0.76
3		2	6,892		3,887	1.77	1.91
4		3	3,978	4,025	4,095	0.97	0.86
5		4	2,145	4,191	4,303	0.50	0.42
6	2003	5	3,288	4,449	4,511	0.73	0.76
7		6	7,812	4,544	4,719	1.66	1.91
8		7	5,126	4,618	4,927	1.04	0.86
9		8	1,757	5,302	5,135	0.34	0.42
10	2004	9	4,267	5,970	5,343	0.80	0.76
11		10	12,305	6,165	5,551	2.22	1.91
12		11	5,976	6,112	5,759	1.04	0.86
13		12	2,463	5,916	5,967	0.41	0.42
14	2005	13	3,137	5,727	6,175	0.51	0.76
15		14	11,867	5,677	6,383	1.86	1.91
16		15	4,903	6,238	6,591	0.74	0.86
17		16	3,136	7,098	6,799	0.46	0.42
18	2006	17	6,955	7,332	7,007	0.99	0.76
19		18	14,931	7,165	7,215	2.07	1.91
20		19	3,712		7,423	0.50	0.86
21		20	2,984		7,631	0.39	0.42
22							

Finally, I calculate the forecast for and perform an error analysis calculating Error, Absolute Error, MSE, MAD, % Error, MAPE, and TS. The excel sheet showing this is given:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	Year, Y	Period, t	Demand, D	Deseasonaliz	Regressed, R	Seasonal Fac	Average Sea	Forecast, F	Error, E	Absolute Err	MSE	MAD	% Error	MAPE	TS
2	2002	1	2,880		3,679	0.78	0.76	2,804.07	-76	76	5,765	76	3	3	-1.00
3		2	6,892		3,887	1.77	1.91	7,442.70	551	551	154,519	313	8	5	1.52
4		3	3,978	4,025	4,095	0.97	0.86	3,516.34	-462	462	174,055	363	12	7	0.04
5		4	2,145	4,191	4,303	0.50	0.42	1,812.17	-333	333	158,236	355	16	9	-0.90
6	2003	5	3,288	4,449	4,511	0.73	0.76	3,438.21	150	150	131,101	314	5	8	-0.54
7		6	7,812	4,544	4,719	1.66	1.91	9,035.79	1,224	1,224	358,861	466	16	10	2.26
8		7	5,126	4,618	4,927	1.04	0.86	4,230.77	-895	895	422,085	527	17	11	0.30
9		8	1,757	5,302	5,135	0.34	0.42	2,162.56	406	406	389,884	512	23	12	1.10
10	2004	9	4,267	5,970	5,343	0.80	0.76	4,072.35	-195	195	350,773	477	5	11	0.78
11		10	12,305	6,165	5,551	2.22	1.91	10,628.88	-1,676	1,676	596,635	597	14	12	-2.19
12		11	5,976	6,112	5,759	1.04	0.86	4,945.21	-1,031	1,031	638,990	636	17	12	-3.67
13		12	2,463	5,916	5,967	0.41	0.42	2,512.94	50	50	585,949	587	2	11	-3.89
14	2005	13	3,137	5,727	6,175	0.51	0.76	4,706.48	1,569	1,569	730,358	663	50	14	-1.08
15		14	11,867	5,677	6,383	1.86	1.91	12,221.96	355	355	687,190	641	3	14	-0.57
16		15	4,903	6,238	6,591	0.74	0.86	5,659.64	757	757	679,544	649	15	14	0.61
17		16	3,136	7,098	6,799	0.46	0.42	2,863.33	-273	273	641,719	625	9	13	0.19
18	2006	17	6,955	7,332	7,007	0.99	0.76	5,340.62	-1,614	1,614	757,278	683	23	14	-2.19
19		18	14,931	7,165	7,215	2.07	1.91	13,815.05	-1,116	1,116	784,393	707	7	14	-3.69
20		19	3,712		7,423	0.50	0.86	6,374.07	2,662	2,662	1,116,089	810	72	17	0.07
21		20	2,984		7,631	0.39	0.42	3,213.72	230	230	1,062,923	781	8	16	0.36
22															
23															

Step 2: Forecast demand using the four-week moving average method and perform an error analysis.

I use the adaptive forecasting framework:

1. Initialize: First we calculate the estimates for the initial level, since the four-week moving average method has only level in the forecast. In this case the initial level is in period 4, and it is calculated as (D1 + D2 + D3 + D4)/4. L0 = 3,974.

2. Forecast: We now repeat the process of calculating the remaining levels throughout the operational periods. Using the level, we calculate the forecast for each period from 5 through 20. Ft+1 = Lt, so if t = 4 F5 = L4, and so forth. This can be seen in excel.

	A	B	C	D	E
1	Year, Y	Period, t	Demand, D	Level, L	Forecast, F
2	2002	1	2,880		
3		2	6,892		
4		3	3,978		
5		4	2,145	3974	
6	2003	5	3,288	4076	3974
7		6	7,812	4306	4076
8		7	5,126	4593	4306
9		8	1,757	4496	4593
10	2004	9	4,267	4741	4496
11		10	12,305	5864	4741
12		11	5,976	6076	5864
13		12	2,463	6253	6076
14	2005	13	3,137	5970	6253
15		14	11,867	5861	5970
16		15	4,903	5593	5861
17		16	3,136	5761	5593
18	2006	17	6,955	6715	5761
19		18	14,931	7481	6715
20		19	3,712	7184	7481
21		20	2,984	7146	7184

3. Estimate Error: Using excel I will calculate the Error, Absolute Error, MSE, MAD, % Error, MAPE, and TS. The excel sheet showing this is given:

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Year, Y	Period, t	Demand, D	Level, L	Forecast, F	Error, E	Absolute Err	MSE	MAD	% Error	MAPE	TS	
2	2002	1	2,880										
3		2	6,892										
4		3	3,978										
5		4	2,145	3,974									
6	2003	5	3,288	4,076	3,974	686	686	470,253	686	21	21	1.00	
7		6	7,812	4,306	4,076	-3,736	3,736	7,214,909	2,211	48	34	-1.38	
8		7	5,126	4,593	4,306	-820	820	5,034,209	1,747	16	28	-2.22	
9		8	1,757	4,496	4,593	2,836	2,836	5,786,026	2,020	161	62	-0.51	
10	2004	9	4,267	4,741	4,496	229	229	4,639,286	1,661	5	50	-0.49	
11		10	12,305	5,864	4,741	-7,565	7,565	13,403,015	2,645	61	52	-3.16	
12		11	5,976	6,076	5,864	-112	112	11,490,099	2,283	2	45	-3.72	
13		12	2,463	6,253	6,076	3,613	3,613	11,685,783	2,450	147	58	-1.99	
14	2005	13	3,137	5,970	6,253	3,116	3,116	11,466,018	2,524	99	62	-0.70	
15		14	11,867	5,861	5,970	-5,897	5,897	13,796,583	2,861	50	61	-2.67	
16		15	4,903	5,593	5,861	958	958	12,625,737	2,688	20	57	-2.49	
17		16	3,136	5,761	5,593	2,457	2,457	12,076,459	2,669	78	59	-1.59	
18	2006	17	6,955	6,715	5,761	-1,194	1,194	11,257,211	2,555	17	56	-2.13	
19		18	14,931	7,481	6,715	-8,216	8,216	15,274,449	2,960	55	56	-4.61	
20		19	3,712	7,184	7,481	3,769	3,769	15,203,302	3,014	102	59	-3.28	
21		20	2,984	7,146	7,184	4,200	4,200	15,355,333	3,088	141	64	-1.84	
22													
23													

Step 3: Forecast demand using the simple exponential smoothing method and perform an error analysis.

Again I use the adaptive forecasting framework:

1. Initialize: Simple exponential smoothing has only level as part of the forecast. The initial level, L0 = (D1 + D2 + … + Dn)/n = 5,526. The initial forecast, F1 = L0 = 5,526.

2. Forecast: We calculate level as, Lt = aDt+1 + (1-a)Lt = 0.06*Dt+1 + 0.94*Lt. The forecast for Ft+1 = Lt. Using excel the complete forecast is:

	A	B	C	D	E
1	Year, Y	Period, t	Demand, D	Level, L	Forecast, F
2		0		5,526	
3	2002	1	2,880	5,367	5,526
4		2	6,892	5,458	5,367
5		3	3,978	5,370	5,458
6		4	2,145	5,176	5,370
7	2003	5	3,288	5,063	5,176
8		6	7,812	5,228	5,063
9		7	5,126	5,222	5,228
10		8	1,757	5,014	5,222
11	2004	9	4,267	4,969	5,014
12		10	12,305	5,409	4,969
13		11	5,976	5,443	5,409
14		12	2,463	5,264	5,443
15	2005	13	3,137	5,137	5,264
16		14	11,867	5,541	5,137
17		15	4,903	5,502	5,541
18		16	3,136	5,360	5,502
19	2006	17	6,955	5,456	5,360
20		18	14,931	6,024	5,456
21		19	3,712	5,886	6,024
22		20	2,984	5,712	5,886
23					

3. Estimate Error: Using excel I will calculate the Error, Absolute Error, MSE, MAD, % Error, MAPE, and TS. The excel sheet showing this is given:

	A	B	C	D	E	F	G	H	I	J	K	L
1	Year, Y	Period, t	Demand, D	Level, L	Forecast, F	Error, E	Absolute Err	MSE	MAD	% Error	MAPE	TS
2		0		5,526								
3	2002	1	2,880	5,367	5,526	2,646	2,646	6,999,728	2,646	92	92	1.00
4		2	6,892	5,458	5,367	-1,525	1,525	4,662,741	2,085	22	57	0.54
5		3	3,978	5,370	5,458	1,480	1,480	3,839,082	1,884	37	50	1.38
6		4	2,145	5,176	5,370	3,225	3,225	5,478,876	2,219	150	75	2.63
7	2003	5	3,288	5,063	5,176	1,888	1,888	5,096,126	2,153	57	72	3.58
8		6	7,812	5,228	5,063	-2,749	2,749	5,506,395	2,252	35	66	2.20
9		7	5,126	5,222	5,228	102	102	4,721,248	1,945	2	57	2.60
10		8	1,757	5,014	5,222	3,465	3,465	5,631,615	2,135	197	74	4.00
11	2004	9	4,267	4,969	5,014	747	747	5,067,851	1,981	18	68	4.68
12		10	12,305	5,409	4,969	-7,336	7,336	9,942,736	2,516	60	67	0.77
13		11	5,976	5,443	5,409	-567	567	9,068,060	2,339	9	62	0.59
14		12	2,463	5,264	5,443	2,980	2,980	9,052,512	2,392	121	67	1.82
15	2005	13	3,137	5,137	5,264	2,127	2,127	8,704,296	2,372	68	67	2.73
16		14	11,867	5,541	5,137	-6,730	6,730	11,318,028	2,683	57	66	-0.09
17		15	4,903	5,502	5,541	638	638	10,590,591	2,547	13	63	0.15
18		16	3,136	5,360	5,502	2,366	2,366	10,278,638	2,536	75	63	1.09
19	2006	17	6,955	5,456	5,360	-1,595	1,595	9,823,601	2,480	23	61	0.47
20		18	14,931	6,024	5,456	-9,475	9,475	14,265,385	2,869	63	61	-2.90
21		19	3,712	5,886	6,024	2,312	2,312	13,796,030	2,840	62	61	-2.11
22		20	2,984	5,712	5,886	2,902	2,902	13,527,235	2,843	97	63	-1.09
23												
24												

Step 4: Forecast demand using Holt's method and perform an error analysis. Again I use the adaptive forecasting framework:

1. Initialize: Holt's method involves using both level and trend in the demand forecast. To obtain both the initial level and trend we run a linear regression on the data. Doing so results in the regression equation: Dt = 4,032 + 142t. The initial level, L0 = 4,032 and the initial trend, T0 = 142.

2. Forecast: At any time t, the forecast Ft+1 = Lt + Tt, the Level Lt+1 = aDt+1 +(1-a)(Lt + Tt) = 0.06*Dt+1 + 0.94(Lt + Tt), and the Trend Tt+1 = b(Lt+1 - Lt) + (1-b)Tt = 0.06(Lt+1 - Lt) + 0.94*Tt. The complete forecast in excel is as such:

	A	B	C	D	E
1	Year, Y	Period, t	Demand, D	Level, L	Trend, T
2		0		4,032	142
3	2002	1	2,880	4,096	137
4		2	6,892	4,393	147
5		3	3,978	4,506	145
6		4	2,145	4,501	136
7	2003	5	3,288	4,556	131
8		6	7,812	4,874	142
9		7	5,126	5,023	143
10		8	1,757	4,961	130
11	2004	9	4,267	5,042	127
12		10	12,305	5,598	153
13		11	5,976	5,764	154
14		12	2,463	5,711	141
15	2005	13	3,137	5,689	132
16		14	11,867	6,184	153
17		15	4,903	6,251	148
18		16	3,136	6,204	137
19	2006	17	6,955	6,377	139
20		18	14,931	7,021	169
21		19	3,712	6,981	157
22		20	2,984	6,889	142
23					

3. Estimate Error: Using excel I will calculate the Error, Absolute Error, MSE, MAD, % Error, MAPE, and TS. The excel sheet showing this is given:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	Year, Y	Period, t	Demand, D	Level, L	Trend, T	Forecast, F	Error, E	Absolute Err	MSE	MAD	% Error	MAPE	TS	
2		0		4,032	142									
3	2002	1	2,880	4,096	137	4,174	1,294	1,294	1,674,436	1,294	45	44.93	1.00	
4		2	6,892	4,393	147	4,234	-2,658	2,658	4,370,493	-682	39	41.75	-5.79	
5		3	3,978	4,506	145	4,540	562	562	3,018,985	-267	14	32.54	-16.88	
6		4	2,145	4,501	136	4,651	2,506	2,506	3,834,589	426	117	53.62	16.48	
7	2003	5	3,288	4,556	131	4,637	1,349	1,349	3,431,502	611	41	51.10	13.71	
8		6	7,812	4,874	142	4,687	-3,125	3,125	4,487,351	-12	40	49.25	-953.79	
9		7	5,126	5,023	143	5,017	-109	109	3,848,010	-26	2	42.52	-447.06	
10		8	1,757	4,961	130	5,166	3,409	3,409	4,819,526	403	194	61.46	37.22	
11	2004	9	4,267	5,042	127	5,092	825	825	4,359,590	450	19	56.77	35.18	
12		10	12,305	5,598	153	5,170	-7,135	7,135	9,015,000	-308	58	56.90	-74.50	
13		11	5,976	5,764	154	5,751	-225	225	8,200,064	-301	4	52.07	-77.12	
14		12	2,463	5,711	141	5,918	3,455	3,455	8,511,628	12	140	59.42	2182.59	
15	2005	13	3,137	5,689	132	5,852	2,715	2,715	8,424,079	220	87	61.51	133.40	
16		14	11,867	6,184	153	5,821	-6,046	6,046	10,433,203	-227	51	60.75	-155.72	
17		15	4,903	6,251	148	6,337	1,434	1,434	9,874,823	-117	29	58.65	-315.95	
18		16	3,136	6,204	137	6,400	3,264	3,264	9,923,354	95	104	61.49	423.86	
19	2006	17	6,955	6,377	139	6,340	-615	615	9,361,849	53	9	58.39	769.68	
20		18	14,931	7,021	169	6,516	-8,415	8,415	12,775,754	-418	56	58.28	-117.70	
21		19	3,712	6,981	157	7,190	3,478	3,478	12,739,989	-212	94	60.14	-247.63	
22		20	2,984	6,889	142	7,138	4,154	4,154	12,965,699	6	139	64.10	9760.51	
23														
24														
25														

Step 5: Forecast demand using Winter's method and perform an error analysis. Again we use the adaptive forecasting framework:

1. Initialize: Winter's method uses level, trend, and seasonality in the forecast. We obtain the initial level, trend, and seasonality the same as we did in the static method. Since we have a periodicity of four, the initial seasonality values are S1 through S4 from the static forecasting method. I will not recalculate these values, but L0 = 3,471, T0 = 208, and S1 = 0.76, S2 = 1.91, S3 = 0.86, S4 = 0.42.

2. Forecast: At any time t, Ft+1 = (Lt + Tt)St+1, Lt+1 = a(Dt+1/St+1) + (1-a)(Lt + Tt), Tt+1 = b(Lt+1 - Lt) + (1-b)Tt, and St+p+1 = g(Dt+1/Lt+1) + (1-g)St+1 where p = 4. Completing the forecast in excel looks as such:

	A	B	C	D	E	F	G
1	Year, Y	Period, t	Demand, D	Level, L	Trend, T	Seasonality,	Forecast, F
2		0		3,471	208		
3	2002	1	2,880	3,686	208	0.76	2,796
4		2	6,892	3,877	207	1.91	7,438
5		3	3,978	4,117	209	0.86	3,512
6		4	2,145	4,373	212	0.42	1,817
7	2003	5	3,288	4,569	211	0.76	3,491
8		6	7,812	4,740	209	1.90	9,092
9		7	5,126	5,007	212	0.87	4,287
10		8	1,757	5,154	208	0.42	2,214
11	2004	9	4,267	5,378	209	0.76	4,069
12		10	12,305	5,644	213	1.89	10,543
13		11	5,976	5,914	216	0.88	5,129
14		12	2,463	6,115	215	0.42	2,570
15	2005	13	3,137	6,198	207	0.76	4,817
16		14	11,867	6,395	207	1.90	12,198
17		15	4,903	6,538	203	0.88	5,835
18		16	3,136	6,786	206	0.42	2,819
19	2006	17	6,955	7,132	214	0.75	5,213
20		18	14,931	7,376	216	1.90	13,969
21		19	3,712	7,391	204	0.88	6,650
22		20	2,984	7,564	202	0.42	3,196
23							

3. Estimate Error: Using excel I will calculate the Error, Absolute Error, MSE, MAD, % Error, MAPE, and TS. The excel sheet showing this is given:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	Year, Y	Period, t	Demand, D	Level, L	Trend, T	Seasonality,	Forecast, F	Error, E	Absolute Err	MSE	MAD	% Error	MAPE	TS	
2		0		2,151	354										
3	2002	1	2,880	2,505	354	1.15	2,881	1	1	1	1	0	0.03	1.00	
4		2	6,892	2,859	354	2.41	6,890	-2	2	2	1	0	0.03	-0.87	
5		3	3,978	3,213	354	1.24	3,984	6	6	14	3	0	0.07	1.70	
6		4	2,145	3,567	354	0.6	2,140	-5	5	17	3	0	0.11	0.00	
7	2003	5	3,288	3,857	350	1.15	4,509	1,221	1,221	298,337	247	37	7.52	4.94	
8		6	7,812	4,150	347	2.41	10,141	2,329	2,329	1,152,380	594	30	11.23	5.98	
9		7	5,126	4,475	345	1.24	5,575	449	449	1,016,562	573	9	10.88	6.98	
10		8	1,757	4,707	339	0.60	2,892	1,135	1,135	1,050,642	644	65	17.60	7.98	
11	2004	9	4,267	4,969	334	1.13	5,712	1,445	1,445	1,165,826	733	34	19.40	8.98	
12		10	12,305	5,295	334	2.38	12,612	307	307	1,058,645	690	2	17.71	9.98	
13		11	5,976	5,581	331	1.23	6,947	971	971	1,048,071	715	16	17.58	10.98	
14		12	2,463	5,809	325	0.59	3,467	1,004	1,004	1,044,761	740	41	19.51	11.98	
15	2005	13	3,137	5,934	313	1.12	6,844	3,707	3,707	2,021,200	968	118	27.10	12.99	
16		14	11,867	6,172	308	2.38	14,837	2,970	2,970	2,507,025	1,111	25	26.95	13.99	
17		15	4,903	6,331	299	1.22	7,934	3,031	3,031	2,952,465	1,239	62	29.28	14.99	
18		16	3,136	6,559	295	0.58	3,824	688	688	2,797,524	1,204	22	28.82	15.99	
19	2006	17	6,955	6,829	293	1.08	7,406	451	451	2,644,911	1,160	6	27.50	16.99	
20		18	14,931	7,076	291	2.35	16,723	1,792	1,792	2,676,366	1,195	12	26.64	17.99	
21		19	3,712	7,111	275	1.20	8,822	5,110	5,110	3,909,571	1,401	138	32.49	18.99	
22		20	2,984	7,257	267	0.57	4,216	1,232	1,232	3,790,006	1,393	41	32.93	19.99	
23															
24															

Step 6: Which forecasting method gives us the smallest error.

I am going to judge the forecasting methods by on the average % error they have. Whichever method resulted in the smallest forecasting error is the method to proceed forward with forecasting demand for the next year (2007).

Forecasting Method	% Error
Static	16%
Moving average	64%

Simple exponential smoothing	63%
Holt's method	64%
Winter's method	17%

As we can see, static forecasting gives us the smallest average % error, and thus it is the forecasting method I will use to project demand for clear plastic in 2007.

SP3: What is the demand forecast for each quarter of 2007 for black plastic and for clear plastic?

Step 1: Which forecasting method am I going to use for black plastic.

I will be using Winter's method to forecast demand for 2007.

Step 2: Forecast demand for black plastic during each quarter of 2007 using that method.

To forecast demand for 2007 using Winter's method I must first understand what the seasonal factors will be during the year. This can be done by continuing the process I used to calculate seasonality during the earlier part of the forecast. The formula for calculating seasonality is $S_{t+p+1} = g(D_{t+1}/L_{t+1}) + (1-g)S_{t+1}$ where p is four in this case, and this formula can be applied to calculate the seasonality for all four periods of 2007. To calculate the forecasts for the four periods of 2007 we use the following formulas:

F21 = (L20 + T20)*S21 = 5,975

F22 = (L20 + 2*T20)*S22 = 4,106

F23 = (L20 + 3*T20)*S23 = 4,922

F24 = (L20 + 4*T20)*S24 = 13,046

The excel spreadsheet show this demand forecast:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	Year, Y	Period, t	Demand, D	Level, L	Trend, T	Seasonality,	Forecast, F	Error, E	Absolute Err	MSE	MAD	% Error	MAPE	TS	
2		0		2,333	204										
3	2002	1	2,025	2,520	203	0.9	2,283	258	258	66,719	258	13	12.76	1.00	
4		2	1,563	2,716	203	0.6	1,634	71	71	35,855	164	5	8.64	2.00	
5		3	2,170	2,929	203	0.7	2,043	-127	127	29,300	152	6	7.71	1.33	
6		4	6,542	3,162	205	1.8	5,638	-904	904	226,193	340	14	9.24	-2.07	
7	2003	5	3,162	3,378	206	0.89	3,011	-151	151	185,499	302	5	8.34	-2.82	
8		6	1,928	3,561	204	0.60	2,145	217	217	162,406	288	11	8.83	-2.21	
9		7	3,113	3,806	207	0.70	2,645	-468	468	170,458	314	15	9.71	-3.52	
10		8	6,350	3,981	205	1.82	7,287	937	937	258,911	392	15	10.34	-0.43	
11	2004	9	3,708	4,183	205	0.90	3,754	46	46	230,378	353	1	9.33	-0.34	
12		10	2,489	4,376	204	0.60	2,611	122	122	208,835	330	5	8.89	0.00	
13		11	2,309	4,500	199	0.71	3,249	940	940	270,112	385	41	11.78	2.44	
14		12	7,427	4,664	197	1.80	8,472	1,045	1,045	338,589	440	14	11.97	4.51	
15	2005	13	4,941	4,901	199	0.90	4,356	-585	585	338,828	452	12	11.96	3.10	
16		14	3,943	5,193	205	0.59	3,027	-916	916	374,558	485	23	12.77	1.00	
17		15	3,883	5,408	206	0.70	3,765	-118	118	350,509	460	3	12.12	0.80	
18		16	10,831	5,640	207	1.79	10,049	-782	782	366,823	480	7	11.81	-0.86	
19	2006	17	5,083	5,834	206	0.90	5,279	196	196	347,496	464	4	11.34	-0.47	
20		18	3,326	6,008	204	0.60	3,645	319	319	333,845	456	10	11.24	0.22	
21		19	4,358	6,214	205	0.70	4,342	-16	16	316,288	432	0	10.67	0.19	
22		20	11,787	6,427	205	1.80	11,541	-246	246	303,497	423	2	10.24	-0.38	
23	2007	21				0.90	5,975								
24		22				0.60	4,106								
25		23				0.70	4,922								
26		24				1.80	13,046								
27															
28															

We can see that overall demand is expected to increase in 2007 at about the same rate it has been growing the past four years, or about a 3,500 unit increase. The forecast also

matches seasonal trends that have been consistent, with an increase coming in the fall. Total demand for the year is expected to be 28,049 units.

Step 3: Which forecasting method am I going to use for clear plastic.

I will use static forecasting to perform the demand forecast for clear plastic in 2007 as it produced the smallest average percent error of all the forecasting methods.

Step 4: Forecast demand for clear plastic during each quarter of 2007 using that method.

To forecast demand in 2007 using static forecasting I first have to get the seasonality for each period in 2007. The seasonality in each period of 2007 is the same as the seasonality in each period of the other years. In this case:

S21 = 0.76

S22 = 1.91

S23 = 0.86

S24 = 0.42

We then calculate the regressed deseasonalized data for the periods, which is equal to the initial level + the trend * the period number. Rt = L0 + t*T0.

R21 = 7,839

R22 = 8,047

R23 = 8,255

R24 = 8,463

To obtain the forecast for each period in 2007 I multiply the regressed deseasonalized demand for the period by the seasonality for the period.

F21 = 5,975

F22 = 15,408

F23 = 7,089

F24 = 3,564

The excel sheet:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	Year, Y	Period, t	Demand, D	Deseasonaliz	Regressed, R	Seasonal Fac	Average Sea	Forecast, F	Error, E	Absolute Err	MSE	MAD	% Error	MAPE	TS
2	2002	1	2,880		3,679	0.78	0.76	2,804	-76	76	5,765	76	3	3	-1.00
3		2	6,892		3,887	1.77	1.91	7,443	551	551	154,519	313	8	5	1.52
4		3	3,978	4,025	4,095	0.97	0.86	3,516	-462	462	174,055	363	12	7	0.04
5		4	2,145	4,191	4,303	0.50	0.42	1,812	-333	333	158,236	355	16	9	-0.90
6	2003	5	3,288	4,449	4,511	0.73	0.76	3,438	150	150	131,101	314	5	8	-0.54
7		6	7,812	4,544	4,719	1.66	1.91	9,036	1,224	1,224	358,861	466	16	10	2.26
8		7	5,126	4,618	4,927	1.04	0.86	4,231	-895	895	422,085	527	17	11	0.30
9		8	1,757	5,302	5,135	0.34	0.42	2,163	406	406	389,884	512	23	12	1.10
10	2004	9	4,267	5,970	5,343	0.80	0.76	4,072	-195	195	350,773	477	5	11	0.78
11		10	12,305	6,165	5,551	2.22	1.91	10,629	-1,676	1,676	596,635	597	14	12	-2.19
12		11	5,976	6,112	5,759	1.04	0.86	4,945	-1,031	1,031	638,990	636	17	12	-3.67
13		12	2,463	5,916	5,967	0.41	0.42	2,513	50	50	585,949	587	2	11	-3.89
14	2005	13	3,137	5,727	6,175	0.51	0.76	4,706	1,569	1,569	730,358	663	50	14	-1.08
15		14	11,867	5,677	6,383	1.86	1.91	12,222	355	355	687,190	641	3	14	-0.57
16		15	4,903	6,238	6,591	0.74	0.86	5,660	757	757	679,544	649	15	14	0.61
17		16	3,136	7,098	6,799	0.46	0.42	2,863	-273	273	641,719	625	9	13	0.19
18	2006	17	6,955	7,332	7,007	0.99	0.76	5,341	-1,614	1,614	757,278	683	23	14	-2.19
19		18	14,931	7,165	7,215	2.07	1.91	13,815	-1,116	1,116	784,393	707	7	14	-3.69
20		19	3,712		7,423	0.50	0.86	6,374	2,662	2,662	1,116,089	810	72	17	0.07
21		20	2,984		7,631	0.39	0.42	3,214	230	230	1,062,923	781	8	16	0.36
22	2007	21			7,839		0.76	5,975							
23		22			8,047		1.91	15,408							
24		23			8,255		0.86	7,089							
25		24			8,463		0.42	3,564							
26															
27															

Step 4: Check Your Work.

I am confident my work is correct.

Step 5: Learn and generalize.

There are five forecasting methods each of which take different factors into account when determine the systematic part of demand. A forecast can have any combination of level, trend, and seasonality as part of the forecast. Different forecasting methods give different results, some of which are better than others. We can use demand forecasting to predict what we expect demand to be going forward, allowing us to make our supply chain more efficient.

Extra Credit

What values should Julie use for the smoothing constants of the selected forecasting methods in order to minimize forecast error?

Step 1: Define the problem.

SP1: What smoothing constant values should Julie use to minimize forecast error in the demand forecast for black plastic?

Step 2: Plan how to solve the problem.

Assumptions: I am an engineer at SPC determining what smoothing constants to use to minimize forecast error in both demand forecasts.

Available information: The SCM textbook, lecture notes, and information on the internet.

SP1: What smoothing constant values should Julie use to minimize forecast error in the demand forecast for black plastic?

Step 1: What forecasting method is being used, and what are the smoothing constants used in the forecast.

Step 2: Perform a sensitivity analysis on each of the smoothing constants.

Step 3: What combination of smoothing constants minimizes forecast error the most?

Step 3: Execute the plan.

SP1: What smoothing constant values should Julie use to minimize forecast error in the demand forecast for black plastic?

Step 1: What forecasting method is being used, and what are the smoothing constants used in the forecast.

I am using Winter's method for the black plastic forecast. The smoothing constants are, alpha = 0.06, beta = 0.06, and gamma = 0.06.

Step 2: Perform a sensitivity analysis on each of the smoothing constants.

The initial absolute error is 8,462. I will first decrease alpha by 0.02 to 0.04, leaving beta and gamma at 0.06. The equation for level is now $L_{t+1} = 0.05*(D_{t+1}/S_{t+1}) + (0.95)(L_t + T_t)$. The new excel sheet is:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	Year, Y	Period, t	Demand, D	Level, L	Trend, T	Seasonality,	Forecast, F	Error, E	Absolute Err	MSE	MAD	% Error	MAPE	TS
2		0		2,333	204									
3	2002	1	2,025	2,523	203	0.9	2,283	258	258	66,719	258	13	12.76	1.00
4		2	1,563	2,720	203	0.6	1,635	72	72	35,986	165	5	8.70	2.00
5		3	2,170	2,931	203	0.7	2,046	-124	124	29,135	152	6	7.71	1.36
6		4	6,542	3,160	205	1.8	5,642	-900	900	224,137	339	14	9.22	-2.05
7	2003	5	3,162	3,373	205	0.89	3,008	-154	154	184,027	302	5	8.34	-2.81
8		6	1,928	3,561	204	0.60	2,142	214	214	160,961	287	11	8.80	-2.21
9		7	3,113	3,798	206	0.70	2,644	-469	469	169,327	313	15	9.69	-3.52
10		8	6,350	3,979	205	1.82	7,273	923	923	254,640	389	15	10.30	-0.46
11	2004	9	3,708	4,181	205	0.90	3,752	44	44	226,560	351	1	9.29	-0.38
12		10	2,489	4,376	204	0.60	2,610	121	121	205,365	328	5	8.84	-0.04
13		11	2,309	4,513	200	0.71	3,249	940	940	267,033	383	41	11.74	2.42
14		12	7,427	4,684	198	1.80	8,498	1,071	1,071	340,434	441	14	11.96	4.53
15	2005	13	4,941	4,914	200	0.90	4,375	-566	566	338,888	450	11	11.92	3.18
16		14	3,943	5,190	205	0.59	3,035	-908	908	373,588	483	23	12.72	1.08
17		15	3,883	5,403	205	0.70	3,763	-120	120	349,637	459	3	12.08	0.88
18		16	10,831	5,631	207	1.79	10,039	-792	792	366,960	480	7	11.78	-0.81
19	2006	17	5,083	5,827	206	0.90	5,269	186	186	347,420	462	4	11.30	-0.44
20		18	3,326	6,007	204	0.60	3,641	315	315	333,617	454	9	11.20	0.25
21		19	4,358	6,212	204	0.70	4,341	-17	17	316,075	431	0	10.63	0.22
22		20	11,787	6,424	205	1.80	11,537	-250	250	303,386	422	2	10.20	-0.36
23	2007	21				0.90	5,972							
24		22				0.60	4,103							
25		23				0.70	4,920							
26		24				1.80	13,039							
27														
28														
29														

The new absolute error is 8,421 which is an improvement. I now decrease beta to 0.04 and fill out the excel sheet again:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	Year, Y	Period, t	Demand, D	Level, L	Trend, T	Seasonality,	Forecast, F	Error, E	Absolute Err	MSE	MAD	% Error	MAPE	TS	
2		0		2,333	204										
3	2002	1	2,025	2,526	204	0.9	2,283	258	258	66,719	258	13	12.76	1.00	
4		2	1,563	2,724	203	0.6	1,637	74	74	36,130	166	5	8.76	2.00	
5		3	2,170	2,934	204	0.7	2,049	-121	121	28,950	151	6	7.69	1.40	
6		4	6,542	3,158	204	1.8	5,648	-894	894	221,374	337	14	9.19	-2.02	
7	2003	5	3,162	3,369	205	0.89	3,006	-156	156	181,954	301	5	8.33	-2.79	
8		6	1,928	3,560	204	0.60	2,139	211	211	159,028	286	11	8.77	-2.19	
9		7	3,113	3,791	205	0.70	2,644	-469	469	167,775	312	15	9.67	-3.51	
10		8	6,350	3,976	204	1.82	7,258	908	908	249,791	386	14	10.25	-0.49	
11	2004	9	3,708	4,178	204	0.90	3,749	41	41	222,221	348	1	9.23	-0.42	
12		10	2,489	4,375	204	0.60	2,608	119	119	201,411	325	5	8.78	-0.09	
13		11	2,309	4,526	202	0.71	3,249	940	940	263,371	381	41	11.69	2.39	
14		12	7,427	4,703	201	1.80	8,525	1,098	1,098	341,848	441	15	11.94	4.56	
15	2005	13	4,941	4,929	202	0.90	4,395	-546	546	338,463	449	11	11.87	3.26	
16		14	3,943	5,191	204	0.59	3,045	-898	898	371,924	481	23	12.65	1.17	
17		15	3,883	5,402	205	0.70	3,764	-119	119	348,081	457	3	12.02	0.97	
18		16	10,831	5,625	205	1.79	10,035	-796	796	365,974	478	7	11.72	-0.74	
19	2006	17	5,083	5,822	205	0.90	5,262	179	179	346,331	460	4	11.24	-0.37	
20		18	3,326	6,006	204	0.60	3,637	311	311	332,456	452	9	11.14	0.31	
21		19	4,358	6,212	204	0.70	4,340	-18	18	314,975	429	0	10.57	0.28	
22		20	11,787	6,421	204	1.80	11,535	-252	252	302,412	420	2	10.15	-0.31	
23	2007	21				0.90	5,969								
24		22				0.60	4,101								
25		23				0.70	4,917								
26		24				1.80	13,031								
27															

The absolute error is now 8,401, again an improvement. Doing the same with dropping gamma to 0.04 drops the absolute error to 8,316. Dropping the smoothing constants appears to be decreasing the overall absolute error. I will adjust and increase alpha to 0.2, beta to 0.2, and gamma to 0.2. The new excel sheet is:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	Year, Y	Period, t	Demand, D	Level, L	Trend, T	Seasonality,	Forecast, F	Error, E	Absolute Err	MSE	MAD	% Error	MAPE	TS	
2		0		2,333	204										
3	2002	1	2,025	2,531	204	0.9	2,283	258	258	66,719	258	13	12.76	1.00	
4		2	1,563	2,733	204	0.6	1,641	78	78	36,408	168	5	8.88	2.00	
5		3	2,170	2,940	204	0.7	2,055	-115	115	28,645	150	5	7.68	1.48	
6		4	6,542	3,153	204	1.8	5,658	-884	884	216,678	334	14	9.13	-1.98	
7	2003	5	3,162	3,361	204	0.90	3,015	-147	147	177,664	296	5	8.24	-2.73	
8		6	1,928	3,558	204	0.60	2,137	209	209	155,330	282	11	8.67	-2.13	
9		7	3,113	3,776	204	0.70	2,636	-477	477	165,612	310	15	9.62	-3.48	
10		8	6,350	3,971	204	1.81	7,186	836	836	232,184	375	13	10.06	-0.64	
11	2004	9	3,708	4,174	204	0.90	3,752	44	44	206,606	339	1	9.08	-0.58	
12		10	2,489	4,373	204	0.60	2,619	130	130	187,640	318	5	8.69	-0.21	
13		11	2,309	4,552	203	0.70	3,219	910	910	245,869	372	39	11.49	2.27	
14		12	7,427	4,742	203	1.80	8,566	1,139	1,139	333,412	436	15	11.81	4.55	
15	2005	13	4,941	4,957	203	0.90	4,444	-497	497	326,736	440	10	11.67	3.37	
16		14	3,943	5,189	204	0.60	3,084	-859	859	356,073	470	22	12.39	1.33	
17		15	3,883	5,396	204	0.70	3,771	-112	112	333,166	446	3	11.76	1.15	
18		16	10,831	5,609	204	1.80	10,062	-769	769	349,338	466	7	11.47	-0.54	
19	2006	17	5,083	5,810	204	0.90	5,235	152	152	330,153	448	3	10.97	-0.23	
20		18	3,326	6,004	204	0.60	3,614	288	288	316,419	439	9	10.84	0.42	
21		19	4,358	6,209	204	0.70	4,344	-14	14	299,775	417	0	10.29	0.41	
22		20	11,787	6,415	204	1.80	11,539	-248	248	287,872	408	2	9.88	-0.19	
23	2007	21				0.90	,951								
24		22				0.60	,081								
25		23				0.70	4,918								
26		24				1.80	13,029								
27															

The absolute error dropped to 8,165, again an improvement. I will drop all three smoothing constants to 0.01. The excel sheet now shows:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	Year, Y	Period, t	Demand, D	Level, L	Trend, T	Seasonality,	Forecast, F	Error, E	Absolute Err	MSE	MAD	% Error	MAPE	TS	
2		0		2,333	204										
3	2002	1	2,025	2,534	204	0.9	2,283	258	258	66,719	258	13	12.76	1.00	
4		2	1,563	2,737	204	0.6	1,643	80	80	36,548	169	5	8.93	2.00	
5		3	2,170	2,942	204	0.7	2,059	-111	111	28,509	150	5	7.67	1.51	
6		4	6,542	3,151	204	1.8	5,663	-879	879	214,397	332	13	9.11	-1.96	
7	2003	5	3,162	3,357	204	0.90	3,016	-146	146	175,763	295	5	8.21	-2.71	
8		6	1,928	3,557	204	0.60	2,135	207	207	153,645	280	11	8.63	-2.11	
9		7	3,113	3,768	204	0.70	2,634	-479	479	164,419	309	15	9.60	-3.46	
10		8	6,350	3,968	204	1.80	7,161	811	811	226,107	371	13	9.99	-0.69	
11	2004	9	3,708	4,171	204	0.90	3,752	44	44	201,201	335	1	9.02	-0.64	
12		10	2,489	4,373	204	0.60	2,621	132	132	182,835	315	5	8.65	-0.26	
13		11	2,309	4,564	204	0.70	3,211	902	902	240,257	368	39	11.41	2.23	
14		12	7,427	4,762	204	1.80	8,586	1,159	1,159	332,217	434	16	11.76	4.56	
15	2005	13	4,941	4,971	204	0.90	4,466	-475	475	324,048	437	10	11.60	3.44	
16		14	3,943	5,189	204	0.60	3,099	-844	844	351,810	466	21	12.30	1.42	
17		15	3,883	5,394	204	0.70	3,773	-110	110	329,160	443	3	11.67	1.25	
18		16	10,831	5,603	204	1.80	10,068	-763	763	345,001	463	7	11.38	-0.46	
19	2006	17	5,083	5,805	204	0.90	5,228	145	145	325,936	444	3	10.88	-0.15	
20		18	3,326	6,004	204	0.60	3,608	282	282	312,251	435	8	10.74	0.49	
21		19	4,358	6,209	204	0.70	4,345	-13	13	295,825	413	0	10.19	0.49	
22		20	11,787	6,414	204	1.80	11,541	-246	246	284,070	404	2	9.79	-0.11	
23	2007	21				0.90	5,948								
24		22				0.60	4,077								
25		23				0.70	4,918								
26		24				1.80	13,028								
27															
28															
29															

The absolute error again drops to 8,088. It appears that dropping all the smoothing constants will continue to drop the absolute error but I will increase them all to 0.1 to check. The excel sheet with alpha, beta, and gamma all equal to 0.1 is:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	Year, Y	Period, t	Demand, D	Level, L	Trend, T	Seasonality,	Forecast, F	Error, E	Absolute Err	MSE	MAD	% Error	MAPE	TS
2		0		2,333	204									
3	2002	1	2,025	2,508	201	0.9	2,283	258	258	66,719	258	13	12.76	1.00
4		2	1,563	2,699	200	0.6	1,626	63	63	35,322	160	4	8.38	2.00
5		3	2,170	2,919	202	0.7	2,029	-141	141	30,142	154	6	7.75	1.17
6		4	6,542	3,173	207	1.8	5,618	-924	924	235,927	346	14	9.34	-2.15
7	2003	5	3,162	3,397	209	0.89	3,011	-151	151	193,332	307	5	8.43	-2.91
8		6	1,928	3,568	205	0.60	2,156	228	228	169,767	294	12	9.00	-2.27
9		7	3,113	3,837	212	0.70	2,657	-456	456	175,184	317	15	9.80	-3.54
10		8	6,350	3,992	206	1.83	7,394	1,044	1,044	289,620	408	16	10.63	-0.19
11	2004	9	3,708	4,192	205	0.89	3,756	48	48	257,695	368	1	9.60	-0.08
12		10	2,489	4,378	203	0.59	2,604	115	115	233,251	343	5	9.10	0.25
13		11	2,309	4,446	190	0.72	3,276	967	967	297,051	400	42	12.08	2.63
14		12	7,427	4,585	185	1.80	8,358	931	931	344,463	444	13	12.12	4.47
15	2005	13	4,941	4,845	192	0.89	4,262	-679	679	353,385	462	14	12.24	2.82
16		14	3,943	5,202	209	0.59	2,971	-972	972	395,610	498	25	13.13	0.67
17		15	3,883	5,428	210	0.70	3,763	-120	120	370,194	473	3	12.46	0.45
18		16	10,831	5,682	215	1.78	10,062	-769	769	384,027	492	7	12.12	-1.13
19	2006	17	5,083	5,868	212	0.91	5,344	261	261	365,455	478	5	11.71	-0.62
20		18	3,326	6,020	206	0.61	3,688	362	362	352,435	472	11	11.67	0.14
21		19	4,358	6,228	206	0.70	4,342	-16	16	333,899	448	0	11.07	0.11
22		20	11,787	6,447	207	1.80	11,560	-227	227	319,779	437	2	10.61	-0.40
23	2007	21				0.90	6,015							
24		22				0.60	4,140							
25		23				0.70	4,931							
26		24				1.80	13,087							
27														
28														
29														

The new absolute error is 8,731, or an increase over the original absolute error. We can now see that decreasing the smoothing constants minimizes the forecast error.

Step 3: What combination of smoothing constants minimizes forecast error the most?

Assuming this relationship holds the ideal smoothing constants would be 0.001 for each variable.

Smoothing Constant	Value
alpha	0.001
beta	0.001
gamma	0.001

Step 4: Check Your Work.

I am confident my work is correct.

Step 5: Learn and Generalize.

Adjusting smoothing constants can give a more accurate forecast.

Problem 4: Cycle Inventory for Polystyrene at SPC

Why should SPC have a cycle inventory? SPC buys polystyrene resin from a supplier in 1000-pound units, and each unit costs $20.00, and the percent holding cost is 10%. The fixed shipping cost per order is $300. If we assume that 1,000 pounds of resin yields 1,000 pounds of clear plastic, what are the following values for clear plastic:

a) Lot size per shipment to minimize total cost
b) Economic order quantity (EOQ)

c) Number of shipments/year for polystyrene resin in order to meet the forecasted demand for clear plastic in 2007.
d) Cycle inventory
e) Cycle inventory holding cost
f) Replenishment cycle time
g) Average flow time

Use a diagram showing clear plastic inventory as a function of time to illustrate these values.

Read the section in the SCM text on Short_Term Discounting and then answer the following question. If the supplier offers a promotional discount of 25% per unit at the beginning of the year, what is the optimal order quantity, and how much should the forward buy on polystyrene be?

Step 1: Define the problem.

SP1: Why should SPC have a cycle inventory?

SP2: What is SPC's lot size per shipment to minimize total cost?

SP3: What is SPC's Economic order quantity (EOQ)

SP4: What is SPC's number of shipments/year for polystyrene resin in order to meet the forecasted demand for clear plastic in 2007?

SP5: What is SPC's cycle inventory?

SP6: What is SPC's cycle inventory holding cost.

SP7: What is SPC's replenishment cycle time.

SP8: What is SPC's average flow time.

SP9: If the supplier offers a promotional discount of 25% per unit at the beginning of the year, what is the optimal order quantity, and how much should the forward buy on polystyrene be?

Step 2: Plan how to solve the problem.

Assumptions: I am an engineer at SPC determining how to structure our cycle inventory for the next year to make our supply chain as profitable as possible.

Available information: The SCM textbook, lecture notes, and information on the internet.

SP1: Why should SPC have a cycle inventory?

Step 1: Why do companies have a cycle inventory?

SP2: What is SPC's Economic order quantity (EOQ)?

Step 1: Determine the annual costs (annual material cost, annual shipping cost, annual inventory holding costs).

SP3: What is SPC's lot size per shipment to minimize total cost?

SP4: What is SPC's number of shipments/year for polystyrene resin in order to meet the forecasted demand for clear plastic in 2007?

SP5: What is SPC's cycle inventory?

SP6: What is SPC's cycle inventory holding cost.

SP7: What is SPC's replenishment cycle time.

SP8: What is SPC's average flow time.

SP9: If the supplier offers a promotional discount of 25% per unit at the beginning of the year, what is the optimal order quantity, and how much should the forward buy on polystyrene be?

Step 3: Execute the plan.

SP1: Why should SPC have a cycle inventory?

Step 1: Why do companies have a cycle inventory?

SPC should have a cycle inventory to take advantage of economies of scale at each part of the supply chain. Purchasing more inventory at certain parts of the supply chain may cut costs for them, while purchasing less product may cut costs at another part of the supply chain. Having a cycle inventory allows a company to purchase product in different lot sizes to cut their total costs. This makes the supply chain, and ultimately the company, more profitable.

SP2: What is SPC's Economic order quantity (EOQ)

Step 1: Determine the annual costs (annual material cost, annual shipping cost, annual inventory holding costs).

First I identify the variables needed to calculate the various costs that occur when handling inventory. D = forecasted demand for clear plastic in 2007 = 32,036 units, S = fixed cost incurred per order = $300, C = cost per unit = $20, h = holding cost per year as fraction of product cost = 10% = 0.1.

Annual Material Cost = annual demand * cost per unit = D*C = 32,036 * $20 = $6,405,520

Annual Shipping Cost = (D/Q)*S = (32,036/Q)*300

Inventory Holding Costs = (Q/2)*hC = (Q/2)*0.1*20 = $2(Q/2) = Q or in other words, the inventory holding costs for the year is the average amount of inventory * $2 per unit.

The economic order quantity EOQ = sqrt((2*D*S)/(h*C)) = sqrt((2*32,036*300)/(0.1*20)) = sqrt(19,221,600/2) = sqrt(9,610,800) = 3,100 units.

SP3: What is SPC's lot size per shipment to minimize total cost?

The lot size per shipment to minimize total cost is the EOQ, which is 3,100 units.

SP4: What is SPC's number of shipments/year for polystyrene resin in order to meet the forecasted demand for clear plastic in 2007?

The number of shipments/year is the forecasted demand for 2007 divided by the optimal lot size per shipment.

Number of shipments per year (n*) = D/lot size = 32,036/3,100 = 10.33 shipments per year. This will obviously have to be rounded up to 11 shipments per year.

SP5: What is SPC's cycle inventory?

Cycle inventory is the average inventory throughout the year. It's equal to the lot size divided by two.

Cycle inventory = lot size/2 = 3,100/2 = 1,550 units.

SP6: What is SPC's cycle inventory holding cost.

Cycle inventory holding cost is the cost of holding the average amount of inventory throughout the year, or the annual holding cost.

Cycle inventory holding cost = cycle inventory * h * C = 1,550 * 0.1 * $20 = $3,100.

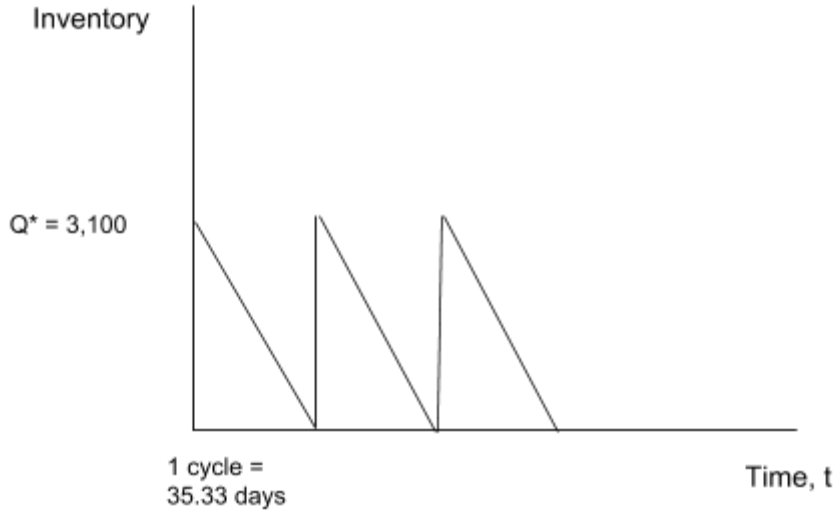
SP7: What is SPC's replenishment cycle time.

n* = 10.33 shipments per year. Replenishment cycle time = 365/n* = 365/10.33 = 35.33 days. So a new shipment will have to sent every 35.33 days.

SP8: What is SPC's average flow time

Average flow time = Q/2D = 3,100/(2*32,036) = 0.048 year = 0.58 months = 18 days.
Each unit of inventory is held for about 18 days before being used.

Metric	Value	Description
EOQ	3,100 units	The economic order quantity is the lot size that minimizes the total costs the company will incur throughout the year.
Lot size	3,100 units	The lot size that minimizes the total costs the company will incur throughout the year.
Number of shipment per year (n*)	10.33 shipments/year	The number of shipments (n*) is the number of times SPC will have polystyrene delivered in 2007 to meet to the expected demand.
Cycle inventory	1,550 units	The average inventory SPC will be holding at any given time.
Cycle inventory holding cost	$3,100	The average holding cost SPC faces throughout the year.
Replenishment Cycle Time	35.33 days	SPC goes through their inventory in 35.33 days on average.
Average Flow Time	18 days	SPC's products are held for 18 days on average.



SP9: If the supplier offers a promotional discount of 25% per unit at the beginning of the year, what is the optimal order quantity, and how much should the forward buy on polystyrene be?

Again we have:

C = $20, D = 32,036, S = $300, h = 10% = 0.1, Q* = 3,100. The discount is 25% meaning the discount is d = $20 * .25 = $5.

The new quantity that should be purchased, Qd = (d*D/(C-d)h) + (CQ*)/(C-d)

Qd = (5*32,036)/((20-5)*0.1) + (20*3,100)/(20-5) = (160,180/1.5) + (62,000/15) = 106,786 + 4,133 = 110,919.

To calculate the forward buy we subtract the EOQ from the new quantity demanded.

Forward buy = Qd - Q* = 110,919 - 3,100 = 107,809.

Metric	Value	Description
Quantity purchased at discount (Qd)	110,919	If SPC's supplier is offering polystyrene at a 25% discount, SPC should purchase 110,919 units. Doing so will allow SPC to save money, even taking into account the holding cost for this extra inventory.
Forward Buy	107,809	At this new quantity purchased at a discount, SPC will have 107,809 units of inventory to use in future production.

Step 4: Check Your Work.

I am confident that my work is correct.

Step 5: Learn and Generalize.

We can calculate the optimal lot size and order frequency to minimize the costs at any part of the supply chain. Doing so allows each part of the supply chain to take advantage of economies of scale, minimizing costs throughout the supply chain making it as profitable as possible.

Problem 5: Safety Inventory for Polystyrene Resin at SPC

Should SPC have a safety inventory? Why? How much safety inventory would you recommend for SPC?

Step 1: Define the problem.

SP1: Should SPC have a safety inventory? Why?

SP2: How much safety inventory would you recommend for SPC?

Step 2: Plan how to solve the problem.

Assumptions: I am an engineer at SPC deciding on what level of safety inventory the company should maintain.

Available information: The SCM textbook, lecture notes, and information on the internet.

SP1: Should SPC have a safety inventory? Why?

Step 1: Why do companies maintain a safety inventory?

Step 2: Should SPC have a safety inventory and why?

SP2: How much safety inventory would you recommend for SPC?

Step 1: Get the weekly demand statistics.

Step 2: Calculate the safety inventory.

Step 3: Execute the plan.

SP1: Should SPC have a safety inventory? Why?

Step 1: Why do companies maintain a safety inventory?

To satisfy demand that exceeds the forecast.

Step 2: Should SPC have a safety inventory and why?

SPC should carry a safety inventory because they experience seasonal upswings in demand for their products. While forecasting methods can give a fairly accurate the estimate it is not perfect, and this could be the case for SPC. Given the companies issues with meeting demand in the past, maintaining a safety inventory is especially important.

SP2: How much safety inventory would you recommend for SPC?

Step 1: Get the weekly demand statistics.

Demand per week, Dw = 32,036/52 = 616

Standard deviation of demand per period = The average forecast error for clear plastic using the static forecasting method = 16% = 0.16 * 616 = 98.56.

I will say that the lead time for the company is 2 weeks.

This means that SPC needs to reorder polystyrene 2 weeks before they run out.

Step 2: Calculate the safety inventory.

I will say that SPC's reorder point is at 1,550 units, or the cycle inventory.

Safety inventory = reorder point - (weekly demand*lead time) = 1,550 - 2*616 = 318.

Weekly demand	616 units
Lead time	2 weeks
Reorder point	1,550 units
Safety inventory	318 units

Step 4: Check Your Work.

I am confident my work is correct.

Step 5: Learn and Generalize.

Companies maintain a safety inventory to handle times when demand is higher than expected. This allows a company to handle unexpected customer requests, likely earning them more business.

Problem 6: Execution of Your Plan

Using a table compare your plan from Problem 1 with its execution. Indicate the reasons for the difference between the plan and its execution. Add at least one more column. What should the new column contain.

Step 1: Define the problem.

SP1: Track how well I execute the schedule.

SP2: Make notes on the obstacles that prevent effective execution.

Step 2: Plan how to solve the problem.

SP1: Track how well I execute the schedule.

Step 1: Add a column to the table tracking when I finished each problem and how long it took.

Step 2: Add a column to the table showing the difference in time it took to complete the problem from the time I thought it would take.

SP2: Make notes on the obstacles that prevent effective execution.

Step 1: Add a column to the table showing what obstacles I ran into preventing effective execution of the problem.

Step 3: Execute the plan.

SP1: Track how well I execute the schedule.

Step 1: Add a column to the table tracking when I finished each problem and how long it took.

Step 2: Add a column to the table showing the difference in time it took to complete the problem from the time I thought it would take.

Date	Problem's to do, Expected Hours	Date finished, Actual Hours to complete	Difference in time to complete the problems
2/9	2, 1 hour	2/9, 2 hours	1 hour
2/10	3, 5 hours	2/11, 7 hours	2 hours
2/11	4,5,6; 2.5 hours	2/12, 4 hours	1.5 hours
2/12	Extra Credit, 2 hours	2/12, 3 hours	1 hour

SP2: Make notes on the obstacles that prevent effective execution.

Step 1: Add a column to the table showing what obstacles I ran into preventing effective execution of the problem.

Date	Problem's to do, Expected Hours	Time finished, Actual Hours to	Difference in time to complete the	Obstacles faced

		complete	problems	
2/9	2, 1 hour	2/9, 2 hours	1 hour	Setting up the problem
2/10	3, 5 hours	2/11, 7 hours	2 hours	Had an issue with roommates
2/11	4,5,6; 2.5 hours	2/12, 4 hours	1.5 hours	Studying for another midterm
2/12	Extra Credit, 2 hours	2/12, 3 hours	1 hour	Studying for another midterm

Step 4: Check Your Work.

I am confident my work is correct.

Step 5: Learn and Generalize.

Various obstacles will stop you from being able to execute your work plan exactly as expected.