Option Value Analysis of Flexibility in Supply Chain Postponement

Executive Summary

This paper presents the valuation of the flexibility option in postponing assembly of transformers to printer modules at warehouses local to the printer market. The flexibility idea is that, in case of lower than expected demand for the printer at one particular region, the printer module can be quickly shipped to another region to minimize storage cost as well as meeting the demand in other regions. The advantage of this flexibility is that only transformers would incur storage cost, as transformers are produced locally in each region.

The decision analysis and lattice valuation models are used to evaluate the uncertainties with the flexibility design. Several uncertainties with regard to the postponement strategy are presented. The uncertainty of interest, the uncertainty of demand in the US market, is analyzed using decision tree analysis for two stage period to derive the value of the postponement alternative. The lattice model is then used to value exercising the flexibility option of adjusting shipment quantity of the printer module to different region based on the observed demand.

The result of the decision analysis revealed that flexibility offers the printer manufacturer greater expected value when the option of altering the shipment schedule is exercised based on the demand pattern in the market. The expected value from exercising the option is approximately $600 dollars higher than the inflexible alternative for the two stage analysis of 100 printers market.

The lattice valuation analysis revealed that the manufacturer would achieve greater Net Present Value by mixture of flexibility strategies. The combined NPV for the mixture strategy is approximately $3100 dollars compared to $1500 dollars from the inflexible option, despite high switching cost playing a key element in the flexible option.

The conclusion is that mixture of flexible states yields the best net present value despite the high switching cost. Manufacturer with this agility achieve greater ROI and minimize inventory and depreciation costs.

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1 Idea of Postponement

The idea of postponement in the supply chain process is to delay the final configuration of merchandise to as late as possible. The most ideal place would be the step in the chain prior to customer. This way, the merchandise could be configured in such ways that appeals to consumers in that region or culture. In a sense, postponement allows company to customize its products so it could target consumers by behavior, culture, or geography more effective manner.

The postponement flexibility is achievable in the manufacturing and sales of printers. Printer modules could be manufactured without transformers. The transformer module could be assembled at the end point of the supply chain, might that be the warehouse at a particular region or the retail outlet, to complete the printer module that complies with the regulations and needs of that region. For example, the same printer modules could be shipped to the US and EU market from the manufacturing plant. The transformer specific to the US and EU region could then be assembled to the printer module prior to actual sales to end consumers.

The flexibility of assemble the transformer separate from the printer module provide the manufacturer alternatives to divert unsold printer module to different regions. This would greatly reduce the inventory cost of printer modules, as well as avoid discounting the printers due to outdated technology. For example, if the printer modules are not selling well in the EU market, but is well perceived in the US market, the manufacturer could exercise the option of altering its shipment quantity to each region to meet consumer demand.

Though the flexible alternative allows the manufacturer to adjust its shipment quantity to different region based on the demand of each region, the plan does carry with it uncertainties. These uncertainties will be discussed in detail in the next section.

2 Uncertainty in Postponement of Printer Modules

As mention in the last section, there are many uncertainties associated with the flexibility alternative of postponing the complete assembly of printer modules. I believe the 3 most important ones are:

- Demand of printers in each region at each stage – demand might fluctuate up and down in one or several regions.
- The duration of the uneven demand pattern at one or multiple region – demand might fluctuate up and down for one stage only, or indefinitely for one or multiple regions. How, then, should the shipment quantity be adjusted to maximize the profit while minimize shipping and cost of adjusting the shipment schedule.
- The marginal cost of producing printers separately from transformers due to loss of economies of scale – the marginal cost will vary depending on the labor rate in each region, and the price of the printer will need to reflect this cost while remain competitive in the market.

I would use the following metrics to measure to characterize the uncertainties listed above:

- Material & Operating Cost of producing printers
- Shipping Cost
- Switching Cost

Expected values and range of possibilities will be used as the numeric methods to convey the meaning of these metrics.

Case studies on companies that have implemented postponement strategies will be used as a major source of information to obtain the numeric data for the metrics defined above.
As such, the MIT Library and its online resources will be vital in gathering relevant case studies. Further, Google Search Engine will be used as well to obtain any relevant statistics. The following list several possible case studies that could contribute relevant statistics to this application:

- Inventory Decisions in Dell's Supply Chain. Kapuscinski, Roman; Zhang, Rachel Q.; Carbonneau, Paul; Moore, Robert; Reeves, Bill. Informs, 2004.
- Hewlett-Packard Gains Control of Inventory and Service through Design for Localization. Lee, Hau L.; Billington, Corey; Carter, Brent. The Institute of Management Sciences, 1993.
- Tailored Logistics: The Next Advantage. Fuller, Joseph B.; O'Conor, James; Rawlinson, Richard. ***Harvard Business Review***, May/Jun93, Vol. 71 Issue 3, p87-98, 10p, 3c.
- Rapid-Fire Fulfillment. Ferdows, Kasra; Lewis, Michael A.; Machuca, Jose A.D.. ***Harvard Business Review***, Nov2004, Vol. 82 Issue 11, p104-110, 7p, 3c

Data is provided in the next section, along with an analysis using decision tree.

3 Decision Analysis of Uncertainty

The flexibility of producing printers will be analyzed to see if the flexibility of postponement is a good strategy to hedge against uncertainty in the demand in the US market. There are two alternatives in which the printers can be produced. The first alternative is to produce and assemble the printer modules (i.e. the body) and the transformers at the factory. The second alternative is to produce the printer modules and transformers separately, and perform the final assembly at the retail outlets. The printers are produced to serve North America and Europe markets. The production quantity and costs for both options are provided in the table below.

Shipping Qty By Option By Market

	Market	Printer Module	Transformer (US)	Transformer (EU)
Alternative 1	**US**	50	50	
	EU	50		50
Alternative 2	**All**	100	60	60

Cost, Price, & Profit for Two Stage Analyses

Alternative 1	
Price per printer	100
Material & Operating Cost	73
Shipping	5
Storage (printer)	5
Storage (transformer)	0

Alternative 2	
Price per printer	100
Material & Operating Cost	82
Shipping	5
Storage (printer)	0
Storage (transformer)	2

Stage 1

	Demand High in US	Demand Even	Demand Low in US
US Market			
Shipped	50	50	50
Unit Sold	50	50	40
Unit in Storage	0	0	10
Revenue	5000	5000	4000
Cost	3650	3650	3700
Profit	1350	1350	300
EU Market			
Shipped	50	50	50
Unit Sold	40	50	50
Unit in Storage	10	0	0
Revenue	4000	5000	5000
Cost	3950	3900	3900
Profit	50	1100	1100
Total Profit	1400	2450	1400

	Demand High in US	Demand Even	Demand Low in US
US Market			
Shipped	50	50	50
Unit Sold	50	50	40
Unit in Storage	0	0	10
Revenue	5000	5000	4000
Cost	4100	4100	4120
Profit	900	900	-120
EU Market			
Shipped	50	50	50
Unit Sold	50	50	40
Unit in Storage	0	0	10
Revenue	5000	5000	4000
Cost	4350	4350	4370
Profit	650	650	-370
Total Profit	1550	1550	-490

Stage 2

	Demand High in US	Demand Even	Demand Low in US
US Market			
Shipped	NA	NA	NA
Unit Sold	NA	NA	NA
Unit in Storage	NA	NA	NA
Revenue	NA	NA	NA
Cost	NA	NA	NA
Profit	NA	NA	NA
EU Market			
Shipped	NA	NA	NA
Unit Sold	NA	NA	NA
Unit in Storage	NA	NA	NA
Revenue	NA	NA	NA
Cost	NA	NA	NA
Profit	NA	NA	NA
Total Profit	NA	NA	NA

	Demand High in US	Demand Even	Demand Low in US
US Market			
Shipped	60	50	40
Unit Sold	60	50	40
Unit in Storage (transformer)	10	0	10
Revenue	6000	5000	4000
Cost	4920	4100	3300
Profit	1080	900	700
EU Market			
Shipped	40	50	60
Unit Sold	40	50	60
Unit in Storage	10	0	0
Revenue	4000	5000	6000
Cost	3500	4350	5220
Profit	500	650	780
Total Profit	1580	1550	1480

- Selling price of printer is USD $100 dollars in both markets.
- All printers are manufactured in the US
- Products are distributed equally to both markets, with each market receiving 50 units of printer
- When demand is high in one market, that market gets 60 units of printer, and the other market gets 40
- There are no shipping cost to ship items within the US
- Demand is constant in the European Market
- Demand in the US fluctuate up and down

Initial distribution of goods is assumed to be even in stage 1 for both alternatives. There is a 20% chance that demand would be high in the US market, 60% chance that demand will be even in both markets, and 20% chance that demand would be low in the US market. When demand is high in the US market, demand is low in EU, and the US market would require 60 units to satisfy demand, and 40 units for the EU market. When demand is even, 50 units are needed for each market. When demand is low in the US, 40 units are needed for US and 60 units for EU.

In stage 1, 50 printer modules and transformers are made for the US market, and 50 printer module and transformers are made for the EU market for alternative 1. For alternative 2, 100 printer modules are made, and 60 transformers are made for US and for EU market, which brings the total transforms to 120.

In stage 2, alternative 1 has no flexibility to adjust to the demand pattern in the market and so the distribution of goods is the same as that of stage 1. Alternative 2 has the flexibility to adjust distribution pattern based on the demand patter in stage 1.

EV(Profit from High Demand in US | Alternative 1) = 0.2*(100*90-(50*73+40*78+10*83)) = $280

EV(Profit from Even Demand in US | Alternative 1) = 0.6*(100*100-(50*73+50*78))=$1,470

EV(Profit from Low Demand in US | Alternative 1) = 0.2*(100*90-(40*73+10*78+50*78)) = $280

EV(Profit from High Demand in US | Alternative 2) = 0.2*(3130) = $626

EV(Profit from Even Demand | Alternative 2) = 0.6*(3100) = $1,860

EV(Profit from Low Demand in US | Alternative 2) = 0.2*(1060) = $212

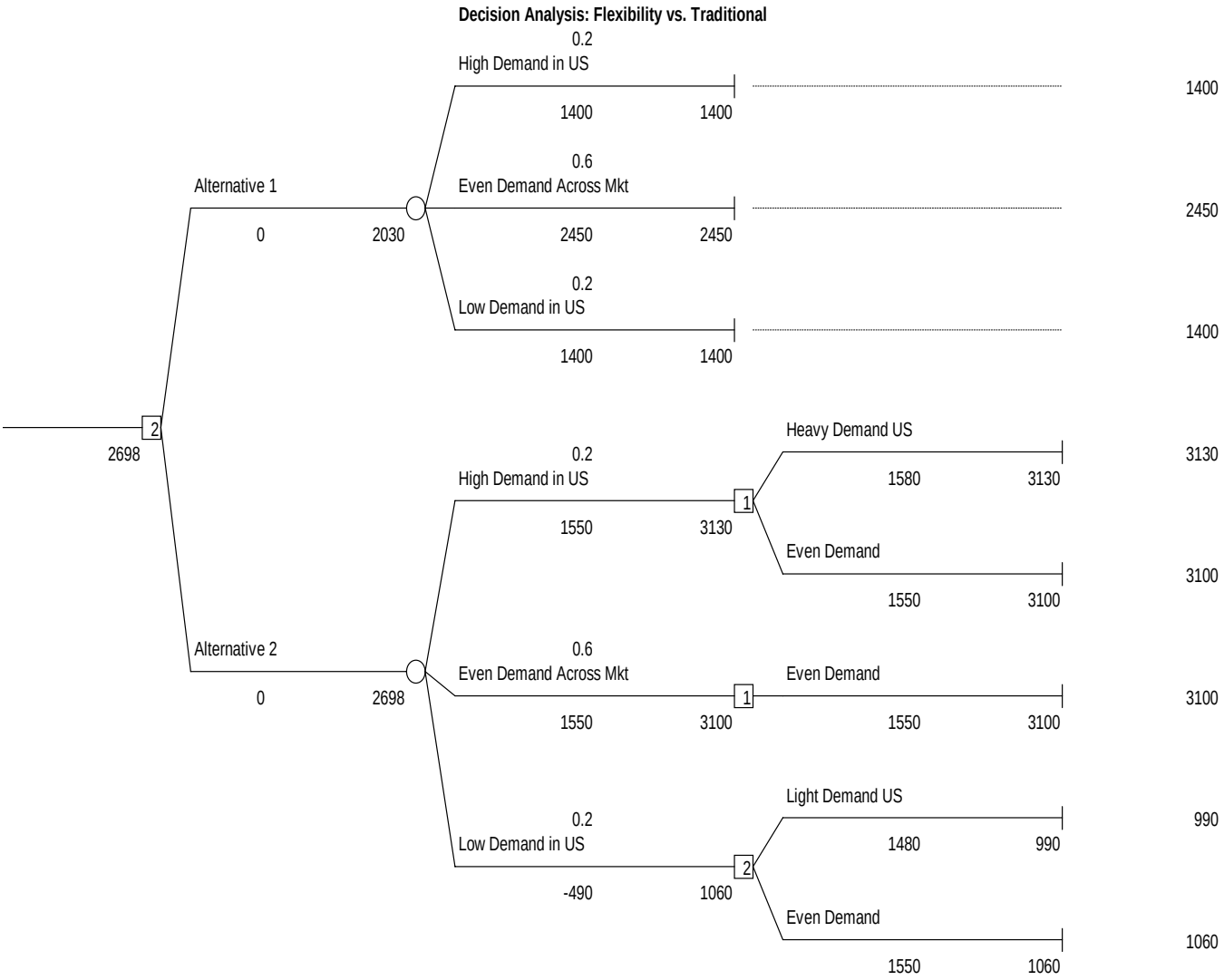
EV (Alternative 1) = 280 + 1470 + 280 = $2030

EV(Alternative 2) = 626 + 1860 + 212 = $2,698

Clearly, the flexible alternative offers better profitability in the long run despite it has a higher material & operating cost per unit of printer & transformer. This is due to the responsiveness that postponement offers in stage 2, where printer modules could be reallocated to region where demands are high. This greatly reduced the inventory cost of storing printer modules. Only the transformers incur storage cost in alternative 2, and it is much cheaper to store transformers than the whole printer module. Further, transformers do not depreciate in value as fast as the entire printer assembly, and thus the transformers could be re-used in other model of printers.

Though alternative 1 was a worse choice under this decision analysis, it could turn out to be a better choice if:

- The probability of even demand in both markets is higher than 0.6
- The flexibility of reallocating printer modules from one region to the other require additional operating and labor costs
- Economies of scale under alternative 1 result in lower operating cost that actually make the cost of inventory due to lower demand insignificant


Decision Analysis: Flexibility vs. Traditional
0.2
High Demand in US
1400
1400
1400
0.6
Even Demand Across Mkt
2450
2450
2450
Alternative 1
0
2030
0.2
Low Demand in US
1400
1400
1400
2
2698
Heavy Demand US
0.2
1580
3130
3130
High Demand in US
1
1550
3130
Even Demand
1550
3100
3100
Alternative 2
0
2698
0.6
Even Demand Across Mkt
1
Even Demand
1550
3100
1550
3100
3100
Light Demand US
0.2
1480
990
990
Low Demand in US
2
-490
1060
Even Demand
1550
1060
1060

4 Lattice Analysis of Uncertainty

In the flexibility alternative as stated in AP3+4, I have the option of shipping more printer modules to the US market than to the EU market. I have chosen to exercise this option based on good sales pattern in the US market in the first stage, in that the market demanded for more printers (greater than 50) than what was available. To analyze the value of this option, I have chosen to model the ratio of US vs. EU demand, and the corresponding net revenue for the following three states:

- Shipping 50 printers to US and the other 50 to EU
- Shipping 60 printers to US and the other 40 to EU
- Shipping 40 printers to US and the other 60 to EU

The following information is known based on the sales in the first stage:

- Demand in the US is increasing at a rate (*v*) of 0.1% per year
- The standard deviation (σ_{demand}) of the demand is 10%
- There is a switching cost of $3,000 dollars to alter the shipping quantity to each region from the quantity defined in year 0
- Discount rate is 12%

The following values are calculated based on the information given above.

u	1.105171
d	0.904837
p	0.505

The *u* value is calculated by raising *e* to the standard deviation of demand in the US market, or EXP(0.1)=1.105171.

The *d* value is calculated with the given equation: $\frac{1}{u} = \frac{1}{1.105171} = 0.904837$

The *p* value is calculated with the given equation: $0.5 + 0.5\left(\frac{v}{\sigma_{demand}}\right) = 0.5 + 0.5\left(\frac{0.001}{0.1}\right) = 0.505$

Based on the *u*, *d*, and *p* values, the following is the demand ratio between US and EU for the next 5 years.

US/EU Demand Ratio LATTICE					
Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
1.00	1.11	1.22	1.35	1.49	1.65
	0.90	1.00	1.11	1.22	1.35
		0.82	0.90	1.00	1.11
			0.74	0.82	0.90
				0.67	0.74
					0.61

In the first year, or year 0, the ratio of the printer demand in the US and EU market is 1, or 50/50 printers demanded in US/EU market. In year 1, the demand ratio is expected to either go up to 1.11 or down to 0.9. These values are calculated based on the demand ratio in year 0 and the *u* and *d* values as follows:

1*1.105171 = 1.11 and 1*0.904837 = 0.90

The following is the probability distribution lattice.

PROBABILITY LATTICE					
Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
1.00	0.51	0.26	0.13	0.07	0.03
	0.49	0.50	0.38	0.25	0.16
		0.25	0.37	0.37	0.32
			0.12	0.25	0.31
				0.06	0.15
					0.03

The probability lattice is calculated by using the values of p, 1 – p and the probability value in the current state. For example, one would take the probability given in year 0, value of p and 1 – p to calculate the probability distribution in year 1. The probability values in year 1 are calculated as: 1 * 0.505 = 0.51 and 1 * (1-0.505) = 0.49. The same concept is applied to calculate values in year 2. The value of the middle node is calculated as: 0.51*(1-p) + 0.49*(p) = 0.50.

5 Lattice Valuation of Uncertainty

This section uses the lattice analysis to valuate exercising the option of flexibility. The price and cost of a printer, along with the values in the demand ratio lattice, are used to calculate the net revenue of shipping printers with 50/50, 60/40, and 40/60 ratio to the US/EU market in year 0. This information, along with the values of the probability lattice, is used to calculate the expected net revenue and NPV for exercising the option of flexibility for year 1 and beyond.

The following is the net revenue lattice with 50/50 as the initial shipment between US/EU markets.

NET REVENUE LATTICE (50/50)					
Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
1550.00	(1420.00)	(1420.00)	(1420.00)	(1420.00)	(1420.00)
	(1520.00)	1550.00	(1420.00)	(1420.00)	(1420.00)
		(1520.00)	(1520.00)	1550.00	(1420.00)
			(1520.00)	(1520.00)	(1520.00)
				(1520.00)	(1520.00)
					(1520.00)

The value in each node of the net revenue lattice is calculated based on the demand ratio lattice. In year 0, the value is calculated by taking the revenue from 50 printers in US – cost for producing those 50 printers. This value is added to the revenue from 50 printers in EU – cost for producing and shipping those 50 printers to EU. In year 1, we have the option of exercising the option of flexibility. If we choose to exercise, we will ship 60 printers to the US market, and 40 to the EU market. By exercising the option, I incur a $3000 dollar switching cost. The value in year 1 is calculated as follows:

For state where demand ratio is higher in the US:
(Price per printer – material cost per printer to US)*(# Printer to US) + (Price per printer – material & shipping costs per printer to EU)*(# printers to UE) – switching cost – transformer storage cost = (100 – 82)*(60)+(100-82-5)*(40)-3000-10*2= -$1420.00.

For state where demand ratio is lower in the US:
(Price per printer – material cost per printer to US)*(# Printer to US) + (Price per printer – material & shipping costs per printer to EU)*(# printers to UE) – switching cost – transformer storage cost = (100-82)*(40)+(100-82-5)*(60)-3000-10*2= -$1520.00.

Based on the demand ratio in the US/EU Demand ratio lattice, similar calculation technique is applied to calculate values for rest of the states from year 2 to year 5 in the net revenue lattice.

The following is the net revenue lattice with 60/40 as the initial shipment between US/EU markets.

NET REVENUE LATTICE (60/40)					
Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
1580.00	1580.00	1580.00	1580.00	1580.00	1580.00
	(1480.00)	1580.00	1580.00	1580.00	1580.00
		(1480.00)	(1480.00)	1580.00	1580.00
			(1480.00)	(1480.00)	(1480.00)
				(1480.00)	(1480.00)
					(1480.00)

Similar to before, the value in each state of the lattice is calculated based on the price and cost of a printer for year 0. In year 1, if the demand ratio is higher in the US, then I will continue with shipping the same amount of printers to the US and EU market. In this case, I would not incur switching cost because I have not altered my shipment schedule from year 0. However, if the demand ration declines in the US, then I would need to exercise the option of shipping 40 to the US and 60 to EU, and therefore incur the $3000 switching cost. Detailed calculation for the net revenue values in year is provided below:

For state where demand ratio is higher in the US:
(Price per printer – material cost per printer to US)*(# Printer to US) + (Price per printer – material & shipping costs per printer to EU)*(# printers to UE) – transformer storage cost = (100 – 82)*(60)+(100-82-5)*(40)-10*2= $1580.00.

For state where demand ratio is lower in the US:
(Price per printer – material cost per printer to US)*(# Printer to US) + (Price per printer – material & shipping costs per printer to EU)*(# printers to UE) – switching cost – transformer storage cost = (100 – 82)*(40)+(100-82-5)*(60)-3000-10*2= -$1480.00.

The following is the net revenue lattice with 40/60 as the initial shipment between US/EU markets.

NET REVENUE LATTICE (40/60)					
Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
1480.00	(1270.00)	(1420.00)	(1420.00)	(1420.00)	(1420.00)
	1480.00	1480.00	(1420.00)	(1420.00)	(1420.00)
		1480.00	1480.00	1480.00	(1420.00)
			1480.00	1480.00	1480.00
				1480.00	1480.00
					1480.00

This is the opposite case of the 60/40 shipment schedule. Calculations are the same as previous two cases.

Expected Value, NPV, and Strategy for each Shipment State:

50/50 US/EU Shipment Ratio:

Expected Revenue (50/50)					
Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
1550.00	(717.10)	(362.14)	(182.88)	(92.35)	(46.64)
	(752.40)	774.92	(537.77)	(362.10)	(228.58)
		(372.44)	(564.24)	581.13	(448.10)
			(184.36)	(372.40)	(470.16)
				(91.26)	(230.42)
					(45.17)

NPV (50/50)					
Year 0	Year 1	Year 2	Year 3	Year 4	
($205.08)	($227.73)	($224.88)	($188.11)	($122.05)	
	($231.69)	($285.86)	($316.90)	($301.11)	
		($232.59)	($323.49)	($409.84)	
			($196.25)	($313.83)	
				($123.86)	

The expected revenue is calculated by taking the value in each state of the net revenue lattice and multiplies by the value in the corresponding state of the probability lattice.

The NPV lattice contains the present expected revenue for each stage. To arrive at the net present value for year 0, I had to work backward by calculating the present values in year 4 with the values in year 5. Since I have switching cost, I need to take that into account in calculating the present value for each stage. For example, using discount rate of 12% and p=0.505 as before, I calculated the value for the first state of year 4 by using the following formula in Excel: NPV(0.12, max(-46.64*p+(1-p)*-228.58, -3000)). In another word, to calculate the present value for the first state in year 4, I would use the values in the two immediate states in year 5 and p. The same formula is applied to calculate the present values for rest of the states in year 4.

The present value in year 3 is calculated by using the present value in year 4 of the NPV lattice. For example, the following formula is used to calculate the present value of the first state in year 3: NPV(0.12, max(-122.04*p+(1-p)*301.11,-3000)=-$188.11. Similar concept is applied to calculate present value for rest of the states in year 3, and is also used to calculate values for rest of the states in other stages. I arrive at -$205.08 as the net present value in year 0.

The following lattice contains present values calculated above with values in the expected revenue lattice. This lattice is used to determine whether exercising the option is a sensible decision.

NPV & Expected Revenue (50/50)					
Year 0	Year 1	Year 2	Year 3	Year 4	
$1,344.92	($944.83)	($587.01)	($370.99)	($214.40)	
	($984.09)	$489.06	($854.67)	($663.21)	
		($605.03)	($887.74)	$171.30	
			($380.60)	($686.23)	
				($215.12)	

The Strategy lattice is constructed based on the values in the lattice above. The Strategy lattice yield CLOSED as a state value when a negative value is found in the corresponding lattice in the NPV &

Expected Revenue lattice. Only when the option yields positive return would I exercise the option of flexibility.

Strategy (50/50)					
O	CLOSE	CLOSE	CLOSE	CLOSE	
	CLOSE	O	CLOSE	CLOSE	
		CLOSE	CLOSE	O	
			CLOSE	CLOSE	
				CLOSE	

The following expected revenue, NPV, and strategy for 60/40 and 40/60 US/EU shipment strategy are evaluated using the same formulation and equations as above.

60/40 US/EU Shipment Ratio:

Expected Revenue (60/40)					
Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
1580.00	797.90	402.94	203.48	102.76	51.89
	(732.60)	789.92	598.37	402.90	254.33
		(362.64)	(549.40)	592.38	498.59
			(179.51)	(362.60)	(457.78)
				(88.86)	(224.36)
					(43.98)

NPV (60/40)					
Year 0	Year 1	Year 2	Year 3	Year 4	
$13.09	$82.32	$165.53	$209.31	$135.80	
	($54.38)	$17.39	$161.00	$335.03	
		($140.77)	($124.91)	$22.49	
			($191.08)	($305.57)	
				($120.60)	

NPV & Expected Revenue (60/40)					
Year 0	Year 1	Year 2	Year 3	Year 4	
$1,593.09	$880.22	$568.47	$412.79	$238.56	
	($786.98)	$807.31	$759.37	$737.93	
		($503.41)	($674.31)	$614.87	
			($370.59)	($668.17)	
				($209.46)	

Strategy					
O	O	O	O	O	
	CLOSE	O	O	O	
		CLOSE	CLOSE	O	
			CLOSE	CLOSE	
				CLOSE	

40/60 US/EU Shipment Ratio:

Expected Revenue (40/60)					
Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
1480.00	(641.35)	(362.14)	(182.88)	(92.35)	(46.64)
	732.60	739.93	(537.77)	(362.10)	(228.58)
		362.64	549.40	554.89	(448.10)
			179.51	362.60	457.78
				88.86	224.36
					43.98

NPV (40/60)					
Year 0	Year 1	Year 2	Year 3	Year 4	
($1.59)	($65.90)	($144.77)	($188.11)	($122.05)	
	$63.62	($1.42)	($135.64)	($301.11)	
		$145.40	$135.18	$0.28	
			$191.08	$305.57	
				$120.60	

NPV & Expected Revenue (40/60)					
Year 0	Year 1	Year 2	Year 3	Year 4	
$1,478.41	($707.25)	($506.90)	($370.99)	($214.40)	
	$796.22	$738.51	($673.41)	($663.21)	
		$508.04	$684.57	$555.17	
			$370.59	$668.17	
				$209.46	

Strategy					
O	CLOSE	CLOSE	CLOSE	CLOSE	
	O	O	CLOSE	CLOSE	
		O	O	O	
			O	O	
				O	

Conclusion:

The combination of 60/40 and 40/60 shipment states would yield in the most NPV and Expected Revenue. The 50/50 state yield positive NPV, but it incur losses after initial stage.

6 Conclusion

When designing the postponement flexibility, the decision tree analysis could be carried out to model the state of nature for each stage of demand pattern. This would give the manufacturer a sense of how the flexible plan is compared against the traditional plan, which is the inflexible shipment schedule that the manufacturer currently has in place.

The option valuation by the binomial lattice would enable the manufacturer to gain further insight into the benefits of the flexible plan. In another words, the lattice model allows the manufacturer to visualize the monetary value of exercising the flexible option.

I have learned how to apply the analytical ideas we learned in class to a real world phoneme through the exercises of assembling various parts of this application portfolio. I have a better understanding of the concepts of decision analysis through decision tree and lattice valuation after completing application portfolios 3 to 6. Without these exercises and the help of the teaching assistant, I would not have known how to construct such analysis should I need to do so in a professional environment in the future.

I believe the result of my valuation could be compared to what really happened in the real world to see how realistic the models that I have constructed to analyze the flexibility of postponement for the printer industry. The exercise of finding out what happened in the real world could be very beneficial to me in terms of how I should alter or better construct my models.

Furthermore, I believe the valuation approach I took to analyze the printer industry could be applied to other industries. A perfect example would be the customizable computers that we are able to order from Dell or specialty local computer shops. The valuation of postponing the assembly of a complete system could be conducted to evaluate the value of having the flexibility to the retailers. The flexibility in this case would be to assemble different configurations of computer systems based on market needs versus the preassembled computer systems that are normally sold at retailers such as Best Buy. Time horizon, such as week or month, could be used as the stages and demand uncertainty in market could be the states in the decision and lattice valuation analyses. The expected revenue from each state specific to each stage could be derived, and decision could be made on how to alter the configuration of computer systems to meet demand in the market.

Finally, I believe this model should be extended to have fluctuating demand in the EU market in order to capture the exogenous factors in the market in a more realistic manner. This would more effectively prove the values of the postponement flexibility in the printer industry.