

## Supply Chain Simulation

Jarrold Goentzel, MIT  
goentzel@mit.edu

## Supply Chain Simulation

- **Design & Forecasting**
  - How did you decide which options to choose?
  - How did you arrive at your forecasts?
- Supplier Choice & Initial Order
- Dynamic Production & Inventory Planning

## Supply Chain Simulation

- Design & Forecasting
- **Supplier Choice & Initial Order**

	FarFarAway	FarAway	Pretty Close	Ve-Ri-Fas
Set-up Cost	\$ 1,000,000	\$ 2,000,000	\$ 1,000,000	\$ 2,000,000
Incremental Unit Cost	-	-	\$ 10	\$ 10
Leadtime (months)	4	3	0	0
Monthly Capacity	60,000	60,000	35,000	40,000
Min Prod'n Level	60%	60%	60%	60%
Prod'n Change Cost	2,000	2,000	2,000	2,000

- How did you decide which supplier(s) to use?
- Worth extra \$1 million for 3 month instead of 4 month lead time?
- Worth extra \$1 million for extra capacity (40 vs. 35) at reactive supplier?
- **Dynamic Production & Inventory Planning**

## Supply Chain Simulation

- Design & Forecasting
- Supplier Choice & Initial Order
- **Dynamic Production & Inventory Planning**
  - How often did you use \$2M change orders?
  - Did you buy \$2M market information? Why or why not?

## Board Votes Results

### Board Member Objectives

Betty: Choose options by mean not consensus  
 Doug: Choose options with lower forecast variance  
 Meryl: Use reactive suppliers & change orders after demand is observed  
 Paul: Use reactive suppliers to produce product with more demand uncertainty  
 Yvonne: Plan ending inventory considering markdown/stockout (Newsvendor)

### Overall Board Votes by Board Member

Year	1	2	3	4	Average
Betty	10%	41%	38%	41%	33%
Doug	14%	41%	45%	28%	32%
Meryl	34%	28%	24%	28%	28%
Paul	45%	24%	14%	28%	28%
Yvonne	10%	0%	7%	7%	6%
Total	23%	27%	26%	26%	25%

## Board Votes Results

Team	Year 1	Year 2	Year 3	Year 4	Total	Rank
KSCHMI12	4	3	3	4	14	1
X142980	3	4	2	5	14	1
USWALST1	3	2	3	4	12	3
ANJOSM	1	4	5	2	12	3
NIKlashamn	3	4	4	1	12	3
RECK	3	4	2	2	11	6
HERMANPINXTE	2	3	1	3	9	7
SPENCER.HENN	1	1	3	3	8	8
LUEDJAS	2	2	1	3	8	8
JMTDEBONT	2	2	2	1	7	10
OVS75	1	3	1	2	7	10
TTATUA	1	2	2	2	7	10
VERD1465	0	0	3	4	7	10
AABBAS1915	2	2	3	0	7	10
SINKOVITZ	2	1	1	1	5	15
AUVEM	0	2	1	1	4	16

## Profits Results

Team	Y1	Y2	Y3	Y4	Total Profits	Rank
TTATUA	\$ 48,987	\$ 34,029	\$ 41,477	\$ 58,628	\$ 183,121	1
X142980	\$ 46,218	\$ 42,176	\$ 37,223	\$ 54,201	\$ 179,818	2
KSCHMI12	\$ 44,066	\$ 39,337	\$ 35,440	\$ 56,264	\$ 175,107	3
NIKLASHAMN	\$ 43,353	\$ 41,591	\$ 38,003	\$ 47,024	\$ 169,971	4
LUEDJAS	\$ 43,438	\$ 45,701	\$ 24,089	\$ 55,970	\$ 169,198	5
RECK	\$ 33,473	\$ 45,047	\$ 39,239	\$ 49,363	\$ 167,122	6
ANJOSM	\$ 32,224	\$ 38,809	\$ 39,660	\$ 51,140	\$ 161,833	7
SPENCER.HENNIGAR	\$ 39,881	\$ 34,702	\$ 25,221	\$ 52,505	\$ 152,309	8
VERD1465	\$ 32,420	\$ 23,272	\$ 40,487	\$ 46,519	\$ 142,698	9
HERMANPINXTEN	\$ 45,375	\$ 35,066	\$ 10,291	\$ 50,902	\$ 141,634	10
SINKOVITZ	\$ 33,679	\$ 34,539	\$ 22,962	\$ 44,935	\$ 136,115	11
USWALST1	\$ 28,552	\$ 33,965	\$ 9,881	\$ 45,418	\$ 117,816	12
JMTDEBONT	\$ 27,092	\$ 20,603	\$ 19,626	\$ 43,763	\$ 111,084	13
OV575	\$ 29,243	\$ 21,088	\$ 21,714	\$ 36,717	\$ 108,762	14
AABBAS1915	\$ 37,986	\$ 32,774	\$ 34,055	\$ -	\$ 104,815	15
AUVEM	\$ 43,863	\$ 20,389	\$ 2,836	\$ 30,861	\$ 97,949	16
Avg	\$ 22,014	\$ 18,727	\$ 15,248	\$ 24,973	\$ 80,962	
Min	\$ 27,092	\$ 20,389	\$ 2,836	\$ 30,861	\$ 28,552	
Max	\$ 48,987	\$ 45,701	\$ 41,477	\$ 58,628	\$ 183,121	

## Final Ranks

### Weighted Average of Board Votes & Profits

Team	Profits		Board Vts		Board Vote Weight		35%	
	Value	Rank	Value	Rank	Std Prof	Std Votes	Composite Value	Composite Rank
X142980	\$ 179,818	2	14	1	1.15	1.54	1.28	1
KSCHMI12	\$ 175,107	3	14	1	0.98	1.54	1.18	2
NIKLASHAMN	\$ 169,971	4	12	3	0.80	0.91	0.84	3
RECK	\$ 167,122	6	11	6	0.69	0.59	0.66	4
ANJOSM	\$ 161,833	7	12	3	0.51	0.91	0.65	5
TTATUA	\$ 183,121	1	7	10	1.27	(0.68)	0.59	6
LUEDJAS	\$ 169,198	5	8	8	0.77	(0.36)	0.37	7
SPENCER.HENNI	\$ 152,309	8	8	8	0.17	(0.36)	(0.02)	8
HERMANPINXTE	\$ 141,634	10	9	7	(0.21)	(0.04)	(0.15)	9
VERD1465	\$ 142,698	9	7	10	(0.18)	(0.68)	(0.35)	10
USWALST1	\$ 117,816	12	12	3	(1.06)	0.91	(0.37)	11
SINKOVITZ	\$ 136,115	11	5	14	(0.41)	(1.31)	(0.72)	12
JMTDEBONT	\$ 111,084	13	7	10	(1.30)	(0.68)	(1.08)	13
OV575	\$ 108,762	14	7	10	(1.39)	(0.68)	(1.14)	14
AUVEM	\$ 97,949	15	4	15	(1.77)	(1.62)	(1.72)	15
Mean	\$ 147,636		9.1					
Std Dev.	\$ 28,049		3.2					

## Takeaways

- Accurate forecasts
  - Gather more data, especially individual forecasts
  - Capture the standard deviation of the individual forecasts
  - A small amount of actual demand can really improve forecasts
- Responsive supply
  - Carefully consider which products to produce with speculative/reactive capacity
  - Structurally aim to shorten lead times and increase reactive capacity
- Optimize inventory\*
  - Critical Ratio (based on the cost of being under/over) as intuition for when to over/underproduce; only when under/over cost are equal should you plan to end up with exactly zero inventory
  - Use standard deviation to determine how much to over/underproduce

\*WARNING: These principles come from the "newsvendor problem," which cannot be applied fully in the game because some assumptions are not realized: e.g. ability carry inventory and issue change orders throughout the year, capacity constraints, supplier lead times. The intuition from the newsvendor problem – that you should consider overage/underage costs when setting inventory targets – is what we are trying to teach. Email us if you would like to know more about the full theory.

## Further Reading

Janice H. Hammond, Ananth Raman. "Sport Obermeyer Ltd." Harvard Business School Case (No. 9-695-022), August 15, 2006.

Fisher, M., J. Hammond, W. Obermeyer, and A. Raman. "Making Supply Meet Demand in an Uncertain World." *Harvard Business Review* 72, no. 3 (May-June 1994): 83-92.

Raman, A., M. Fisher, J. Hammond, and W. Obermeyer. "Accurate Response: The Key to Profiting from Quick Response." *Bobbin Magazine*, February 1994.

Raman, A., M. Fisher, J. Hammond, and W. Obermeyer. "Configuring a Supply Chain to Reduce the Cost of Demand Uncertainty." *Production and Operations Management Journal* 6, no. 3 (fall 1997): 211-225.

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