Weekly presentation SCM research

10th presentation: Optimizing the Supplu Chain Configuration for New Products (Part 2)

Introduction

•Develop support decision tool to use during product development process where the product design has been fixed

•*Minimize the entire supply chain cost*

•*Multiple options differentiated by its lead time and direct cost added*

•*Dynamic program with two states variables to solve supply chain configuration problem (case of spanning tree)*

Summary

I/Industrial example

1) Process description

2) Case study

3) Solutions

4) Observations

II/ Computationnal experiment

1) Test problem

2) Hypothesis evaluation

I/ Industrial example
1) Process description

•***Target costing approach*** *(market price for the product set outside the design group)*

- *fierce comptetition*
- *Price specified by marketing*

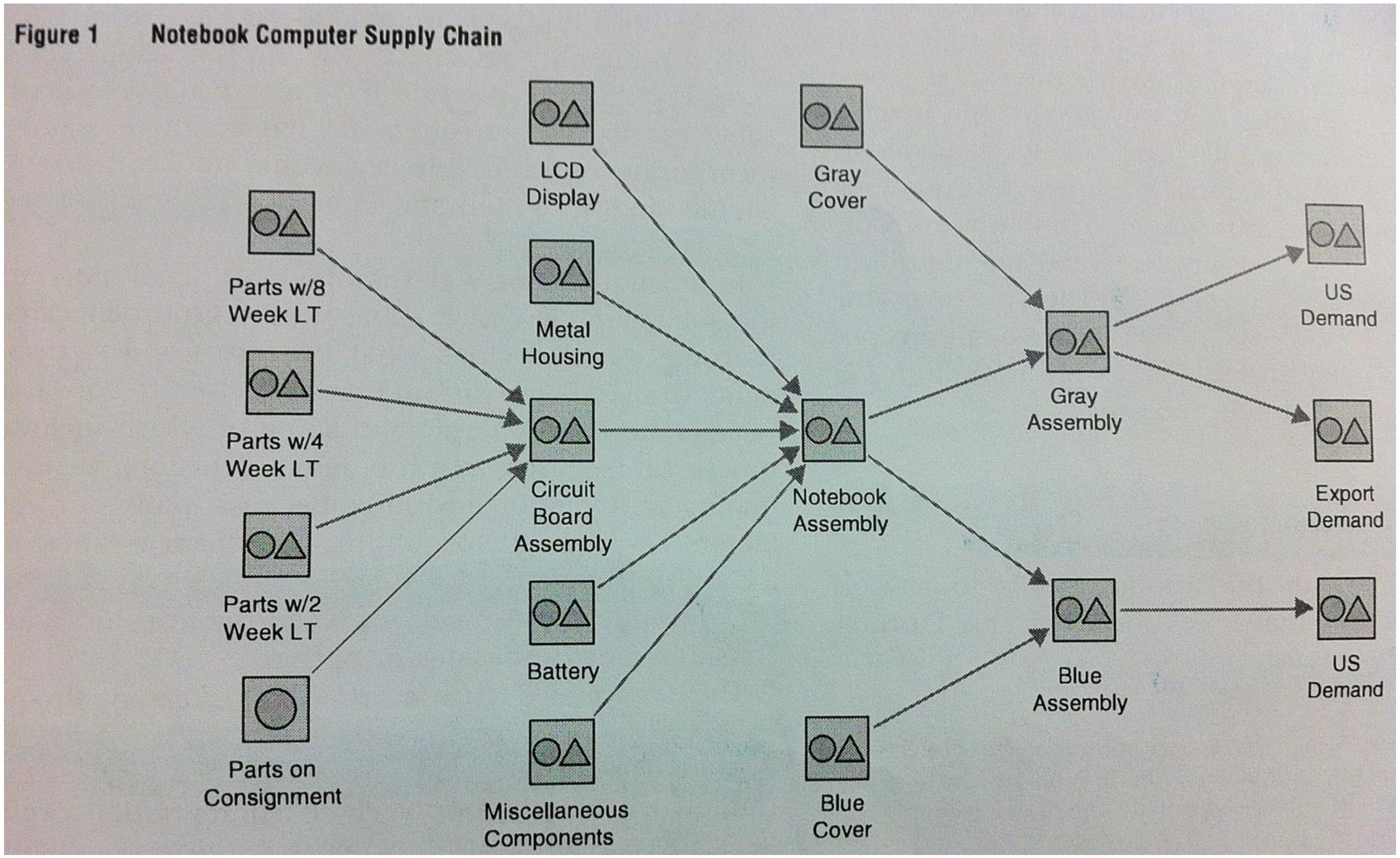
•*The combination of the prespecified selling price and the gross margin target dictates the product's maximum unit cost*

•***UMC*** *= sum of all the direct costs for the production of a single unit*

•*UMC budget allocated across the major subassemblies*

•*Choice of suppliers done by establishing a minimum threshold for each of the intangible factors, and then choose the cheapest option regardless of lead time)*

I/ Industrial example
2) Case study



I/ Industrial example
2) Case study

- *250 workdays / year*
- *Annual holding cost rate of 45%*
- *Immediate service to external customers*
- *Demand*

$$D_j(\tau) = \tau\mu + k\sigma\sqrt{\tau}$$

Table 2 Demand Parameters for Different Markets

Demand stage	Mean	Sigma
U.S. demand—gray	200	120
Export demand—gray	75	50
U.S. demand—blue	125	80

Component/process description	Option	Lead time	Cost added ($)
Parts w/ eight-week lead time	1	40	130.00
	2	20	133.25
	3	10	134.91
	4	0	136.59
Parts w/ four-week lead time	1	20	200.00
	2	10	202.50
	3	0	205.03
Parts w/ two-week lead time	1	10	155.00
	2	0	156.93
Parts on consignment	1	0	200.00
Circuit board assembly	1	20	120.00
	2	5	150.00
LCD display	1	60	300.00
	2	5	350.00
Miscellaneous components	1	30	200.00
Metal housing	1	70	225.00
	2	30	240.00
Battery	1	60	40.00
	2	20	45.00
Notebook assembly	1	5	120.00
	2	2	132.00
Gray cover	1	40	5.00
	2	15	5.50
Blue cover	1	40	5.00
	2	15	5.50
Gray assembly	1	1	30.00
Blue assembly	1	1	30.00
U.S. demand—gray	1	5	12.00
	2	1	20.00
Export demand—gray	1	15	15.00
	2	2	30.00
U.S. demand—blue	1	5	12.00
	2	1	20.00

I/ Industrial example
3) Solutions

Minimum UMC Heuristic

•*Choosing the lowest cost option at each stage*

- *Safety stock cost lower*

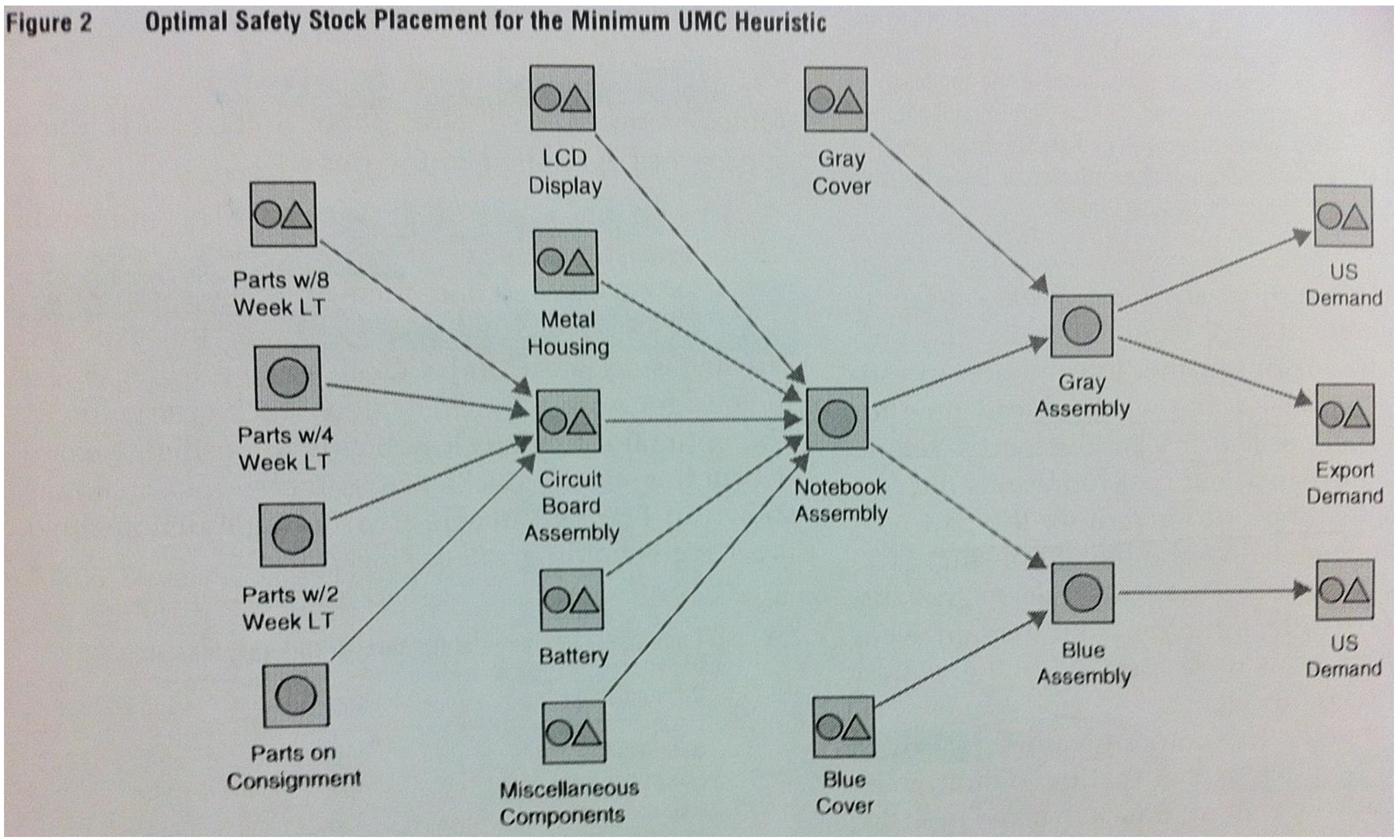
•*Decoupling the safety stocks across the supply chain*

•*Demand stages hold safety stock because of Sn=0*

•*COGS dominates the total supply chain configuration cost (M$41,4 vs $M173,7)*

I/ Industrial example
3) Solutions

Minimum UMC Heuristic



I/ Industrial example
3) Solutions

Minimum Lead-Time Heuristic

- *Chossing the option with the shortest lead time*
- *Same optimal placement but stock levels differ*

- *Huge savings on inventory but 7,8% increase of the product's UMC*

- *Supply chain configuration cost higher than min UMC heuristic by M$1,2*

I/ Industrial example
3) Solutions

Supply Chain Configuration Optimization

- *Hold all electronic components on consignment*
- *Each subassemblies is configured to quote a service time of 30 days to the notebook assembly*
- *UMC increased by 2,2% over the minimum UMC heuristic but total Supply Chain cost reduced by M$2.0*
- *Choices that do not seem obvious*

I/ Industrial example
3) Solutions

Supply Chain Configuration Optimization

Table 4 Options Selected Using Optimization Algorithm

Component/process description	Option	Lead time	Cost added ($)
Parts w/ eight-week lead time	4	0	136.59
Parts w/ four-week lead time	3	0	205.03
Parts w/ two-week lead time	2	0	156.93
Parts on consignment	1	0	200.00
Circuit board assembly	1	20	120.00
LCD display	1	60	300.00
Miscellaneous components	1	30	200.00
Metal housing	2	30	240.00
Battery	1	60	40.00
Notebook assembly	1	5	120.00
Gray cover	1	40	5.00
Blue cover	1	40	5.00
Gray assembly	1	1	30.00
Blue assembly	1	1	30.00
U.S. demand—gray	2	1	20.00
Export demand—gray	2	2	30.00
U.S. demand—blue	2	1	20.00

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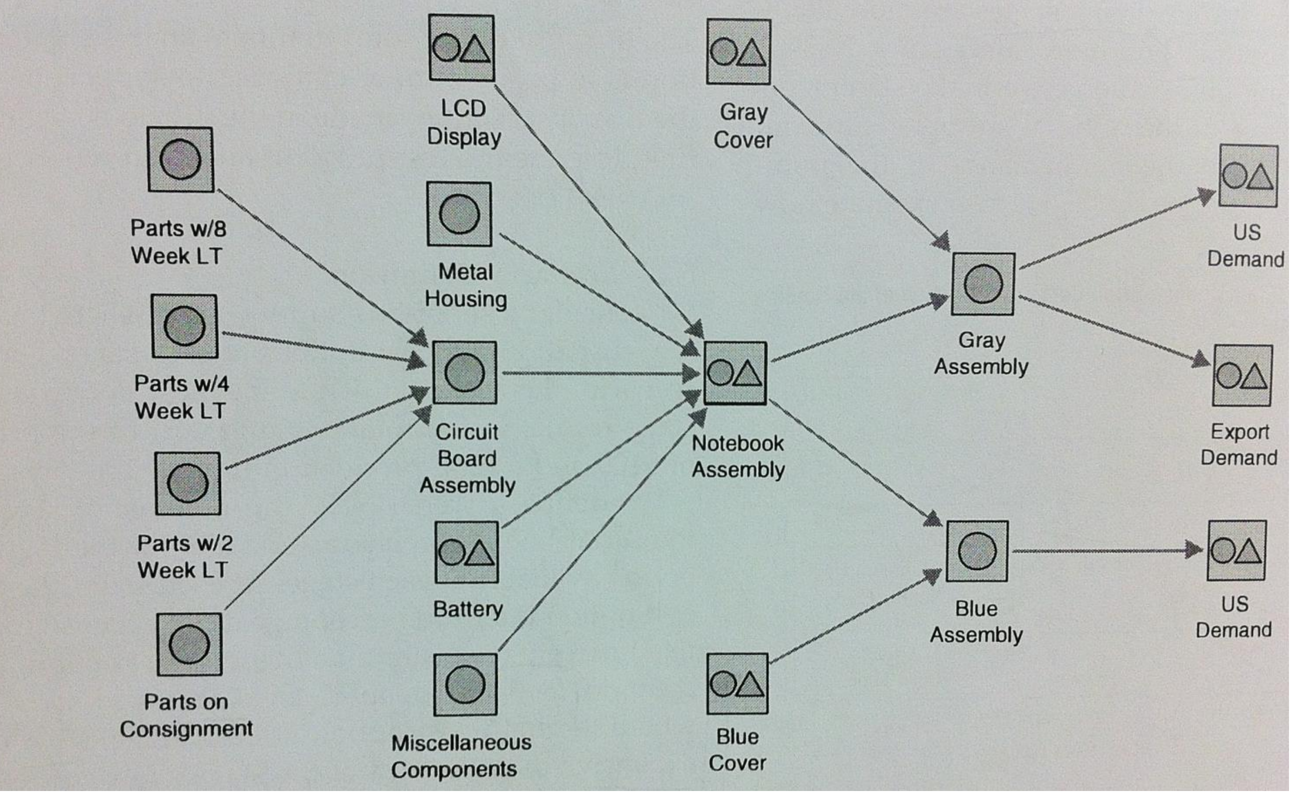
I/ Industrial example

3) Solutions

Supply Chain Configuration Optimization

Figure 3 **Optimal Safety Stock Placement for Optimization Algorithm**



I/ Industrial example
3) Solutions

Comparison

Table 3 Results of Four Solution Approaches

	Current policy	Minimum UMC heuristic	Minimum lead-time heuristic	Supply chain configuration algorithm
Cost components ($M)				
COGS	173.8	173.8	187.3	177.5
Pipeline stock cost	16.2	16.2	4.9	11.0
Safety stock cost	2.8	2.4	1.3	1.8
Total SC cost	192.7	192.3	193.5	190.4
Supply chain metrics				
Inventory investment	41.3	41.3	13.9	28.5
UMC ($/unit)	1,737.56	1,737.56	1,872.93	1,775.43
Longest path (days)	91	91	35	68

I/ Industrial example
4) Observations

- ***1-*** *In the optimal supply chain configuration*
    - *Downstream stages -> high-cost options*
    - *Upstream stages -> low-cost options and hold safety stock*
- ***2-*** *The benefits of supply chain configuration increase with the importance of inventory costs regarding the whole supply chain*
- ***3-*** *With demand variability*
- ***4-*** *With longer lead times at downstream stages*
- ***5-*** *With the number of echelons*

II/ *Computationnal experiment*
1) Test problem

- *8-stage serial-line supply chain*

- *2 options at each stage (low-cost/ high-cost, 3% more expensive and 30% faster)*

- *810 supply chain configuration problems solved*
  - *3 cost-accrual profiles*
  - *3 time-accrual profiles*
  - *3 mean demands*
  - *3 standard deviations of demand*
  - *10 holding cost rates*

- *On average the total cost of the minimum UMC heuristic exceeds the optimal SCC by 1.95%*

II/ *Computationnal experiment*
2) Hypothesis evaluation

Observation 1

In the optimal SCC, downstream stages are more likely to use high-cost options and upstream stages low-cost options and hold safety stock

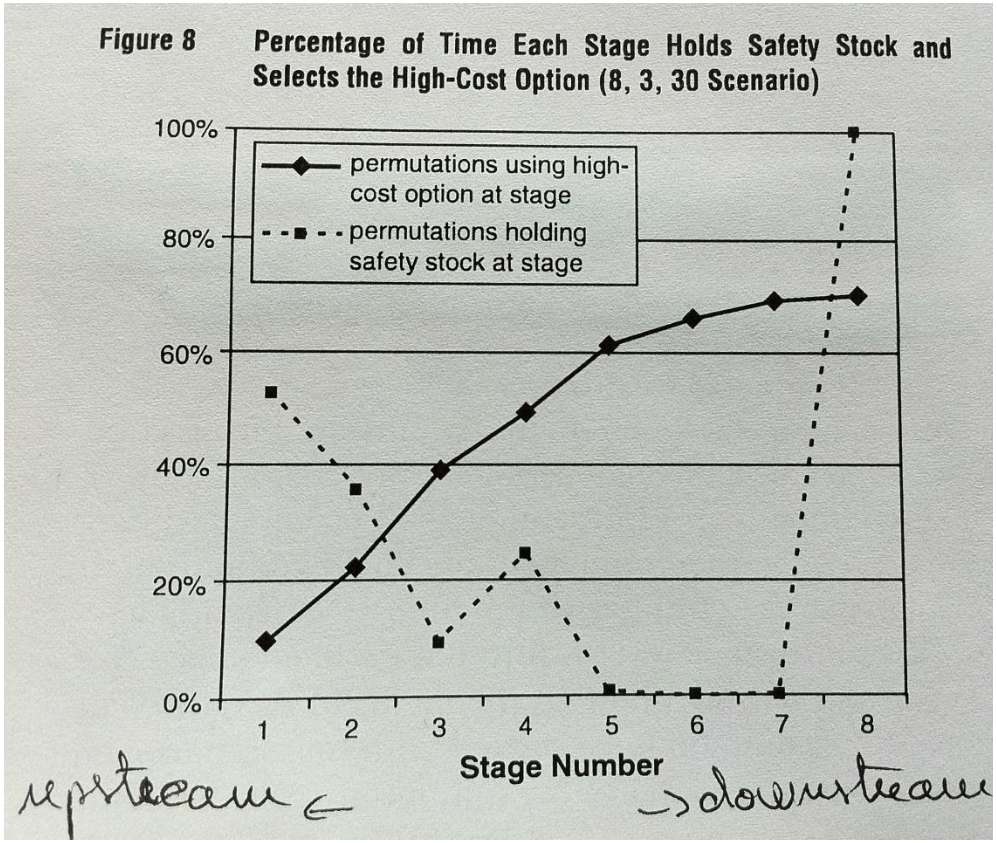
•*A high-cost option increase the COGS, but also the SS and PS of all its downstream stages*

•*A safety stock acts to decouple the stage from the rest of the SC, reducing the effeive lead time to the rest of the SC to zero*

•*Holding inventory at an upstream stage costs less (product value)*

II/ *Computationnal experiment*
2) Hypothesis evaluation

Observation 1



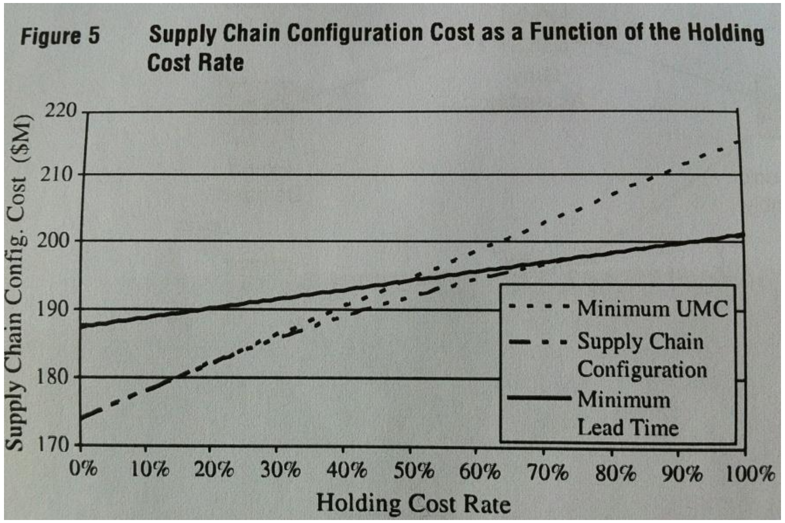
II/ Computationnal experiment
2) Hypothesis evaluation

Observation 2

The benefits of SCC increase as the importance of inventory costs increases relative to the total SC cost

- *The holding cost rate reflects how much risk the company associates with making a large investment in safety and pipeline stock*

- *Balance between COGS and inventory costs*



II/ *Computationnal experiment*
2) Hypothesis evaluation

Observation 3

The benefits of SSC increase as the relative demand variability increases

- *Greater demand variability results in a higher SS cost while leaving COGS and PS cost unchanged*

- *Inventory savings from a high-cost option can offset the increase in COGS*

- *As the mean demand increases or the standard deviation decreases, the benefit of SCC decreases relative to min UMC (impact of COGS increases relative to SS)*

- *And inversely with min leadt-time*

II/ *Computationnal experiment 2) Hypothesis evaluation*

Observation 4

The benefits of SSC increase with longer tead times at downstream stages

•*Downstream stages have higher holding cost than upstream stages*

Observation 5

•The benefits of SSC increase with the number of echelons

•*More echelons provide a greater opportunity to offset an increase in COGS with a decrease in inventory costs (more configuration options available)*

Conclusion

- ***Cost savings can be realized when inventory cost and COGS are jointly optimized***

- ***Further discussions:***
  - *Time-to-market cost to be incorporated*
  - *More geneal network structures to be considered*
  - *Number limitation of the different vendors*
  - *Possible multiple sources at each stage*
  - *More conventional assumptions regarding the inventory behavior*

Thank you for your attention!