

# New Product Supply Chain Configuration Under a CO<sub>2</sub> Emission Constraint

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## Abstract:

To understand how emission constraints might affect operational decision, it is necessary to integrate CO<sub>2</sub> emission into operational models.

We reinvestigate Supply chain configuration (SCC) of new products with CO<sub>2</sub> emission consideration due to transportation activities.

We extend a Graves and Willems(2005) model by imposing cap on transportation related CO<sub>2</sub> emissions.

**Total cost** = safety stock cost + pipeline stock cost + COGS

**CO<sub>2</sub> Emission constraint:**  $\sum_{i=1}^N \sum_{k=1}^{O_i} y_{ik} Em_{ik} \leq Em_{max}$

Where  $Em_{ik}$  = co2 emission of  $k^{th}$  option at stage  $i$ ,

## Numerical study:

- Notebook Computer Case Study
- options for each stage are different in lead time, added cost, CO<sub>2</sub> emissions.
- Calculate emission for air, road, and ship transportation by using NTM methodology.

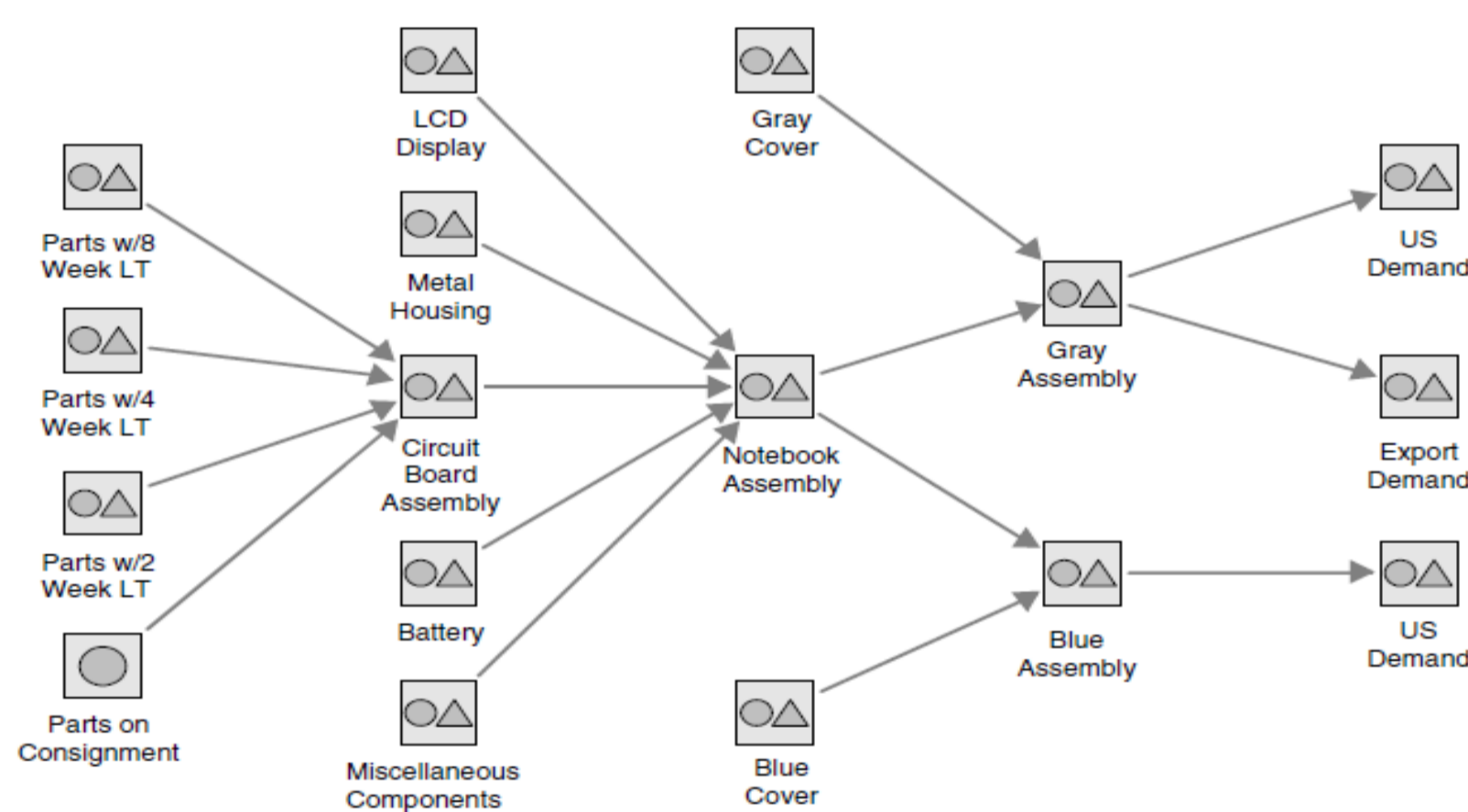
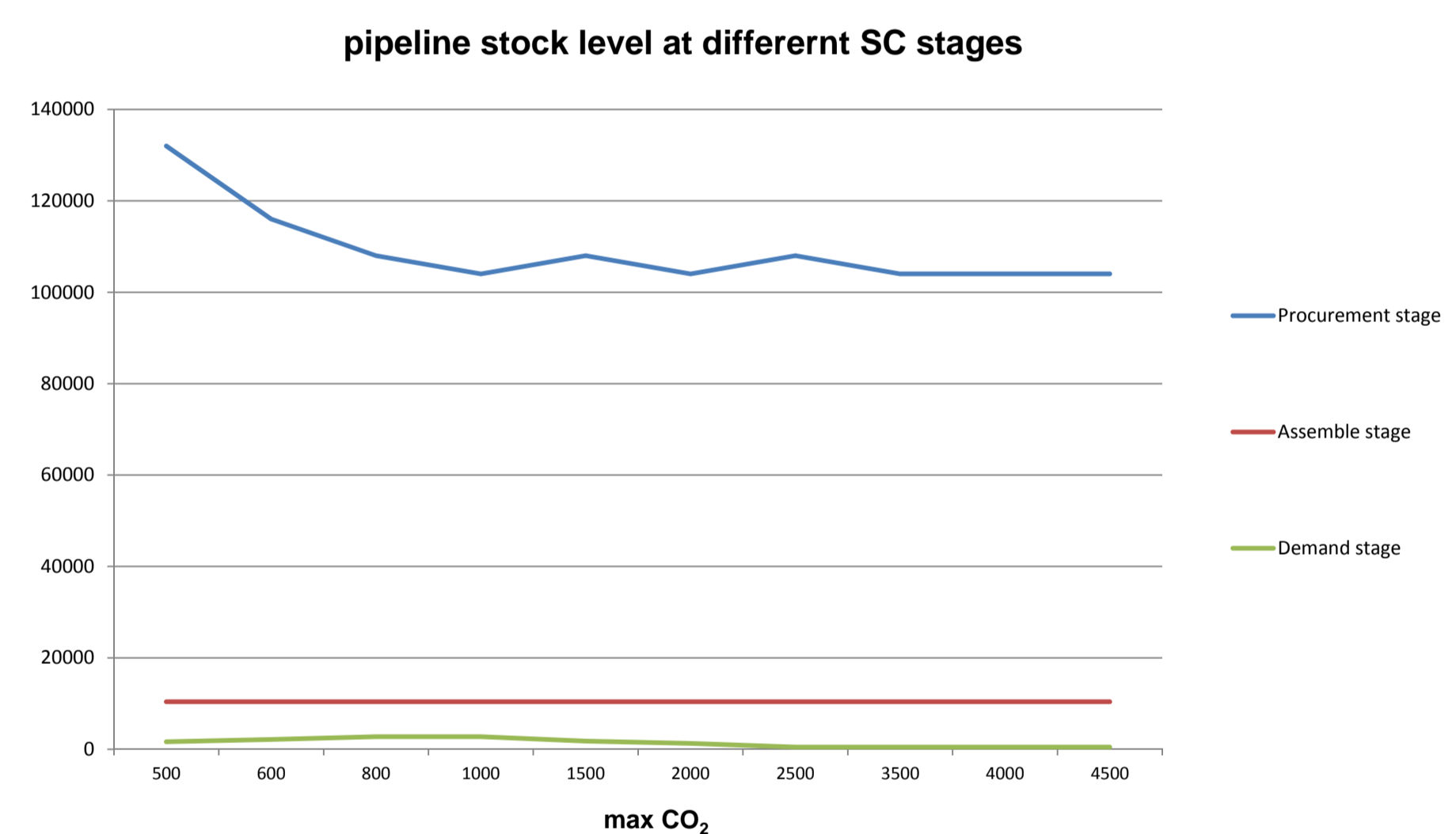
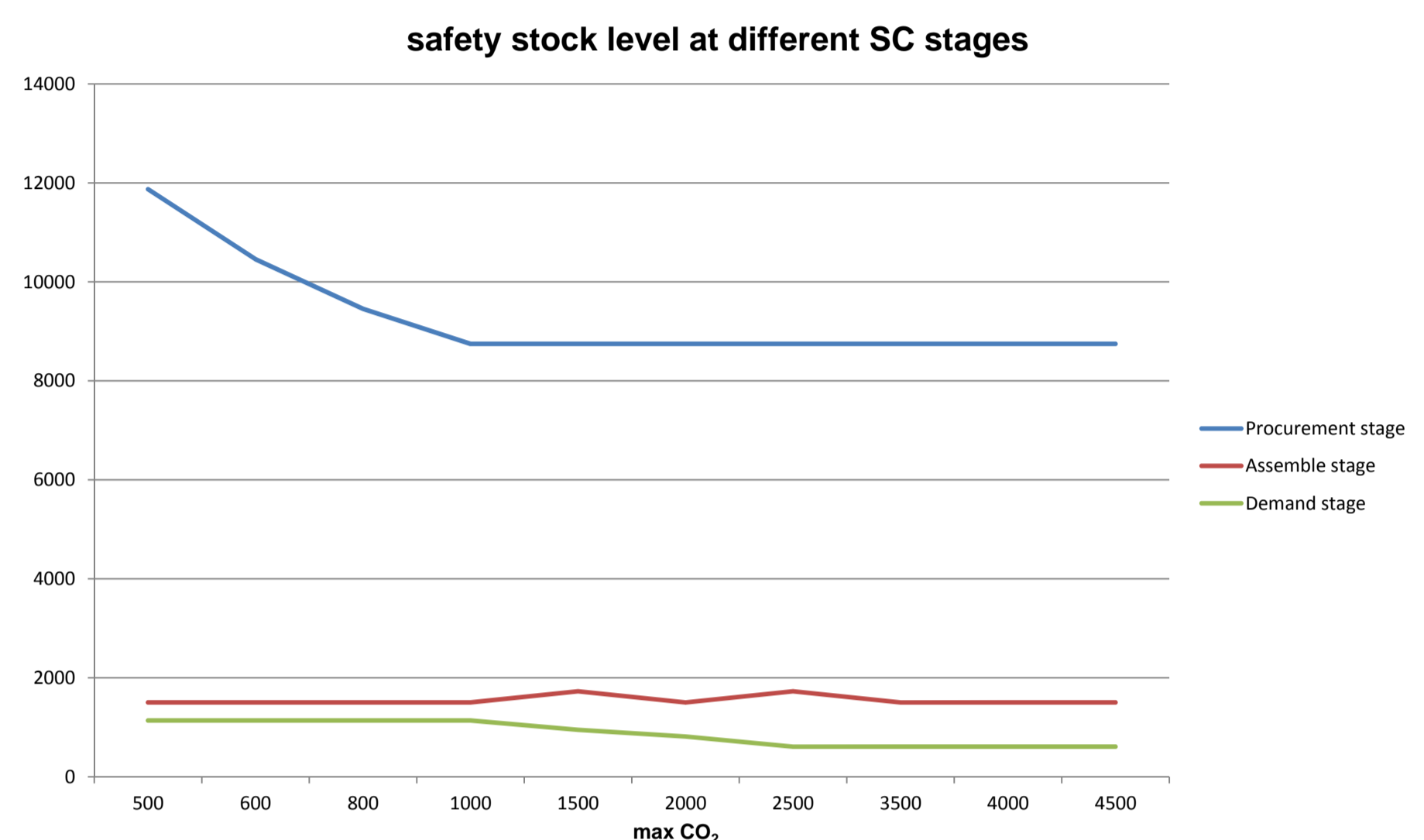


Fig.1 notebook computer supply chain, ( Graves and Willems,2005)



## Conclusions:

- ❖ it is possible to significantly reduce emissions without significantly increasing cost. By increasing just 1% in total cost we could make more than 85% saving in emission.
- ❖ A strict emission cap imposes every stage to select a slow transport mode (low-cost, long lead time option) which causes more safety stock to protect against delay and more pipeline inventory level.
- ❖ A relaxed emission cap causes the cost of goods sold to increase due to using the higher-cost, shorter lead time option and faster transportation mode.
- ❖ Typically upstream parts of supply chain select slow transport mode ( cause to keep more pipeline and safety stock) and downstream parts select faster mode.

## Numerical results:

Table1. Configuration cost result from different max Co<sub>2</sub> emission

max CO <sub>2</sub> (kg)	total cost(\$M)	Safety stock cost	pipeline cost	COGS
500	192,336	2,422	16,158	173,756
600	192,023	2,347	15,261	174,415
800	191,751	2,263	14,57	174,918
1000	191,63	2,216	14,303	175,111
1500	191,156	2,151	13,806	175,199
2000	190,751	1,963	13,145	175,643
2500	190,521	1,884	12,787	175,85
3500	190,363	1,803	12,517	176,043
4000	190,363	1,803	12,517	176,043
4500	190,363	1,803	12,517	176,043
5500	190,363	1,803	12,517	176,043