Enhancing the environmental performance of supply chains

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(In *Positive Development: from vicious circles to virtuous cycles* by J. Birkeland)

The sustainability of global commerce depends on the sustainability of supply chains. 'Green' supply chains have attracted significant interest in recent years. A number of large companies – including Hewlett-Packard, Nike, and STMicroelectronics - have focused attention on the manufacturing practices of their suppliers in an attempt to make their supply chains greener. There is more to it: how we move materials and goods in a carbon-constrained world will also impact our progress toward a sustainable future.

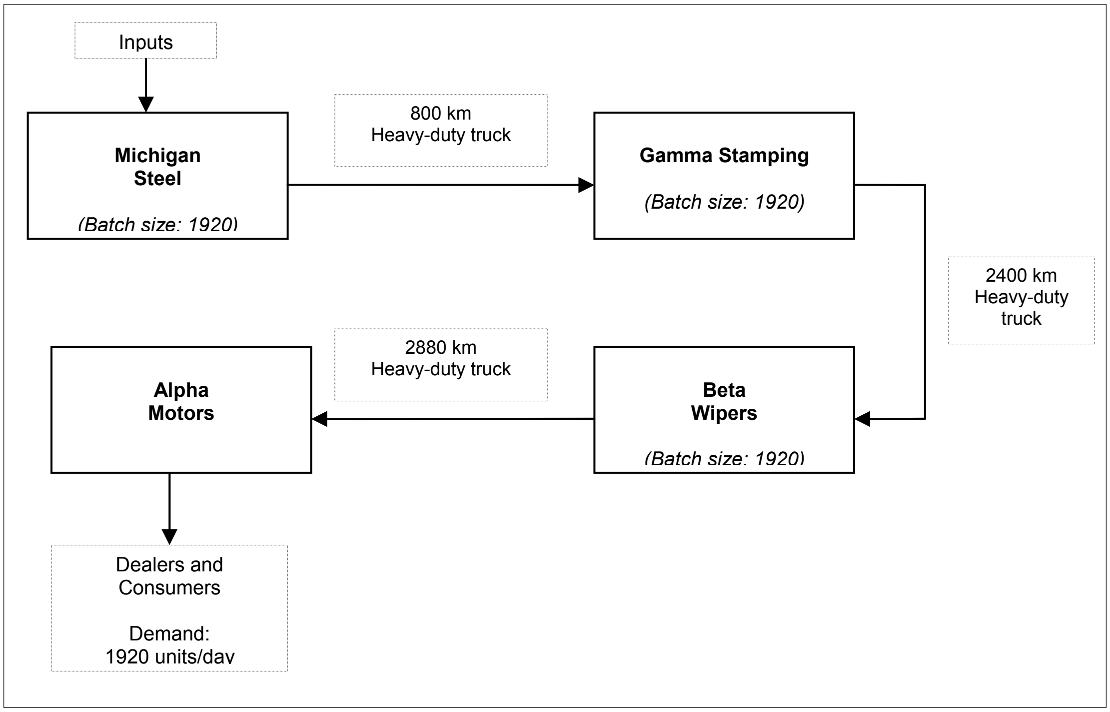
Supply chains are increasingly vulnerable to energy prices and constraints on greenhouse gas emissions. Supply chains now span long distances and require significant use of fossil fuels and carbon dioxide emissions to manufacture and deliver goods to consumers. Freight transport consumes nearly a quarter of all the petroleum worldwide and accounts for over ten percent of the carbon emissions from fossil fuels.[1] At the same time, techniques such as lean manufacturing are keeping inventory levels low and require frequent replenishment throughout the supply chain – which can increase energy use and emissions, depending on the product.[2] The total energy use and emissions in supply chains depend on transport modes, frequency and size of deliveries, and inventory levels.

One way to improve the environmental performance of supply chains is by analyzing the whole system and finding leverage points that can be used for performance optimization. The system includes all the production, transportation and storage along supply chains. Transport modes that can deliver larger quantities of a product result in higher inventory levels, while transport modes that deliver smaller quantities more frequently result in lower inventory levels. Larger inventories require more energy to maintain, while larger delivery sizes require less energy per unit product for transportation. This tradeoff exists at every transport link and associated storage in typical supply chains. Our results suggest that significant opportunities exist for improving the energy/emissions footprint of supply chains, while reducing overall cost in many cases.

This insight has led to the development of a new software package called Supply-Chain Environmental Analysis Tool ('SEAT'). SEAT is an interactive software tool that can be used to quantify and improve the environmental performance of supply chains. SEAT allows users to easily model supply chain elements - including transportation, storage, and production - from an energy and carbon dioxide emissions perspective. It then provides powerful methods to analyze, report, and explore improvements to supply-chain environmental performance. The analysis includes a comprehensive accounting of energy usage, carbon-dioxide emissions, and financial cost. SEAT can be used for detailed analysis of existing supply chains, 'what-if' experiments, and comparisons of alternative supply chain configurations. SEAT can be valuable in a variety of applications, such as:

- achieving overall cost savings from reduced energy use in supply chains;
- meeting voluntary or mandatory greenhouse gas emission targets;
- emission calculations for use in offsetting carbon footprints; and
- detailed corporate reporting of energy use and emissions.

The following example illustrates a manufacturing supply chain that produces windshield wipers for automobiles[3]. The user inputs the supply-chain configuration – including details of the transport and storage modes and their energy-use characteristics – into SEAT and then runs the analysis. The results shown at the bottom include not only the energy consumed and emissions produced at every stage in the supply chain, but also inventory levels and cost. The analysis can be re-done quickly with changes to the transport modes or other aspects of the supply chain. Business decisions about environmental performance can be made in the context of financial cost and acceptable service levels.



File Edit Run Output Help

Node/Link	Mode	Energy/Fuel	Distance (Km)	Delivery Period (Days)	Batch Size or Ave. Inventory	Energy Used per Day (GJ)	Emissions Generated per Day (Kg-CO2)	Energy/Fuel Cost per Day ($)	Transportation Overhead Cost per Day ($)	Storage Overhead Cost per Day ($)	Total Cost per Day ($)
ToGammaStampingIn	HeavydutyTruck (Transport)	Diesel	800.00	3.00	5760.00	3.82	280.88	81.52	80.00		161.52
ToBetaWipersIn	HeavydutyTruck (Transport)	Diesel	2400.00	3.00	5760.00	11.46	842.65	244.57	240.00		484.57
ToAlphaMotors	HeavydutyTruck (Transport)	Diesel	2880.00	3.00	5760.00	13.75	1011.18	293.48	288.00		581.48
GammaStampingIn	Warehouse (Storage)	Electricity			1920.00	2.88	486.62	80.00		8.45	88.45
GammaStampingOut	Warehouse (Storage)	Electricity			1920.00	2.88	486.62	80.00		8.45	88.45
BetaWipersIn	Warehouse (Storage)	Electricity			1920.00	2.88	486.62	80.00		8.45	88.45
BetaWipersOut	Warehouse (Storage)	Electricity			1920.00	2.88	486.62	80.00		8.45	88.45
GammaStamping	Production (Process)	None			1920.00	0.00	0.00	0.00			0.00
BetaWipers	Production (Process)	None			1920.00	0.00	0.00	0.00			0.00
<TOTAL>						40.54	4081.20	939.58	608.00	33.79	1581.37

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[1] Scientific American, September 2006, pp. 55, 61.
[2] K. Venkat and W. Wakeland, “Is lean necessarily green?”, Conference of the International Society for the Systems Sciences, July 2006 (http://www.suryatech.com/pages/ISSS06-IsLeanNecessarilyGreen.pdf)
[3] Adapted from: D.T. Jones and J.P. Womack, *Seeing the Whole: Mapping the Extended Value Stream*, The Lean Enterprise Institute, Brookline, MA, 2002.