

# Student Supply Chain Analysis

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Abstract: Several years ago, an elective in supply chains was added to the Master of Science in Engineering Management program at Milwaukee School of Engineering. A major requirement of this course is student analysis of an actual supply chain. This project consists of three papers over the course of the term: (1) describe a supply chain, (2) identify problems and issues in the chain, and (3) make recommendations for improvement. Since most students are working full-time and attending class part-time, they typically analyze their employer's supply chain. This paper describes the projects and some of the solutions proposed. It also includes the results of a survey of past students and the extent to which their proposed solutions were implemented.

## I. Introduction

Many of the courses offered in engineering management programs reflect well-established disciplines. Others, while clearly important, lack a consensus as to what they should include.

Supply chain management is an example of the latter group. There is widespread agreement as to its importance for the future success of organizations. In fact, for many companies being part of a winning supply chain may mean more for success than anything the company can do on its own. Yet teaching about supply chains can be a challenge both because of the lack of agreement as to what should go into such a course and the rapid rate of change in what is considered best practices.

The lack of a core discipline is underlined by a review of supply chain texts:

1. One group stresses logistics, delving into the details of transportation, materials handling, packaging, and purchasing. The elevation of supply chains can be regarded as a chance to raise the profile of these necessary functions that were often pushed to the periphery of organizational decision-making. For our students, except for the few working in logistics, a focus on the details of logistics would likely prove of little interest.
2. Another group treats supply chains as a model building challenge. How can such models as linear programming, forecasting, those designed to

manage inventory, decision theory, or the various heuristics for facility location or routing be used to improve the supply chain?

3. A third group views the supply chain as a tool of corporate strategy. If the strategy emphasizes low cost, the supply chain should be designed to minimize costs. A strategy emphasizing customer service, however, may be sabotaged by supply chain participants emphasizing costs. Each of the parts of the supply chain should be investigated to see whether they hinder or advance the strategy. Related to this approach is an examination of the tactics that have arisen to improve supply chains, such as delaying differentiation and risk pooling.

A challenge for supply chain courses is the overlap with other courses. For example, some supply chain texts describe inventory models in some detail several, duplicating coverage in operations courses.

In addition to the lack of a core discipline, supply chain management is a field in flux. While the aim is clear—optimizing consumer value—the details will keep changing as new tactics are introduced and the limits of present tactics become more evident. The successful strategy of today may not fit the needs of tomorrow either because better strategies appear or because the benefits of a particular strategy disappear once widely copied.

Students in the Master of Science in Engineering Management (MSEM) at Milwaukee School of Engineering (MSOE) are generally graduate engineers or others with a technological interest working at the intersection of management and technology. They recognize that the success or failure of technology can seldom be determined in isolation from issues of management. Their work exposure to supply chains and logistics varies widely.

## II. The Supply Chain Course

The course that emerged at MSOE is an amalgam of the several approaches described above. Class sessions examine a number of topics, including global optimization, configuring the logistics network, inventory management and risk pooling, information flows and the bullwhip effect, supply chain integration, strategic alliances, procurement and outsourcing strategies, international issues, coordination, customer value, information technology, and decision support systems.

In addition, students are given problems aimed at introducing them to some of the quantitative models, including suboptimization, optimization algorithms, forecasting, and decision models with uncertainty. They also prepare several supply chain cases for class discussion.

Finally each student analyzes an actual supply chain. This project consists of three papers

over the course of the term: (1) description of a supply chain, (2) identification of problems and issues in the chain, and (3) recommendations to improve the supply chain. The final paper incorporates the two previous papers. Since most students are working full-time and attending class part-time, they typically analyze their employer's supply chain.

This project has several goals, including:

1. Encouraging students to apply the course content and concepts.
2. Developing student communication skills.
3. Acting as a window into current supply chain issues and practices, a particular advantage for the instructor

This report summarizes the ten supply chains analyzed in the fall 2004 course. It concludes with observations about issues and challenges that have surfaced.

### III. Examples of Projects: Fall 2004 Supply Chain

During fall 2004 ten students analyzed their company supply chains. The chart below summarizes the supply chains, a sample of the challenges identified, and some of the student recommendations.

Supply Chain	Some Challenges	Selected Recommendations
Contract electronics manufacturer making parts for an OEM	Too many days of inventory, tying up cash. Customer wants high availability.	Moving the push/pull boundary backwards and do away with forecast, making the system entirely pull and delaying differentiation.
Manufacturer of production equipment which imports and configures industrial computers.	Demand fluctuations and long lead times. Supplier reluctant to act on anticipated demand.	Better forecasting by adding likely orders into projected demand and delay differentiation by reducing configurations in stock to 5 instead of 10 using unconfigured units as safety stock.
Supplier of mechanical components for transportation equipment	Raw material lead time up to 16 weeks at one small supplier that must buy large quantities of specialized materials	Do more to develop tier 2 supplier capabilities and integrate information systems

Supply Chain	Some Challenges	Selected Recommendations
Consumable part used on production equipment from same manufacturer.	Part moves among numerous suppliers for processing steps. Large order fluctuations despite steady demand.	Reduce order quantities for material and have direct flow from one vendor to the next.
Assembly of part for vehicle, involving moving assembly.	Complex flow through several states. Problems at small suppliers can stop system.	Move from MRP system to pull system, eliminating separate warehouse, and make Tier 1 supplier responsible for product and manage tier 2 suppliers.
Bank fraud detection center: detection & investigation	Missed fraud and, when found, slow to recover losses	Strategic alliance with another company to pool existing resources, skills & expertise, and technology
Industrial control supply chain.	High costs and inventory, and bull whip effect.	Redesign for off-the shelf components and standardize & centralize component inventories.
Manufacturer of built-in home appliance with high growth, but hit hard by steel problems	Steel tariff shrank industry, creating shortages, reducing competition, decreasing quality, and extending lead times	Consolidate division orders at corporation level to increase bargaining power.
Frozen food supply chain	Obsolescence concerns over specialized food ingredient	Shorten lead time, find synergies with other products, use consumer testing to better define life cycle

#### IV. Challenges of the supply chain project

A project of this sort depends on student access to information on a supply chain. Thus implementation would be more difficult with a class of full-time students with little work experience, without, at least, developing in-depth sources of information. Even with a program designed for working students, there have been challenges:

##### A. Too many supply chains.

Large organizations usually have a multitude of supply chains. A single product can have many supply chains—too many for the student to analyze in any depth. Students do best if they focus on a single supply chain that is crucial to success and that may be causing worries.

Students should be encouraged to avoid supply chains of trivial importance such as those for ordering office supplies.

B. "We don't have a supply chain"

In a manufacturing environment, supply chains are usually easy to spot. Information and money flow in one direction and physical goods flow in the opposite. Yet for other organizations, supply chains may be less obvious. In services the product may be virtual; with utilities the product may be delivered instantaneously. In a typical class, one or two students' initial reaction to the assignment is that their employer does not have a supply chain or that those that do exist have little consequence.

Yet these organizations usually have processes that take on many of the characteristics, and many of the problems, of typical supply chains for industrial products. Requests and orders come in. Money and information flows from a customer through the organization. Customers either get what they want or don't get it, or they get it late.

For example, with deregulation of the telecommunications market old-line phone companies are losing business in part because customers get discouraged at dealing with a huge bureaucracy. The process of the customer asking for a change of service could be treated as a supply chain, with the changed service filling the role of the product.

As another example, one approach to the question of bank fraud would be to treat the bank as having two superimposed supply chains. One is for the honest customer, easily producing cash; the other for the person intent on fraud and resistant to supplying cash. The trick is being able to quickly switch from one to the other.

C. No access to a supply chain

As noted, this project works best if the student has direct access to information on a supply chain. Yet even in a program like MSOE's there are occasional students without such access. Perhaps the student never worked for an organization—often an international student prevented from working by visa restrictions. Occasionally a student's employer refuses to allow the student to analyze its supply chain, out of competitive or legal concerns.

While some students are able to analyze other supply chains, either through contacts or from publicly available information, others are stymied by that challenge. Thus it may be desirable to have alternative projects available. In the class described above one student without access to an organization developed an annotated bibliography of supply chain articles.

V. Survey of Previous Students

In preparation for this report, an e-mail was sent to students in two previous supply chain

classes, requesting comments on the supply chain picked, issues or problems found, improvements suggested, whether they made suggestions to their company and, if so, the outcome. They were promised anonymity. This message received seven responses from six former students of roughly twenty surveyed.

One student commented on the difficulty of establishing the cause of a change:

I did present this to our logistics manager for review. A fair number of the suggestions are moving forward, however, they were already being evaluated. I am not sure if my approach to justifying them was the same, however, it appears that we came to similar conclusions.

Another commented that the price tag can be a barrier even though the change might have overwhelming advantages:

[I looked at] the supply chain from when the customer calls the business office to the time service is installed [and found that] the billing system does not “talk to” the provisioning system meaning a customer can have services or features and not being billed for them (or being billed and not have them). [I suggested that the firm] create a communication link between the billing system and the switch..... However, because of the cost thus far nothing has happened. Some of the current systems need to be updated before this communication link can be established.

In some cases, the problem addressed is not sufficiently pressing to motivate change:

[I analyzed the] supply chain for acquiring information from remote business unit. Problem - access not granted for appropriate people, computer server slow to retrieve data from remote locations. [Suggestion:] have a local "mirror" of the information copied to the company's server for access. No change initiated yet. Demand is not necessarily present for this information at all times.

One student responded twice. The first response reported no progress:

[Analyzed] optimization of the Design to Fabrication Supply Chain Process. [Problems were] mechanistic org. structure vs. organic / natural org. structure; command and control management style, vertical communication, many silo's, slow, manual processes, not utilizing talent of employees directly involved in the fabrication process. [Suggested] self-directed work teams, organic org. structure, employee engagement, simultaneous engineering, reduce silo's, eliminate manual requisition of goods and services, take advantage of technology & e-procurement. [These would result in] 4 weeks (est). vs 16 weeks for new product design to fabrication, \$100K's of potential revenue, \$10K's of potential cost savings. [Make suggestions to the company?] NO !! Highly charged, Extremely political

proposal.

The second e-mail reported:

I would like to follow up with some rather good news. In the past few weeks and even as recently as yesterday, there has been some positive news on the [company] front. My department was recently transitioned due to a reorganization. We are now reporting directly to the operations management group. One of the two major personnel road blocks to the S.C.P. initiative decided to take early retirement and has left the company. The other of the two major personnel road blocks has been transferred out of the department. My department has taken on additional mfg. engineering responsibilities. The silos are going away and we are moving toward the optimization of the current supply chain. It is a natural process and is progressing in a positive manner.

One student had used the project to develop the supply chain for his planned manufacturing company. But manufacturing had not yet gotten off the ground because of continued demand for his consulting services:

.... my business (which has been operating for about 1 1/2 years now) is an HVAC/R contracting firm serving smaller commercial and high-end residential clients. My goal is to amass enough capital to eventually branch into manufacturing as well because I believe there are some useful synergies between manufacturing and contracting.

In the meantime, my supply chain consists mainly of a handful of HVAC/R wholesalers. These middlemen provide me with heating and cooling equipment as well as parts and supplies. Supposedly they provide application assistance and engineering knowledge as well, but I don't lean on them too heavily for those things - and for darn good reason: I believe many of the wholesalers in this industry have some major systemic and personnel shortcomings.

For example, three of my major suppliers routinely fill my orders incorrectly. They frequently provide incorrect items, screw up the quantities, or make billing and shipping errors. This even occurs with the suppliers that augment their sales counters with Internet-based shopping carts.

Unfortunately, one of these suppliers is the only full-line wholesaler of refrigeration equipment and supplies in the area. Another is the most competitive supplier of ductwork and sheet metal-related supplies around here. The third is

the most complete supplier of boiler and hydronic specialties in the region. The one supplier I've dealt with that really seems to have their act together is Grainger... and even if they DID carry a complete line of HVAC/R equipment and supplies, their list prices are not competitive.

Anyway, enough complaining! I enjoy what I do, and I am pleased that my business is growing. For what it's worth, the things I picked up in the MSEM program have been invaluable. I can't imagine how difficult all this would be had I not been involved with the program.

## VI. Conclusions

The project is a useful educational approach, especially for a group of students who have access to information. For the teacher, it can be a valuable reality check, as a way to monitor trends in the world of supply chain management. And occasionally, it may lead to worthwhile changes in their company's supply chains.

## Biography

BRUCE R. THOMPSON is professor in the Rader School of Business at the Milwaukee School of Engineering. He holds a Ph.D. in mechanical engineering from the University of Pennsylvania, an MBA from the University of Chicago, and a BA in physics from Amherst College. He has served as president of the Milwaukee Board of School Directors and started a software company. His research interests include using statistical models to measure effectiveness.