

UNIVERSITY OF PENNSYLVANIA
Course Syllabus

ESE 351
Logistics, Manufacturing and Transportation
Spring 2009
Department of Systems and Electrical Engineering
University of Pennsylvania

Class Time and Location:

26 January – 27 April 2009
Mondays, 6:00 to 9:00 pm
Classroom: 303 Towne Building

Instructor:

Dr. Eric C. Bruun 276 Towne Building
215-729-7840
Office Hours: 3:00 – 5:00 Monday and by appointment
E-mail: bruun@seas.upenn.edu

TA:

TO BE ANNOUNCED

Course Description:

In today's business environment, the creation of customer value is a key driver of competitive advantage. At the enterprise level, the design of the value chain is intimately linked with the management of a supply chain. An effective supply chain must be configured to deliver customer value while also maintaining crucial cost advantages. To minimize system-wide costs, firms increasingly rely on new tools for modeling the full supply chain to integrate the firm's logistics and operations. This course introduces students to the concept of value-driven supply chains and its integration with manufacturing and process operations.

The course first focuses on the history of logistical management its evolution towards modern supply chain management. The next topic is Logistical Network Design using math programming. This is followed by Inventory Management methods. Next come transportation technology, cost estimating and operations. It then briefly introduces likely impacts from higher environmental standards, technology changes and other global trends that can be expected in the future. It continues with discussion of the additional competitive pressures and reengineering possibilities generated by the rapid advances in Information Technology (IT) and Intelligent Transportation Systems (ITS) technologies. The final part of the course is an introduction to mathematical distribution routing and distribution strategies.

There will be at least one field trip, most likely to a FedEx package-processing center. If you can't attend, you will be required to visit another facility instead and answer a few questions about it.

This course started as ESE 250 but has been renumbered as ESE 351 in recognition of the fact that it has evolved into a course for *mostly upper division* undergraduates. The course introduces the complexity of the physical processes involved in the distribution of goods and products and the roles of managers and engineers in the design and operation of various systems in a supply chain. It uses probability distributions and some techniques from mathematical programming and operations research. Thus, lower division undergraduates would be at a competitive disadvantage against students who have taken courses in probability and in mathematical programming

techniques.

Prerequisites:

ESE 304 (Optimization).

Freshmen and Sophomores must have permission from the instructor.

Required Reading/Textbook:

There is no textbook. The primary source primary is a course bulk pack of readings, which may be obtained from the *SEAS Copy Center*.

Required Work and Grading Policy:

Students will be responsible for the lecture material and for the required reading listed in the Course Schedule. Reading assigned materials prior to class will make following the lectures much easier. Student work primarily will be done as individuals, except for the research topic.

Evaluation of your performance for the course grade will be based on the following:

(5%) Course Attendance Course in-class participation is encouraged.

(30%) Homework Assignments

- There will be five, unequally weighted homework assignments.
- Assignments and due dates are specified in the Course Schedule.
- Each assignment should be submitted at the beginning of class on the due date.
- A late homework should be submitted to Ms. Denice Gorte in the ESE Main Office during business hours. Contact info: 215-898-9390 gorte@seas.upenn.edu.

(15%) Research Paper and Presentation

- There will be a choice of topics. Due to time constraints for the presentations, **this must be done in pairs**. Both students will receive the same grade.
- The purpose of the paper is to demonstrate that you can apply principles of logistical analysis to complex, real-life issues. It is to further demonstrate that you can research relevant analysis performed by others, or find support for your own argument. The paper need not be long, but it should be comprehensive. For example, if a list of factors is relevant, each should be included, but coverage of each factor can be succinct. Restated, the validity and completeness of the analysis approach is more important than the detail with which each factor is discussed.
- Your findings will be presented in class in an 8-10 minute presentation.

(25%) Mid-term Exam

In-class exam. Example problems will be given for practice.

(25%) Final Exam

In-class exam. Example problems will be given for practice. At least half of the last day of class will be a review of topics to be covered on this exam.

Academic Integrity:

The issue of academic integrity is taken very seriously. Individual homework sets and assignments are to be prepared independently by each student, although consultation is allowed. Late submissions of assignments without a valid excuse (per University policy) will be penalized by 10% of the total score. Cheating on exams will not be tolerated, and students who fail to comply with the University's academic integrity policies will be subject to the maximum University penalties.

Learning Module 1: Introduction to the Supply Chain

- 1.1 Logistical Management
 - What is “logistical management”, or “logistics”?
 - Trends in logistics costs and performance
 - Objectives of logistical management
 - A typical supply chain
 - Supply chain examples
 - Processes involved in supply chains
 - Drivers of supply chain performance
- 1.2 Why Study the Supply Chain?
- 1.3 Key Issues in Logistical and Supply Chain Management (SCM)
 - Complex supply chain environments
 - Logistic and supply chain planning and decisions
 - Customer service strategy
 - Product life cycle strategy
 - Typical logistics tradeoffs
- 1.4 International Issues in the Supply Chain
 - Forces driving toward globalization
 - Regional differences and issues
- 1.5 Some Strategic Questions

Learning Module 2: Logistics Network Design

- 2.1 The Role of Major Network Design Decisions in a Supply Chain
 - Major network design decisions
 - Objective network design
 - Data for network design
- 2.2 Solution Approaches
 - Exact algorithms
 - Linear Programming: introduction
 - Linear programming: model formulation
 - Linear programming: graphical solutions
 - Linear programming: multivariable problem solutions using COTS software
- 2.3 Network Design Problems
 - Best distribution strategy

Learning Module 3: Inventory Management

- 3.1 Introduction
 - Where do we hold inventory?
 - Types of inventory
 - Why do we hold inventory?
 - Why inventory management?
 - Inventory policy
- 3.2 Inventory Models
 - Economic lot size / Economic Order Quantity (EOQ) model
 - Optimal amount with discount on purchase price
 - EOQ model with backlogging
 - Effect of nonzero lead-time
 - Variations on the EOQ model -- (r,W) Models
 - Effect of demand uncertainties (with a probabilistic demand distribution)

- Model with uniform lead-time demand and constant lead-time
- Model with normal lead-time demand and constant lead-time
- Model with both uncertain lead-time demand and uncertain lead-time
- Calculation of average inventory under (r,W) policy
- Expected annual cost of Safety Stock
- Summary

Learning Module 4: Transportation in a Supply Chain

- 4.1 Introduction
- 4.2 Modes of Transportation and their Performance Trends
 - Air
 - Ocean Ship
 - Truck
 - Rail
 - Intermodal (Truck/rail)
 - Other Modes – pipelines, barges
- 4.3 Transportation Cost Concepts
 - Different groups experience different transportation costs
 - Fixed and variable costs
 - Cost-output curve
 - More definitions of different types of costs
 - Factors affecting transportation decisions
 - Factors affecting carrier decisions
 - Factors affecting shipper decisions
- 4.4 Time Value of Money: Future Costs and Present Value
 - Centrality of Capital to Decision Making
 - Opportunity cost
 - Nominal and effective interest rates
 - Compounding for Future Value
 - Discounting for Present Value
 - Annuity Equivalents
 - Uniform series present worth factor
 - Capital Recovery Factor
 - Evaluation – a Few Alternative Techniques
- 4.5 Transportation Cost Modeling
 - Engineering unit cost models
 - Intermodal Cost-Output models
- 4.6 Tradeoffs: Transportation versus Inventory Costs
 - Total Logistics Cost (TLC) model for intermodal service
 - Choice of transportation mode
 - What will make intermodal service more appealing?
- 4.7 Future Changes in Transportation
 - Larger vehicle sizes
 - Capacity constraints
 - Urban congestion
 - Terminal facility and right-of-way congestion
 - The relationship between speed and fleet size
 - Increasing use of intermodal (truck/rail) services
 - Driving down the cost of intermodal services
 - Use of Intelligent Transportation Systems (ITS) will expand
 - Increasing demands to protect urban and natural environments

Energy consumption increases – can it go on?
Technological, operational and modal efficiency
Commodity-based research towards consumption reduction
Increasing conflicts over public policy- cost and planning implications

Learning Module 5: Reengineering the Supply Chain Using IT and ITS

Definitions

Information Technology (IT) and software
Intelligent Transportation Systems (ITS) and hardware

Proving the impacts of fast changing technologies

Simulation – studying the Bullwhip Effect
Complexity of doing cost versus benefit analysis
Specialized skills favor larger firms
Solutions for the smaller firms

Key IT functions -- Case studies

Paperwork and documentation
Tracking and ordering
Enabler of Third-party Logistics (3PL)

From Software (IT) to Hardware (ITS)

Benefits of RFID
Distribution routing and scheduling
Bringing the benefits of ITS to the Littlest Guy

Highly complex IT and ITS environments

Reengineering the railroad
“Lean Transportation”

Learning Module 6: Distribution Strategy

6.1 Shipping Strategies

6.2 Routing and Scheduling in Transportation

Traveling Salesperson Problem (TSP)
Simple heuristics for TSP
Local search heuristics for TSP

Basic Vehicle Routing Models

Capacitated Vehicle Routing Problems (CRVP)
Vehicle Routing Problem with Time Windows (VRPTW)

ESE 351

Course Schedule

Spring 2009

Session	Date	Topics	Subtopics	Reading	Homework
1	1/19	MLK Day (no class)		1-9	
	1/26	LM 1: Introduction to the Supply Chain	- Role and Importance of Logistics in Industry		HW 1 Assigned
2	2/2	LM 2: Logistics Network Design	- Major Design Decisions - Solution Approaches - Design Problems	10	HW 1 Due HW 2 Assigned
3	2/9	LM 3: Inventory Management	- Introduction - Basic Inventory Models	11,12	
4	2/16	LM 3: Inventory Management	- Variations on Inventory Models	13	HW 2 Due HW 3 Assigned
5	2/23	LM 3: Inventory Management	- Probabilistic Inventory Models <i>Industry Guest Speaker</i>	14-17	
6	3/2	LM 4: Transportation in a Supply Chain Mid-term Exam	-Role of Transportation in a Supply Chain	18-22	HW 3 Due Research Paper Assigned
7	3/9	Spring Break			
	3/16	LM 4: Transportation in a Supply Chain	-Modes and Performance -Transport Cost Concepts -Morlok's Intermodal Unit Cost Model	Slides 23-24 25	
8	3/23	LM 4: Transportation in a Supply Chain	- Morlok's Intermodal Total Logistics Cost Model - Future Changes	Slides 26-33	HW 4 Assigned
9	3/30	LM 5: Reengineering the Supply Chain using IT and ITS	- Evaluation methods - IT and software - ITS and sensors	34-35 36-40 41-49	
10	4/6	Paper Presentations I			
11	4/13	Paper Presentations II LM 6: Distribution Strategy	- Routing and Scheduling	50-51	HW 4 Due HW 5 Assigned
12	4/20	LM 6: Distribution Strategy	- Routing and Scheduling		
13	4/27	LM 6: Distribution Strategy	- <i>Guest Speaker</i> -Review		HW 5 Due
	TBD	Final Exam			

Learning Module 1: Introduction to the Supply Chain

1. Bowersox, Donald J., David J. Closs and Omar K. Helderich. *Logistical Management*. McGraw Hill, 1996, Chapter 1 (Logistical Management)
2. Bowersox, Donald J., David J. Closs and Omar K. Helderich. *Logistical Management*. McGraw Hill, 1996, Chapter 2 (Logistical Strategy and Decision)
3. Bowersox, Donald J., David J. Closs and Omar K. Helderich. *Logistical Management*. McGraw Hill, 1996, Chapter 3 (Customer Service and Marketing Strategy)
4. Anderson, David L, Frank F. Britt and Donovan J., Favre. "The Seven Principles of Supply Chain Management," *Supply Chain Management Review*, Spring 1997, pp.31-41. Also available at: www.manufacturing.net/scm/.
5. Holmes, Jeff. "5 Hot Spots of Supply Chain Management," *Inbound Logistics*, October 1997, pp 40-44.
6. Davis, Tom. "Effective Supply Chain Management," *Sloan Management Review*, Summer 1993, pp 35-46.
7. Gill, Penny and Jules Abend. "Wal-Mart: The Supply Chain Heavyweight Champ," *Supply Chain Management Review*, Spring 1997, pp.12-20.
8. Aron, Laurie Joan. "Speeding Cycle Times – The Mattress Industry Wakes Up," *Inbound Logistics*, January 1997, pp 29-38.
9. Richardson, Helen. "Cross-docking -- moving products directly from inbound to outbound – can be a strategic weapon in a successful supply chain design," *Inbound Logistics*, April 2004.

Learning Module 2: Logistics Network Design

10. Winston, Wayne L. *Operations Research: Applications and Algorithms*, 3rd Edition, Belmont: Duxbury Press, 1994. Chapter 3 (Introduction to Linear Programming), pp.49-73, 94-96, 99-103, 111-112.

Learning Module 3: Inventory Management

11. Ballou, Ronald H. *Business Logistics Management*, Chapter 12 (Inventory Policy Decisions), pp. 403-455.
12. Eppen, Gary D. Charles Schmidt and Floyd J. Gould. *Quantitative Concepts for Management: Decision Making without Algorithms*. Prentice Hall College Division, 3rd Edition, 1988. Chapter 15 (Inventory Control with Known Demand), pp. 555-583,588-589.
13. Eppen, Gary D. Charles Schmidt and Floyd J. Gould. *Quantitative Concepts for Management: Decision Making without Algorithms*. Prentice Hall College Division, 3rd Edition, 1988. Chapter 16 (Inventory Models with Probabilistic Demand), pp. 590-605.
14. Hoffman, William. "Dell Beats the Clock," *Traffic World*, October 24 2005, pp.10-12.
15. McCrea, Bridget. "Playing the Waiting Game," *Logistics Management*, April 2005, pp.69-72.
16. Lacefield, Susan K. "Shippers See Inventory Rising," *Logistics Management*, Oct.2005, pp.59-64.
17. Cooke, James A. "Sole Sourcing," *Logistics Management*, October 2004, pp.33-35.

Learning Module 4: Transportation in a Supply Chain

18. Lahsene J. Susie, Tony Furst and Paul Bingham, 2008. "Introduction, Policy Direction and Megatrends," *Freight Demand Modeling*, Conference Proceedings 40, TRB, Washington, DC, pp 3-10.
19. Thomas, Daniel and Roseann O’Laughlin 2007, "How a TV Made in China Affects Life in Chicago," *Planning*, May, pp.26-29.
20. U.S. Federal Highway Administration data tables 2007
 - a. Table 2-2 Value of Shipment by Mode: 2002, 2006, 2035
 - b. Table 3-1 Miles of Infrastructure by Transportation Mode: 1980-2005
 - c. Table 3-2 Number of U.S. Vehicles, Vessels, and other Conveyances: 1908-2005

- d. Table 5-7M Fuel Consumption by Transportation Mode: 1980-2005
21. LaLonde, Bernard J. "Intermodal Freight Requirements," TR News 192, September-October 1997, pp.13-17.
 22. Quinn, John Paul 2005 "Shouldn't you be transloading?" Logistics Management. May 2005, pp.41-46.
 23. DeGarmo, E. Paul, et.al. *Engineering Economy*, 8th Edition, Macmillan, 1989. Chapter 3, (Principles of Money-Time Relationships), pp.62-96 and 108-112.
 24. Morlok, Edward K. *Introduction to Transportation Engineering and Planning*, McGraw Hill, 1978, Chapter 9 (Transport Costs), pp.345-354,369-381.
 25. Morlok, Edward K. *Intermodal Containerized Service Cost-Output Model*, University of Pennsylvania Working Paper.
 26. Morlok, Edward K. and M. John Vickerman. 1997. "Opportunities for Furthering Intermodal Freight Transport in the United States," European Commission.
 27. _____, "Modalohr Plans Europe-wide Expansion," Railway Gazette International, Nov.2006, pp.724-726.
 28. Vanek, Francis M. and Edward K. Morlok. "Improving the Energy Efficiency of Freight in the United States through Commodity Based Analysis: Justification and Implementation," Transportation Research Part D, 5:1, 2000, pp.11-29.
 29. Bradshear, Keith 2007. "Trucks Power China's Economy, at a Suffocating Cost," New York Times, Dec 8.
 30. Carey, Bill. "Wal-Mart's Trucking Mandate," Traffic World, November 14 2005, pp.57-59.
 31. Cox, Stan. "Boatloads of Trouble: How We Are Importing Our Way to Destruction," September 5, 2008. Accessed 9 January 2009 at <http://www.alternet.org/story/97496>.
 32. Gallagher, John. "Rerouting Rail Costs," Traffic World, February 28 2005, p31.
 33. Rohter, Larry. "Pedestrians and Drivers Beware: Motoboys Are in a Hurry," New York Times, November 30, 2004.

Learning Module 5: Reengineering the Supply Chain Using IT and ITS

34. Turnquist, Mark 2008. "Characteristics of Effective Freight Models," Conference Proceedings 40, TRB, Washington, DC, pp 11-16.
35. Zorner G. and D. Nieu Kirk 2005. "Evaluation Methodologies for Urban Logistics Schemes," Chapter 7 in *Systems and Advanced Solutions for eLogistics in the Sustainable City*, ENEA (Italian National Agency for New Technologies, Energy and the Environment).
36. Opperman, Grant. "The Five Kinds of Inventory: Invisible to Customers, Crucial to Profits, Crucial to the Bottom Line," Inbound Logistics, July 2005.
37. Machuca Jose A.D and Rafael P. Barajas. "The Impact of Electronic Data Interchange on Reducing Bullwhip Effect and Supply Chain Inventory Costs," Transportation Research Part E, 40, 2004, pp.209-228.
38. _____, "Doing It Their Way," Traffic World, November 21, 2005, p.16.
39. Kerr, John. "Yamaha Tunes Up its Import Operations," Logistics Management, November 2004, pp. 51, 53, 54, 56.
40. Carr, David L. "Pilot Air Freight: the Sky's the Limit," Baseline, October 1, 2004.
41. Napolitano, Maria Ida. "Get Ready for RFID," Logistics Management, August 2005, pp.83-88.
42. Rehring, Emily. "Wal-Mart Tags RFID Benefits," Traffic World, October 31, 2005, p.10.
43. Hoffman, William. "Shippers Still Reject RFID," Traffic World, October 31, 2005, p.12.
44. Shanahan, John. "Ports Go High Tech," Logistics Management, Ports Supplement, October 2004, pp.S73-S77.
45. _____, "Oiling Delivery Schedules," ITS International, Sept/Oct 2004, p.44.
46. Global Intermodal Freight Transport System (GIFTS), brochures (2 pages). <http://gifts.newapplication.it>.
47. O'Reilly, Joseph. "Track to the Future," Inbound Logistics, November 2005.

48. Carey, Nick. Railroads and High-tech Logistics,” 2006. InformationWeek, March 27, Reuters. <http://www.informationweek.com/story/showArticle.jhtml?articleID=184400022> (2 pages)
49. Taylor, Linda and Robert Martichenko, “Lean Transportation – Fact or Fiction?” LeanCor/FedEx joint brochure.

Learning Module 6: Distribution Strategy

50. Winston, Wayne I. and Munirpallam Venkataramanan. “Solving Combinatorial Optimization Problems by the Branch-and-Bound Method”, *Operations Research, Volume 1*, 4th Edition, Thompson, 2003, pp.527-537.
51. Lecture notes on routing and distribution algorithms and worked examples (13 pages).