

GENERAL INFORMATION

Objectives: The first objective is to introduce modeling, optimization and simulation, as it applies to the study and analysis of manufacturing systems for decision support. The introduction of optimization models and algorithms provide a framework to think about a wide range of issues that arise in manufacturing systems. Probabilistic simulation methods are also a powerful tool for the study, analysis and design of manufacturing systems. The second objective is to expose students to a wide range of applications for these methods and models, and to integrate this material with their introduction to operations management. The third objective is to ‘refresh’ the student’s analytic thinking and background in anticipation of the rest of the LFM curriculum.

Topics: The topics to be covered include a subset of the following: linear programming, sensitivity analysis for linear programs, network flow problems, introduction to integer and non-linear programming, Lagrange multipliers, simulation, and computer applications. Examples are drawn from manufacturing processes and manufacturing systems.

Text (B): Optimization: A Spreadsheet-Based Approach, by Kenneth R. Baker, Duxbury Press, 2003.

The textbook is not yet published but the author and publisher have granted us permission to use the manuscript, based on our commitment to provide some feedback. As the name suggests, the textbook will cover optimization topics. For the simulation component of the class, we will distribute readings and notes.

We also mention some other very useful books that we have used in prior years: Introduction to Mathematical Programming, by W. L. Winston, PWS Kent, 1995, which does a great job on algorithms and model formulations; Practical Management Science, by W. L. Winston and S. C. Albright, Duxbury, second edition, 2001, which is excellent in describing a wide range of applications as well as illustrating spreadsheet modeling; The Science of Decision Making, by E. V. Denardo, Wiley 2002, which was used last year and provides a problem-based approach both to optimization as well as probability applications; and Data, Models, and Decisions: The Fundamentals of Management Science, by D. Bertsimas and R. Freund, South-Western College Publishing, 2000, which was written for the Sloan MBA core class in Data, Models and Decisions. Indeed, we will use some of the cases and other material from this book.

Instructors

S. C. Graves
J. Gallien

Week	Date	Topic	Reading
1	June 9	Introduction and overview	B: 1 & 2.1 – 2.19
	June 10	LP – introduction, formulations and geometry	B: appendix 2A
	June 11	LP - example	Red Brand case
2	June 16	Networks – introduction	B: 3; Polaroid example
	June 17	LP – example	Filatoi Riuniti
3	June 23	LP – example: Tony Palumbo, Ford	Ford Case
	June 24	LP – solution methods and sensitivity analysis	B: 5
		MID TERM – DUE JUNE 30	
4	June 30	Integer programming – formulations	B: 6.1 – 6.27
	July 1	Integer programming – algorithms	B: 6.28 – 6.33
	July 2	Integer programming – heuristics	B: 8 (skim)
5	July 7	Debriefing of Inventory Simulation (with 15.761)	
	July 8	Stochastic LP	B:2.20 – 2.26 Red Brand (B)
	July 9	Optimization in practice: John Bean, Intel	
6	July 15	Simulation: Introduction and Examples	Simulation Module Outline
	July 16	Monte-Carlo Theory and Examples	Prob/Stat Review 1
7	July 21	Ontario Gateway Case Discussion	Ontario Gateway
	July 22	Discrete-Event Framework and Examples	Introduction to Simul8
	July 23	Theory of constraints (joint session with 15.761)	
8	July 28	Discrete Event Case Discussion	Discrete Event Case
	July 29	Simulation Experiments: Design and Interpretation	Prob/Stat Review 2
	July 30	Advanced Modeling, Simulation-Based Optimization	
9	Aug 4	Non linear programming - formulations	B: 7
	Aug 5	NLP – examples and algorithms	Apollo Paper
10	Aug 11	Project presentations	
	Aug 12	Project presentations	
	Aug 13	Project presentations and class summary	

Week	Assignment	Due Date
1	Prepare Red Brand	June 11
2	Prepare Filatoi Riuniti	June 17
	Group problem set 1: LP	June 19
3	Prepare Ford case	June 23
	Group problem set 2: LP	June 26
4	Mid term due	June 30
	Prepare TSP challenge	July 2
	Group problem set 3: LP & Networks	July 3
5	Prepare Red Brand (b)	July 8
	Group problem set 4: ILP	July 10
	Group meeting with instructor	July 9 - 11
6	Prepare questions 1 to 3 in ClearPicture	July 15
	Book report due	July 17
	Group problem set 5: Simulation I	July 17
7	Prepare questions for Ontario Gateway	July 21
	Implement ClearPictures in Simul8	July 22
	Group project proposal	July 23
	Group problem set 6: Simulation II	July 24
8	Prepare questions for Discrete Event Case	July 28
	Group problem set 7: Simulation III	July 31
9	Prepare Apollo	Aug. 5
10	Group projects	Aug. 11,12,13
	Group problem set 8: NLP	Aug. 14

Course Requirements

Grading will be based on performance on assignments, exams, and class participation.

Individual:	Midterm (25%)	Book Report (10%)
Group:	Problem Sets (25%)	Group Project (30%)
Individual/Group	Case Preparations, Class Participation, & Feedback on Text (10%)	

Due July 17

Individual Assignment: "Book Report "

Find an article or set of articles that describe an application of linear or integer programming, or some other form of optimization. [A good source for management applications is a journal titled **INTERFACES** that you can find in Dewey or at <http://silmaril.smeal.psu.edu/interfaces/>; if you have a particular interest, we may be able to direct you to specific articles or places to look, or use the Search capabilities on the **INTERFACES** home page.] Summarize briefly and prepare a critique and evaluation of the paper(s). Your report (exclusive of appendix and attachments) should be no longer than 3 single-spaced, typed pages, normal fonts, normal margins. The desired length is two pages.

You should assume the role of a member of a corporate operations research staff, who has identified an optimization application at your prime competitor. Your report should be addressed to your manager, and its objective is to inform of the application and to explore its potential for your firm.

Your report ...

a. Should be written as a memorandum in terms and language that is appropriate for your manager's level of familiarity with the subject matter, and for his/her attention span. In particular, the manager is not an expert in math programming or mathematics, and indeed, may possess both disdain for the technical details as well as some skepticism about the applicability of this methodology to his/her operational context.

You may want to include a technical appendix with model formulations and exhibits (for the manager's staff). To help us in reviewing your memorandum, please also submit a copy of the original article(s).

b. Should describe the problem context and model construction, the implementation and application, as appropriate.

c. Should critique the model and its application. For instance, is the model a realistic representation of the problem? Does the data exist to parameterize the model? How hard will it be to implement the model? Is the model suitable for sensitivity analysis, and for "what if" analyses? What are the alternatives to the model?

d. Before submitting your report, please take some time within your groups, and discuss and share each of your reports.

8/11 - 8/13 Group Project: Application of Optimization

Each student should identify a potential or actual linear, non-linear or integer programming application based on their prior work experience, or from some other personal experience. You should then develop the formulation, and present the application and formulation to your group. Your presentation should review the decision-making context; go over the model and how it is or would be formulated; and discuss relevant issues associated with implementing this model for decision support. For instance, how would the parameters be determined? What type of sensitivity analysis or "what if's" would be valuable to do? What resistance would you anticipate to this approach and how might you overcome the resistance? This should be done during the week of July 7 - 11.

After the individual presentations, each group should schedule a 30-minute meeting with S. Graves to review their project status and plans, ideally between July 9 and July 11.

Each group should select one of the examples, or possibly a synthesis of more than one, to share with the rest of class. The group should submit on July 23 a short proposal (2 pages) that briefly describes the problem and gives a *mathematical formulation* of the model. The mathematical formulations should clearly define the decision variables, the constraints, and the objective function. We will use the proposal to give feedback on developing your final presentation and report.

The group should then prepare a presentation that describes the application. The presentations are scheduled in class during the week of August 11; each group will have a maximum of 20 minutes. Each presentation should present and describe the decision context; describe the model and its formulation; and finally discuss briefly issues associated with implementing the model for decision support. If the problem is not too large, you might run an illustrative example, using an appropriate solver.

Each group should also submit a final memorandum (3 - 5 pages as a target, possibly with a technical appendix) to accompany the presentation and to hand in.

Grading will be based on the overall quality of the work, both in oral presentations and in the written report – how interesting and relevant is the problem chosen? How well did the group do in modeling the problem? How well did the group do in exploring how to parameterize the model? Did the group do any computational experiments? Was anything learned from experimenting with the model? Did the group make a realistic appraisal of the applicability of the model?