Stevens Institute of Technology
Howe School of Technology Management
Syllabus
BIA 650
Process Optimization and Analytics

<table>
<thead>
<tr>
<th>Spring 2013</th>
<th>Thursday 6:15 pm</th>
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<tbody>
<tr>
<td><strong>Edward A. Stohr</strong></td>
<td>Office Hours:</td>
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<tr>
<td>Babbio 428</td>
<td>Wed 5:00 and 9:00 pm</td>
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<tr>
<td>Tel: 201-216-8915</td>
<td>Also by appointment</td>
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<tr>
<td>Fax: 201-216-5385</td>
<td>Course Web Address:</td>
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<tr>
<td><a href="mailto:estohr@stevens.edu">estohr@stevens.edu</a></td>
<td><a href="http://elearn.stevens.edu">http://elearn.stevens.edu</a></td>
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Overview
This course covers basic concepts in optimization and heuristic search with an emphasis on process improvement and optimization. This course emphasizes the application of mathematical optimization models over the underlying mathematics of their algorithms. While the skills developed in this course can be applied to a very broad range of business problems, the practice examples and student exercises will focus on the following areas: healthcare, logistics and supply chain optimization, capital budgeting, asset management, portfolio analysis. Most of the student exercises will involve the use of Microsoft Excel’s “Solver” add-on package for mathematical optimization.

Prerequisites: Admission requirements for the BI&A program.

Course Objectives
This course develops students’ ability to analyze a real-world problem and develop a mathematical formulation that is amenable to solution using techniques of operations research such as linear and integer programming, simulation and genetic algorithms. The ability to translate practical problems into representations that are amenable to analysis requires critical thinking and imagination and is an essential skill for analysts wishing to develop creative solutions in practice. While the emphasis is on modeling rather than mathematical algorithms, the analytical techniques learned in this course are essential building blocks for risk analysis, social network analysis and machine learning techniques such as neural networks. A final module of the course covers the analysis of workflow logs and introduces students to process data mining. This course is therefore an essential foundation for the study of other subject areas in the BI&A curriculum.

List of Course Outcomes:
After taking this course, students will be able to:

- Understand the optimization and search techniques underlying machine learning techniques such as neural networks and social network analysis.
• Develop and solve optimization models in a number of domains such as supply chain modeling, production, asset management, capital budgeting and financial portfolio analysis.
• Use genetic algorithm techniques to solve complex problems.
• Develop simulation models and design simulation experiments.
• Perform process mining on workflow logs.

**Pedagogy**

The course will employ lectures, class discussion, in-class individual assignments, individual homeworks and a team project. In the team project, students will analyze a real industrial problem, formulate a model, collect data, solve the problem using one of the techniques discussed in class, and interpret the solution for management.

**Readings**

**Required Text**


**Supplementary Texts**


**Articles**


Simulation Models (Course Notes).

Process Mining (Course Notes).
   ProM - process mining toolkit.
   Fluxicon: http://www.fluxicon.com学术/  

Assignments

**INDIVIDUAL HOMEWORKS (30%)**
To help reinforce the material covered in the lectures, a homework exercise will be assigned each week, which will involve formulating and solving a small but practically-relevant homework problem from the text book. Oral presentations of homeworks are part of the course.

*Format of Homeworks.* Please avoid pdf submissions to the extent possible. The Excel assignments will be graded on their clarity as well as numerical accuracy. Each week’s Excel assignments should be included in ONE Excel file; the file name should include “HWK week #”, your last name, the textbook chapter and number of the question(s) and the date of submission in that order (e.g., “HWK #2 Ch3 Qs 4, 6 and 8, March 23 2013”). Each worksheet in the file should have a clear heading and a named tab.

**MIDTERM EXAMINATION (30%)**
This take-home examination will take place shortly after the mid-point of the course. Its purpose is to consolidate the learning on optimization techniques. It will involve the formulation and solution of a number of small but typical problems from business practice.

**TEAM PROJECT REPORT & PRESENTATION (30%)**
The class practical will involve solving a real industry problem presented in the form of a case study. Alternatively, the team can take a real industry problem collect data and develop a recommended solution. One of the deliverables for this exercise is a team oral presentation, which should last thirty (30) minutes and will be worth 5% of your final grade.

**CLASS PARTICIPATION (10%)**
To enhance the learning experience, all students are expected to participate in class discussion and the in-class team exercises. Attendance in class sessions is an important component of this grade.

All assignments are due as noted below. In fairness to others, late work will be penalized 10% per week overdue.
Ethical Conduct

The following statement is printed in the Stevens Graduate Catalog and applies to all students taking Stevens courses, on and off campus.

“Cheating during in-class tests or take-home examinations or homework is, of course, illegal and immoral. A Graduate Academic Evaluation Board exists to investigate academic improprieties, conduct hearings, and determine any necessary actions. The term ‘academic impropriety’ is meant to include, but is not limited to, cheating on homework, during in-class or take home examinations and plagiarism.“

Consequences of academic impropriety are severe, ranging from receiving an “F” in a course, to a warning from the Dean of the Graduate School, which becomes a part of the permanent student record, to expulsion.


Consistent with the above statements, all homework exercises, tests and exams that are designated as individual assignments MUST contain the following signed statement before they can be accepted for grading.

____________________________________________________________________

I pledge on my honor that I have not given or received any unauthorized assistance on this assignment/examination. I further pledge that I have not copied any material from a book, article, the Internet or any other source except where I have expressly cited the source.

Signature _________________________ Date: _____________

Please note that assignments in this class may be submitted to www.turnitin.com, a web-based anti-plagiarism system, for an evaluation of their originality.

Course/Teacher Evaluation

Continuous improvement can only occur with feedback based on comprehensive and appropriate surveys. Your feedback is an important contributor to decisions to modify course content/pedagogy which is why we strive for 100% class participation in the survey.

All course teacher evaluations are conducted on-line. You will receive an e-mail one week prior to the end of the course informing you that the survey site (https://www.stevens.edu/assess) is open along with instructions for accessing the site. Login using your Campus Pipeline (email) 'CPIPE' username and password. This is the same username and password you use for WebCT. Simply click on the course that you wish to evaluate and enter the information. All responses are strictly anonymous. We especially encourage you to clarify your position on any of the questions and give explicit feedbacks on your overall evaluations in the section at the end of
the formal survey which allows for written comments. We ask that you submit your survey prior to the last class.

### PRELIMINARY COURSE SCHEDULE

Note: Homework exercises are subject to change

<table>
<thead>
<tr>
<th>1. Introduction to Modeling</th>
<th>Thur, January 17</th>
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<tr>
<td><strong>Readings</strong>: W&amp;A Text: Chapters 1 &amp; 2</td>
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<tr>
<td><strong>HWK 1</strong>: W&amp;A Ch 2 Qs 6 &amp; 20 ; “Data manipulation in Excel”</td>
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<tr>
<th>2. Introduction to Linear Programming</th>
<th>Thur, January 24</th>
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<td><strong>Readings</strong>: W&amp;A Text: Chapter 3</td>
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<tr>
<td><strong>HWK 2</strong>: W&amp;A Ch. 3: #24 p.122 production problem, #30 p 123 – Market research</td>
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<tr>
<th>3. The Simplex Technique; Ethics Quiz</th>
<th>Thur, January 31</th>
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<td>Ethics quiz discussion; Simplex Algorithm; Simple inventory optimization problem.</td>
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<tr>
<th>4. Linear Programming Applications</th>
<th>Thur, February 6</th>
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<tr>
<td>Production scheduling. Bond portfolio optimization. Extracting additional meaning from LP models: shadow prices, sensitivity analysis.</td>
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<tr>
<td><strong>Readings</strong>: W&amp;A Text: Chapter 4</td>
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<tr>
<td><strong>HWK 3</strong>: W&amp;A Ch 4 #3 p142 Gen Threads #13 p160 Sure Step</td>
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<th>5. Network Models</th>
<th>Thur, February 14</th>
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<td>The classic transportation model. Supply chain modeling. Graph theory – the shortest path model.</td>
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<td><strong>Readings</strong>: W&amp;A Text: Chapter 5</td>
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<tr>
<td><strong>HWK 4</strong>: W&amp;A Ch. 5: # 10 – machine -job, 19 – transport; # 64 – shortest route</td>
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<th>6. Integer Programming</th>
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<tr>
<td>Approaches to optimization with integer variables. Either-or constraints. Examples: capital budgeting, spatial analysis: location models</td>
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<tr>
<td><strong>HWK 5</strong>: W&amp;A Ch. 6: #1 cap budgeting; Term project proposal</td>
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<tr>
<th>7. Integer Programming Solution Approaches</th>
<th>Thur, February 28</th>
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<td>The branch and bound approach; heuristic approaches</td>
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<tr>
<td><strong>Readings</strong>: W&amp;A Ch. 6; Course Notes: Heuristic approaches</td>
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## HWK 6: W&A Ch. 6:  #11 p.308 Great threads, #25, p326 set covering

### 8. Nonlinear Optimization  
**Thur, March 7**


*HWK 7:* W&A Ch 7 #36 Portfolio optimization

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#### No Class – Spring Break –  
**Thur, March 14**

### 9. Non-linear optimization Solution Approaches  
**Thur, March 21**

Quadratic programming; Method of steepest ascent.

*Readings:* W&A Text: Ch 7 #50 – optimal pricing

*HWK 8:* Individual DEA Research Proposal

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### 10. Genetic Algorithms  
**Thur, March 28**

Conditions under which standard optimization techniques fail. The evolutionary approach.

*Readings:* W&A Text: Ch. 8; Dhar and Stein: Ch. 6

### 11. Multi-objective Function Decision Making  
**Thur, April 4**

Goal programming; pareto optimality and trade-off curves; the Analytic Hierarchy Process (AHP)


*HWK 9:* W&A Ch. 8: # 15 – classification using genetic algorithm

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### 12. Uncertainty: Simulation Modeling/Process Mapping  
**Thur, April 11**

Process mapping. System modeling; discrete event simulation; random numbers; generating variates from discrete and discontinuous distributions; Monte Carlo simulation; business process design example.

*Readings:* Course Notes: W&A Chapter 11

*HWK 10:* W&A Ch. 9: #26 Multiple objectives (AHP). Midterm due.

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### 13. Introduction to Process Mining  
**Thur, April 18**

Concept and content of workflow logs; discovering the underlying process; discovering exceptions. Process Mining (Course Notes).

ProM - process mining toolkit.

Fluxicon: http://www.fluxicon.com/academic/

*Readings:* Course Notes: Process Mining, The “Process Mining Manifesto.”

*HWK 11:* (Work on team project)

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### 14. Student Presentations of Term Projects  
**Thur, April 25**

Each team presents their term project: written report plus oral presentation