IME 3300: Simulation Modeling and Analysis
Spring 2009; MWF 10:30–11:20am; Room CEAS C0227

2005-2006 Catalog Description: Use of computer modeling and discrete event simulation methodology with emphasis on designing and analyzing manufacturing and service systems. Commercial simulation packages will be used. Prerequisite: IME 206 & IME 262.

Textbook:

1. Simulation using ProModel; 2nd edition; Harrell, Ghosh and Bowden; McGraw Hill; 2004.
2. Notes on Simulation Modeling using ProModel; Houshyar.

Course Coordinator and Instructor:

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Office Hours: Wed: 1:00 pm – 4:00 pm

References:

1. System Improvement Using Simulation; Harrell, Bateman, Cogg and Mott; ProModel Corp; 1997
2. ProModel Student Version, User's Guide, and Reference Guide.
3. Simulation Modeling & Analysis; Law and Kelton; 2nd Edition, 2000.
4. Simulation with Arena, Kelton, Sadowski, and Sadowski, McGraw Hill; 1998
5. Introduction to Simulation Using SIMAN, Pegden, Shannon and Sadowski, 2nd Edition, 1995.

Course Learning Objectives[1]: By the end of semester the student should be:

1. Apply knowledge of mathematics and engineering to discrete-event simulation problems (a)
2. Numerically analyze and solve all discrete-event simulation problems (b, c)
3. Report and present individual and group results (e, g)

Performance Criteria (Learning Outcomes)[2]: The student should be able to:

Course Objective 1

a) Provide accurate description to the discrete-event simulation questions.
b) Determine the appropriate solution technique to solve real-world simulation problems.

Course Objective 2

a) Provide accurate description to the random number generation, input modeling, output analysis, and comparison of alternative system designs questions.
b) Determine the appropriate simulation model to solve any real-world problems.

Course Objective 3

a) Participate in teamwork, class discussion, case studies, and submit written and oral reports to the class.

1) Letters in parentheses refer to ABET EAC Criterion 3, categories a-k.

Professional Component: This course addresses ABET Criterion 4 (EAC) requirements for professional component as follows:

a) College-level math, basic science:	0 %
b) Engineering topics (engineering science and design):	3 credits or 100%
c) General education:	0%

Relationship to IME Program Educational Objectives/Student Learning Outcomes:
This course provides significant support for the following IME program outcomes:

1. Generate an understanding of concepts in engineering or engineering technology (b, c, d, e)
2. To integrate state-of-the-art knowledge and practice into the curricula (a, c, d)
3. To prepare students to immediately enter professional careers in engineering or engineering technology (a, b)

Evaluation:

1st exam	20 pts
2nd exam	20
Term-project	35
Portfolio	5
Quiz, Case Studies, Homework and Active Participation	20
Total Score	*100 pts*

The tests will be graded on a numerical scale. At the end of the term, the grades will be added up for all the items and then converted to a letter scale.

93 - 100	A	89 - 92	BA
83 - 88	B	79 - 82	CB
73 - 78	C	69 - 72	DC
60 - 68	D	Below 60	E

Computer Usage:

Extensive use of computer software is required throughout this course. Students are encouraged to solve problems on statistical analysis manually, and then reconfirm their results using computer.

Academic Honesty Policy:

The Faculty Senate's Professional Concerns Committee recommends all instructors include the following paragraph in each syllabus they prepare.

"You are responsible for making yourself aware of and understanding the policies and procedures in the Undergraduate and Graduate Catalogs that pertain to Academic Honesty. These policies include cheating, fabrication, falsification and forgery, multiple submission, plagiarism, complicity and computer misuse. [The policies can be found at http://catalog.wmich.edu under Academic Policies, Student Rights and Responsibilities.] If there is reason to believe you have been involved in academic dishonesty, you will be referred to the Office of Student Conduct. You will be given the opportunity to review the charge(s). If you believe you are not responsible, you will have the opportunity for a hearing. You should consult with your instructor if you are uncertain about an issue of academic honesty prior to the submission of an assignment or test."

In addition, instructors are encouraged to direct students to http://osc.wmich.edu and www.wmich.edu/registrar to access the Code of Honor and general academic policies on such issues as diversity, religious observance, student disabilities, etc.

Attendance Policy:

Attendance is mandatory. The student will receive a score of zero for any assessment item not submitted because of absence. This includes the quizzes and the exams. Extreme circumstances will be considered on an individual basis, however, arrangements must be made prior to the due date, and supporting documentation is necessary.

Portfolio:

Each individual is expected to create a portfolio that contains all the graded assignments, quiz, tests, and submit it along with a disk containing all the created files.

Quiz/Exam/Cheat Sheet (!)

In some sessions, we may have a 20-30 minutes quiz on the previously covered subject matters. The same rules of test apply to quizzes as well. The day and time of the tests is listed in the schedule. During the exam you are allowed to use a calculator. You will have two hours to complete the final. You are allowed to use one side of an 8x11" paper to write in complex formulas.

Notes:

1. Some notes on the lecturers is available at my web site. The address of the site is: http://homepages.wmich.edu/~houshyar/. You may need a password to get into the "Teaching Material" Section of the site. If so, you will get your password in the first day of class.
2. Using your password, you can visit the site to download notes, samples of quiz, exams, etc.
3. The lectures will focus on the main topics, but students are responsible for reading the whole chapter.
4. The style of teaching is based on the notion of *Critical Thinking*. As such, students are expected to review the chapter prior to coming to class. In doing so, the class time will be dedicated to answering questions and solving problems. Rather than an elaborate lecture plan, a brief review of the main topics will be conducted in class, but you should study them in detail, and ask questions, if necessary.

Requirements for Homework Problems:

1. All homework assignments are due at the beginning of class on the date of submission.
2. Computer programs must be well documented. The program should be submitted with necessary output. The output format will be discussed in class for each assignment.
3. Each computer assignment must include a process flow chart.
4. A section titled "Analysis of Output & Important Conclusions" should be included with each completed assignment.

Term-Project: Group Projects using ProModel

Students are teamed-up in-groups of two. Each team is expected to identify a real-world manufacturing/ industrial/financial/service problem to be simulated. The grade is based on the complexity of the problem, the elegance of the simulation model, and the quality of the presentation.

Each team is free to choose any problem, but they are expected to adhere to this guideline. The simulation problem should include:

1. A minimum of ten Locations with at least ten Processing Stations
2. A minimum of five Random processing times
3. A minimum of five Resources
4. A minimum of three Attributes
5. A minimum of three locations and resources Downtimes
6. Shift assignments to locations and resources
7. Path network for the material handlers, resources and entity movements
8. Counters that show the number of processed part in each station, throughput, and a summary of major statistics.
9. Appropriate use of Macros, Subroutines, Table Functions, user Distributions, Arrival Cycles, ...

Each team should submit five reports during the course of the semester along with a disk-copy of the simulation model and supporting material. The proposed due dates are selected so that you will not be overwhelmed with submitting a comprehensive report for the whole project at the end of semester.

The nature of the reports and the corresponding due dates for these reports are as follows:

1. Report 1: Proposal/Problem Definition. Due Jan 21
2. Report 2: Data Collection/Processing Report. Due Feb 16
3. Report 3: Building the Simulation Model. Due March 9
4. Report 4: Validation and verification Report. Due March 30
5. Report 5: Final Report: Project Finding Due April 13
6. Final Powerpoint Presentation by the Team. Due April 17

First Report: Consists of description of the problems, clear statement of how you propose to solve it, clear statement of the objective/s to be measured for the current system and compared with the proposed system, the number of entities, the number of locations, the number of resources, the flow of material, the flow of personnel, flow chart, operational logics, ..., the data that is needed to be collected (for this report just name them, you will collect them in the next report).

The First Report should include:

- One page description of the problem
- A clear statement of the goal of project
- A very clear and detailed flow chart of the current process
- A complete list of the components of the model
- A list of decision variables (factors)
- Description of the types of data to be collected

Second Report: Consists of Data Collection and Data processing. In this report, all the data, whether they are for arrival, operations, logics, or downtimes has to be collected and statistically processed.

The Second Report should include:

- All the collected data in the original raw form, categorized into
  - Operational Data
  - Structural Data
  - Logical Data
- A clear explanation of the methodology used to process the raw data
  Comprehensive detail of the processed data (fitted distributions), along with the corresponding charts and graphs.

Third Report: Is the ProModel that you build to represent the current situation. The ProModel should be as comprehensive as possible and should be running. Don't worry about validation or verification. That will be done in the next report.

The Third Report should include:

- A Disk containing the most up-to-date simulation model that reasonably depicts the real-world problem, and is error-free (can run!!!).

Fourth Report: This report will show the verification and validation efforts that were used to prove that the ProModel represents the real world problem. You must show that your Model output is statistically the same as the real-world output. For this purpose, you have to run simulation numerous times, and find the mean and standard deviation of the objective(s) of interest. Then use statistical test to compare that with the real-world distribution and show that they are statistically indifferent. You have to, also, list all tools that you used for verification, and explain each one. For instance, you used animation to correct the way resource is modeled. In addition, you will to build Proposed Scenarios for what if analysis.

Fifth Report: This is your final report and shows all your simulation runs, your statistical analysis of the output, and your recommendations. It has to be submitted to me prior to your final presentation.

Final Powerpoint Presentation: Each team will have 10 minutes to present their cases to the class and answer questions and concerns. The presentation should include:

1. Define the problem
2. State the goal of the simulation modeling
3. Depicts the flow of material/resources/information through the system
4. List a complete list of decision variables/factors
5. State the procedure used to collect data relevant to the problem
6. Describe the simulation model
7. Description of the experimental design procedure
8. Explain the simulation outputs
9. Discuss the team's interpretation of the output; and
10. List the team's recommendations as to how the problem can be resolved.

COURSE OUTLINE

Week Number	Topic
Week 1: January 5-9	Chapter 1: Introduction to Modeling Simulation Chapter 2: System Dynamics
Week 2: January 12-16	Chapter 3: Simulation Basics *Lab 1: Introduction to ProModel* *Lab 2: ProModel World View, Menu, and Tutorial* *Lab 3: Running a ProModel Simulation*
Monday January 19	*MLK Day*
Week 3: Jan 21-23	Chapter 4: Discrete-Event Simulation *Lab 4: Building Your First Model*
Week 4: Jan 26-30	Chapter 5: Getting Started *Lab 5: ProModel's Output Module*
Week 5: February 2-6	Chapter 6: Data Collection and Analysis *Lab 6: Fitting Statistical Distribution to Input Data*
Week 6: February 9-13	Chapter 7: Model Building *Lab 7: Basic Modeling Concepts*
Week 7: February 16-20	Review of the Previous Chapters
Monday February 23 *Wednesday February 25* *Friday February 27*	*Preparation for the 1st Test* *First Test* *Spirit Day*
March 2-6	*Spring Break*
Week 10: March 9-13	Chapter 8: Model Verification and Validation *Lab 8: Model Verification and Validation*
Week 11: March 16-20	Chapter 9: Simulation Output Analysis *Lab 9: Output Analysis*
Week 12: March 23-27	Chapter 10: Comparing Systems *Lab 10: Comparing Alternative Systems*
Week 13: March 30-April 3	Chapter 10: Comparing Systems *Lab 10: Comparing Alternative Systems*
Week 14: April 6-10	Semester Project Review
Week 15: April 13-17	Review of the Previous Chapters
Tuesday April 21	*Final Exam: 10:15 am-12:15 pm?*