Lingnan University
Department of Computing and Decision Sciences
The First Term, 2006–2007
CDS 399: Special Topics in Logistics and Decision Science (Simulation)
(**three credits**)

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Class Times	Wednesdays (9:30am–11:00am)	Fridays (9:30am–11:00am)
Class Rooms	BU 321	BU 321

Simulation is a commonly-used and practical technique for modeling and analyzing the real operating systems in order to make more effective decisions. Examples of such systems include transportation, supply chain network, job flow, airports, banks, ocean terminals, information systems, emergency response systems. Due to considerable complexity of real systems, many firms feel difficult to investigate the manufacturing and service design and processes without a computer simulation model. More than 89% of *Fortune* 500 firms have used simulation for the system improvement and experienced the benefits for a long time. This course is designed to introduce basic concepts of system modeling and computer simulation. The process and methodology of using simulation for problem solving and decision making are emphasized.

The course is designed for the students in the stream of Logistics and Decision Sciences.

- *Quantitative background*: The course assumes a previous knowledge of probability and statistics (at a level equivalent to BUS 102—Statistics for Business). Although some of these topics will be reviewed in the course to a limited extent, the review is intended only as a refresher and will not be comprehensive.

- *Computer programming*: The course assignments involve the use of simulation language Arena (the program CD is free and comes with the textbook). Some of the assignments may require the ability to write simple computer programs in a language of the student's choice, or the use of a spreadsheet.

Course Objective

The purpose of this course is to provide students with an opportunity to develop skills in modeling and simulating a variety of management-related problems. After learning the

simulation techniques, the students are expected to be able to solve real world problems which cannot be solved strictly by mathematical approaches.

This course begins by demonstrating the usefulness of simulation as a tool for problem solving in business, industry, government, and society. Coverage includes a brief review of probability and statistics, discrete event simulation, and statistical aspects of simulation. The process and methodology of using simulation for problem solving in manufacturing and service environments are particularly discussed. The computer simulation packages (i.e., *Excel* and a Graphic Simulation System—*Arena*) are used as the tools for model and decision making. Students are placed in teams of two or three and the main exercise in the course is to develop a model/simulation of a practical problem which is identified from a business/industrial situation. Through a term project students are expected to present the simulation models that will be useful to the business/industrial decision-makers in managing their specific problems. Furthermore, advances in simulation development will be explored through reference reading, class discussion and team presentation.

Course Materials

- **Textbook**. W. David Kelton, Randall P. Sadowski and David T. Sturrock, *Simulation with Arena*, Third Edition, McGraw-Hill Higher Education, 2004. The following web site of Rockwell Corporation has additional information on the textbook and Arena software: <http://www.arenasimulation.com/programs/sim_w_arena_3.asp>.

- **Supplementary Reading List**:

  1. Averill Law and Averill M. Law, *Simulation Modeling and Analysis with Expertfit Software*, Forth Edition, McGraw-Hill Higher Education, 2007.
  2. Daniel Maki and Maynard Thompson, *Mathematical Modeling and Computer Simulation*, Thomson Corporation, 2006.
  3. Hans P. M. Veeke, *Simulation Integrated Design for Logistics*, DUP Science, 2003.
  4. Philip H. Anderson, David A. Beveridge, Timothy W. Scott and David L. Hofmeister, *Threshold Competitor: A Management Simulation*, Version 3.0, Prentice Hall, 2003.

- **Software**: Arena 7.01 (Academic version) and Microsoft Excel 2003.

  Note: A free CD-ROM of the Arena software version 7.01 accompanies the textbook for installation on the students' computers running on MS Windows 95 or higher.

Grading System

Class Participation	5%	
Marked Assignments	10%	
Project	20%	(Presentation 10%, report 10%)
Midterm Exam	20%	
Final Exam	45%	

Class Participation

Class participation will be measured by circulating a "Class Attendance Record" during each class. Each student is expected to initial the Class Attendance Record indicating they are present. One attendance will be awarded 1 point. The class participation mark will be computed as follows: Total points earned divided by total number of classes times 5 equals Class Participation mark.

Simulation Project

- **Objective**

  To gain experience on applying modern simulation technology for problem solving in business and industry.

- **Guidelines**

  Each student will participate in one of five/six teams which will be formed by the students rather than the instructor. Each group is managed by a leader who is selected by the group members. The leader is expected to report the member list and send the project report and presentation slides to the instructor. The group presentation is expected to take place in the last week. Each group presentation should take around 30 minutes for speaking and 10 minutes for Q&A at the end of the presentation. Attendance at project presentations is *mandatory* for the entire class.

  It is the students' responsibility to find a real world problem for system modeling and simulation. The project should be carefully selected to demonstrate the meaningful use of simulation and to be completed in a reasonable amount of time. The project proposal should be submitted to and be approved by the instructor.

- **Project Presentation** (10%)

  The project presentation will be evaluated by both the classmates (5%) and the instructor (5%). The instruction for presentation will be distributed in class.

- **Project Report** (10%)

  The project report should include at least the following sections:

  1. **Introduction**. Background of the organization involved. Decision problems under study. The justification of using simulation for solving the problem.
  2. **Problem formulation**. Variables and constraints. System performance measures and objective functions. The interrelationship between variables.
  3. **Data collection and analysis**. Methods of data collection. Data analysis.
  4. **Model construction and validation**. Simulation model written using Arena. Model verification and validation.
  5. **Model experimentation and output analysis**.
  6. **Conclusion and recommendation**. The interpretation of simulation results. Recommendations to solve the problem.
  7. **Limitations and further improvement**. The limitation of current study. Suggested improvement in the future.
  8. **Sample** project is available at the WebCT.

Midterm and Final Exams

The midterm and final exams would consist of analytical problems and the problem of constructing Arena models for simulation. The exams are expected to take place in a computer lab.

Course Announcements

Course handouts, other materials and course announcements will be distributed via WebCT. Students are advised to check the WebCT and e-mails frequently.

Warnings

- **Classroom disciplines**. General rules should be observed. It is absolutely unacceptable to use mobile phones or pagers during the classes. Students are expected to attend every class. Punctuality is also very important.
- **Assignments and Exams**: Information on all assignments and exams will be posted at WebCT in advance of the events. Students should attend all the examinations. No re assessment test or exam will be given to absentees for trivial excuses.
- **Other regulations in Lingnan University Calendar**:

- Adding and Dropping Courses and Changing Courses / Sections.
- Class Attendance and Leave of Absence.
- Conduct of Student.

Course Schedule (Tentative)

- *Chapter 1: What is simulation?* (1 week: Sept. 6 & 8)
  - All Sections, pp. $3-16$.
  - Preliminary review on Arena 7.01. (Show the simulation models and distribute the *Arena—Forward Visibility for Your Business* and a successful SCM/Logistics example—*An Application of Arena in the Simulations at Bayer Corporation.*)
- *Chapter 2: Fundamental Simulation Concepts* (1 week: Sept. 13 & 15)
  - Quick review of statistics.
  - All Sections with an emphasis on *Pieces of a simulation model* and *Event- and process–oriented simulation*, pp. $17-43$.
- *Chapter 3: A Guided Tour Through Arena* (1 week: Sept. 20 & 22)
  - All sections, pp. $47-96$.
  - Show the process of building an Arena model (i.e., Model $3-1$).
  - Explore Arena functions: menus, toolbars, drawings and printings.
  - *Assignment 1 will be due on October 3, 2006.*
- *Chapter 4: Modeling Basic Operations and Inputs* (2 weeks: Sept. 27 & 29 and Oct. 4 & 6)
  - All Sections, pp. $101-168$.
  - Build four Arena models (i.e., Models $4-1$, $4-2$, $4-3$ and $4-4$).
  - Input analysis: Specifying model parameters and distributions. (Distribute copies of Appendix D to the students.)
  - *Assignment 2 will be due on October 23, 2006.*

★ **Midterm Examination** [Oct. 20 (tentative)].

- *Chapter 5: Modeling Detailed Operations* (2.5 weeks: Oct. 11, 13, 18, 25 & 27)

  - All Sections, pp. $175 - 247$.
  - Build two Arena models (i.e., Models $5-1$ and $5-2$), which use new modeling issues.
  - Use the Blocks and Elements panels to construct a (s, S) inventory model $5-2$.
  - *Assignment 3 will be due on November 20, 2006.*

- *Chapter 6: Statistical Analysis of Output from Terminating Simulations* (1 week: Nov. 1 & 3)
  - All Sections, pp. $255 - 279$.
  - Emphasize the simulation analysis with Process Analyzer (PAN) and the optimization with Optquest®.

- *Chapter 7: Intermediate Modeling: A Small Manufacturing System* (1 week: Nov. 8 & 10)
  - Sections $7.1.1 - 7.1.5$, pp. $283 - 300$.
  - Build one Arena model (i.e., Model $7 - 1$).

  ♣ **Groups for the simulation project are formed based on the students' choices on November 10, 2006**.

  ♣ Instruction for project study

- *Chapter 8: Entity Transfer* (1.5 weeks: Nov. 15, 17 & 22)
  - All sections, pp. $319 - 350$.
  - Build one Arena model (i.e., Model $8 - 1$) which is concerned with resource-constrained transfers.
  - Build two Arena models (i.e., Models $8 - 2$ and $8 - 3$) with transporters.
  - Build two Arena models (i.e., Models $8 - 4$ and $8 - 5$) with conveyors.

♣ **Project Presentation** starts on November 29, 2006.

★ **Final Examination** (TBA).

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