Computer Simulation IE413 / CS482
Group Project: A Bowling Alley Problem
Due: April 28, 2010, 3PM

A bowling center has 16 lanes available. It opens at noon (seven days per week) and stays open until all the bowlers have left the center. The center owner is not sure whether the size of center should be left as is, or additional lanes should be installed. To assess what to do, the owner has hired a consulting company to come in to help with this decision. The operation of the center is as follows:

The manager assigns lanes to customers who come to bowl at the center. Suppose that the interarrival time between groups arriving at the center is distributed according to an exponential (mean = 4 minutes) random variable. Suppose each group has 1, 2, 3, or 4 people in it, with probabilities .3, .2, .1, and .4, respectively. Assume that each group is assigned exactly one lane. A group with K people (K = 1,2,3,4) will take X_K minutes to bowl, where X_K is distributed IID N(μ = 30K, σ = 4K) minutes. If there are no lanes available, the group is put on a waiting list until the first available lane becomes available. The probability that a group, once being told that there are no lanes available and that they must be put on a waiting list, leaves the bowling center immediately is 0 for M = 1,2,3,4,5, (M-5)/10 for M = 6,7,...,15, and 1 for M > 15, where M denotes the number of groups who are currently on the waiting list (not including the arriving group). When the center opens at noon, there is no one bowling, but there is always one group of people waiting to enter the center to bowl. At 11PM, the manager stops adding people to the waiting list. All people on the list at 11PM stay until they have bowled.

The consulting company has decided to build a discrete event simulation model of the bowling center's operation. A simulation model is needed, since the system is too complex to be solved analytically. To successfully complete the consulting project, the following must first be done.

1) Identify all the entities and attributes in the system.
2) Construct an event graph simulation model of the system, with all state changes carefully depicted.
3) Write a computer program of the simulation model.
4) Design computer experiments necessary to help the bowling center owner decide whether to expand. Issue to be considered include
   a) the fraction of groups who leave the center because there they are unwilling to wait for a lane,
   b) the waiting time for a lane for those who must wait,
   c) the distribution of the number of lanes in use over different time intervals,
   d) the closing time of the center each day.
5) Make all necessary simulation runs and use the information to help the owner make a decision.
6) If a profit of $5/bowler is earned by the center, while each group that leaves without waiting for a lane costs the center $10/group, and the owner has decided to add either 2, 4, 6, 8 or 10 lanes, what is the maximum cost that the owner is willing to pay for each pair of lanes, given that money neither appreciates nor devalues over time, and the owner is willing to spread the cost over 5 years? What is the optimal business decision for the owner?
7) How sensitive are the answers obtained in 6) to such parameters as the mean interarrival rate of groups, the mean and standard deviation of the time it takes a person to bowl, and the profit per bowler?

Your project (to be done in your group of two or three people) is to do the proposed work. You will be required to:
1) Meet the deadline (see the project guide for late project procedures).
2) Prepare a writeup of the project, following the project guidelines sheet. This should include a description of and justification for how you decided to run all the simulation experiments that are needed to answer the owner's questions. The numerical results should be depicted in clearly labeled tables. Graphs should also be included, as appropriate and necessary, particularly when they will help to explain the results.
3) A CD with the computer program(s) on it, the listing of the program(s) with sufficient auxiliary documentation, and a user's guide which tells us, step by step, how to make one run of your simulation program(s), and how to accumulate data for multiple runs.

NOTE: The entire write-up should not be more than 10 typed, 1.5-spaced pages, INCLUDING TABLES AND GRAPHS, so be selective in how you present your results, and which results to present. Use the project guideline sheet as your guide when writing up the results.