**E211 – Operations Planning II**

**Pre-HW Worksheet for Problem 10: Analyzing the Packing Line**

Need for simulation

1. Simulation can be used to model and solve certain real world problems. What do you understand by simulation?

Simulation is the process of designing a digital/physical model of a real system and conducting experiments with this model for the purpose either of understanding the behaviour of the system or of evaluating various strategies (within the limits imposed by a criterion or set of criteria) for the operation of the system.

1. How are simulation models classified? State the different types of simulation models covered in the pre-reading.

Static Simulation Model - a representation of a system at a particular point in time (i.e., time plays no role)

Dynamic Simulation Model - a representation of a system as it evolves over time

Examples include models of a bank, a processor

1. What are the steps that Alex needs to go through in performing a simulation study?

**1.Problem formulation:**

Every study should begin with a statement of the problem. If the statement is provided by the policy makers, or those that have the problem, the analyst must ensure that the problem being described is clearly understood.

**2.Setting of objectives and overall project plan:**

The objective indicates the questions to be answered by simulation. At this point a determination should be made concerning whether simulation is the appropriate methodology for the problem as formulated and objectives as state.

**3.Model conceptualization:**

The construction of a model of the system is problem as much art as science. The art of modelling is enhanced by an ability to abstract the essential features of a problem, to select and modify basic assumptions that characterize the system, and then to enrich and elaborate the model until a useful approximation result.

**4.Data collection:**

There is a constant interplay between the construction of the model and the collection of the needed input data. As the complexity of the model changes, the required data elements may also change. Also, since data collection takes such a large portion of the total time required to perform a simulation, it necessary to begin it as early as possible, usually together with early stages of the model building.

**5.Model translation:**

Since most real-world systems result in models that require a great deal of information storage and computation, the model must be entered into a computer-recognizable format. We use the term "program". The modeller must decide whether to program the model in a simulation language.

**6.Verified?**

Verification is refers to the process of ensuring that the model is free from logical errors; that it does what it is intended to do.

**7.Validated?**

Validation is the determination that the model is accurate. Ensures representation of the actual system or problem. Validation is usually achieved through the calibration of the model.

**8.Experimental Design:**

The alternatives that are to be simulated must be determined. Often, the decision concerning which alternatives to simulate may be a function of run that have been completed and analysed.

**9.Production runs and analysis:**

Production runs, and their subsequent analysis, are used to estimate measures of performance for the system designs that are being simulating.

**10.More runs?**

Based on the analysis of the runs that have been completed, the analyst determines if additional runs are needed and what design those additional experiments should follow.

**11.Documentation and reporting:**

There are two types of documentation:

Program documentation is necessary for numerous reasons. If the program is going to be used again by the same or different analysts, it may be necessary to understand how the program operates.

Progress reports give a chronology of work done and decisions made. This can prove to be of great value in keeping the project on course.

1. Define the objectives for the simulation study of the packing Line. What are the possible **performance measures** for the simulation study?

Objectives: Find out if the sealing operation is the bottleneck based on inter-arrival time

Performance Measures: Mean Inter-Arrival Time (exponentially distributed)

1. Based on the process flow given in the problem statement, list the data to be collected for the study. How do you think you can get these data?

Data required include: Process Timings, Resource Availability, Demand Pattern and Existing System Performance.

Sources include: Historical Records, Auditing Records, On-site Observations.

1. What is a “conceptual model” used in a simulation? Explain its importance in conducting simulation analysis.

A simulation conceptual model:

* Documents and details the explicit statement of assumptions and relationships to be included in the simulation model in accordance with the problem statement
* A non-software specific description of the simulation model that is to be developed, describing the objectives, inputs, outputs, content, assumptions and simplification of the model

1. List down the different simulation components for today’s problem.

|  |  |
| --- | --- |
| Component | Examples for the final functional test system |
| Events | Arrival of incoming boxes |
| Entity | Refrigerators |
| Activity | Process times of various operations in the current packing line |
| Attributes | Refrigerator Model Number or Code |
| Resources | Sealing Machines, Inspection Crew |
| State | Status of Sealing Machines, Status of Staff |

1. What type of simulation software should you select for the study? What factors should you consider in the selection of such software?

Advice when evaluating and selecting simulation software:

* Consider the accuracy and level of detail obtainable, ease of learning, vendor support, and applicability to your applications.
* Execution speed is important.
* Beware of advertising claims and demonstrations.
* Ask the vendor to solve a small version of your problem.
* Beware of “checklists” with “yes” and “no” as the entries, e.g. many packages claim to have a conveyor entity, however, implementations have considerable variation and level of fidelity ( accuracy).
* Determine whether the simulation package and language are sufficiently powerful to avoid having to write logic in any external language.
* Beware of “no programming required,” unless either the package is a near-perfect fit to your problem domain, or programming is possible with the supplied blocks, nodes, or process-flow diagram.

1. What does it mean by to i) verify and ii) validate your simulation model?

Validation is the process of comparing two results. In this process, we need to compare the representation of a conceptual model to the real system. If the comparison is true, then it is valid, else invalid.

Verification is the process of comparing two or more results to ensure its accuracy. In this process, we have to compare the model’s implementation and its associated data with the developer's conceptual description and specifications.

1. What are the different scenarios you can study for Alex?

* The difference in arrival time when a new refrigerator model is introduced into the packing line
* Scenario variations visualizing and describing how the shortlisted 3 machines will change the packing line when packing the new and old refrigerator models.
* Input different factors to test the mean time and effectiveness of the manual sealing operation as compared to the machines

1. How are statistics used in simulation study?

The use of probability and statistics is an integral part of a simulation study and

are used to understand how to model a probabilistic system that meets the following characteristics:

* To validate the simulation model.
* To choose the probability distributions to start with.
* To obtain random samples from the distributions.
* To make a statistical analysis of the simulation results.
* To design the simulation experiments.

1. Discuss in general the advantages and disadvantages of using simulation as compared to mathematical models.

Advantages

* Simulation is best suited to analyse complex and large practical problems when it is not possible to solve them through a mathematical method.
* Simulation is flexible, hence changes in the system variables can be made to select the best solution among the various alternatives. This could prove rather difficult.

Disadvantages

* Simulation does not generate “optimal” solutions (Mathematically Speaking).
* It may take a long time to develop a good simulation model as compared to formulating a mathematical model.