SIMULATION

Simulation is not an optimization technique. Rather, it is a technique for estimating the measures of performance of the modeled system.

[Taha, *Operations Research, An Introduction*, p. 673]

Simulation may be defined as a technique that imitates the operation of a real-world system as it evolves over time.

[Winston, *Operations Research*, p. 1183]

Simulation - The operations research view of simulation is that it is a controlled statistical sampling technique for estimating the performance of complex stochastic systems when analytical models do not suffice.

[H&L, *Intro. to Operations Research*, p. 901]

Simulation versus Optimization

In an ***optimization model***, the values of the decision variables are ***outputs***. That is, the model provides a set of values for the decision variables that maximizes (or minimizes) the value of the objective function.

In a ***simulation model***, the value of the decision variables are ***inputs***. The model evaluates the objective function for a particular set of values.

Input	Decisions and parameter values	Parameters
	”	”
	Simulator	**Optimizing Algorithm**
	”	”
Output	Measures of effectiveness	Optimal decision variables and optimal value of the measure of effectiveness

Simulation - Advantages & Disadvantages

[Eppen, et al., *Quantitative Concepts for Management,* 3rd ed. (1988), p. 674-675]

Advantages:

(1) Uncertainty - A major advantage of simulation models is that they provide a means of dealing with uncertainty. These models typically deal with a multitude of uncertainties, as opposed to the expository examples in textbooks where only a single uncertain event (e.g., product demand) was involved. Simulation models typically deal with a multitude of uncertainties.

(2) Versatility - Another advantage is that the model can be run many times, either varying parameter values to explore sensitivity effects, or using different sequences of random numbers in order to study the magnitude of possible statistical variations.

(3) Variability - Simulation models should do a reasonable job of reproducing the amount of variability that actually occurs in the system being simulated. It should be emphasized that variability in the results of different trials in intrinsically neither good or bad.

(4) Multiple Outputs - Simulation models allow for many different measures of effectiveness to be observed (analyzed), whereas optimization models are generally limited to a single objective function (although goal programming allows for multiple objectives).

(5) Rational Tool - Simulation models provide a means for the consistent evaluation of alternative policies (scenarios) while handling a large number of interactions in a consistent but adjustable manner.

Simulation - Advantages & Disadvantages

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Limitations:

(1) Model Size - Modeling realistic simulation models often lead to very large, complex models. Big models are expensive to build and operate. The "tractability" versus "validity" tradeoff is a very important consideration. In addition, a large simulation model with many parameters will require many executions in order to study variability and to test the sensitivity of the output to parameter values.

(2) Complex Relationships - A second limitation, beyond sheer size, is that in a highly complex scenario it may well be the case that no one understands the interactions and the relationships well enough to build even a simulation model that works effectively.