Simulation

General Topics

Topics

- Definition of Simulation
- Simulation Methodology
- Designing New Experiments
- Types of Simulations
- Features of Simulation Software
- Advantages & Disadvantages of Simulation
- Brief History

Definition of Simulation

- A *simulation* is a computer-based model used to run experiments on a real system
  - Typically done on a computer
  - Determines reactions to different operating rules or changes in structure

Definition of Simulation

- **A *system* is a facility or a process**
  - Examples
    - Manufacturing facility
    - Airport operations (passengers, security, planes, crews, baggage)
    - Transportation/logistics/distribution operations
    - Hospital facilities (emergency room, operating room, admissions)
    - Computer network
    - Bank branch
    - Supermarket
    - …

Simulation Methodology

- Understand the system
- Construct representation model
- Translate into simulation software
- Verify program
- Validate model
- Design new experiments
- Make runs
- Analyze, document results

Designing New Experiments

- Consider changing on factors:
  - parameters
  - decision rules
    - If the initial decision rules led to poor results or if simulation runs yielded new insights into the problem, then a new decision rule may be worth trying

Types of Simulation Models

- Static vs. *Dynamic*
  - Is time relevant in system state determination?
- Continuous vs. *Discrete*
  - Does system state change continuously or at discrete points in time?
- Deterministic vs. *Stochastic*
  - Is there any uncertainty in system behavior?
- Most operational systems are:
  - *Dynamic*, *Discrete*, *Stochastic*

Features of Simulation Software

- Be user-friendly
  - Allow friendly interaction
  - Allow new modules to be built
  - Allow users to write and incorporate their own routines

Features of Simulation Software (continued)

- Output standard statistics such as cycle times, resources utilization, waiting times, number waiting
- Allow a variety of data analysis for both input and output data
- Have material flow capability and animation capabilities to display graphically the product flow through the system

Advantages of Simulation

- Often leads to a better understanding of the real system
- Years of experience in the real system can be compressed into seconds or minutes
- Simulation does not disrupt ongoing activities of the real system

Advantages of Simulation (Continued)

- Simulation may provide a more realistic replication of a system than mathematical analysis
- Many standard packaged models, covering a wide range of topics, are available commercially
- Simulation answers what-if questions

Disadvantages of Simulation

- Building a simulation model could be time consuming
- Simulation may be less accurate than mathematical analysis because it is randomly based
- A significant amount of computer time may be needed to run complex models
- The technique of simulation still lacks a standardized approach

Brief History

(1950s-1960s)

- Very expensive, specialized tool to use
- Required big computers, special training
- Mostly in FORTRAN

(1970s-early 1980s)

- Computers got faster, cheaper
- Simulation software improved

Brief History

(late 1980s-1990s)

- Microcomputer power
- Software expanded into GUIs, animation
- Wider acceptance across more areas
- Still mostly in large firms
- Often a simulation is part of the "specs"

Now…

- Proliferating into smaller firms
- Becoming a standard tool
- Being used earlier in design phase