BUILDING VALID AND CREDIBLE SIMULATION MODEL

The most important problem faced by Simulation Analyst is whether the model is valid or not?

Let's start with

**What is Verification?**

Determining that a simulation computer program performs as intended i.e. debugging the computer program.
It checks the translation of the conceptual simulation model into a correctly working program.

**What is Validation?**

Determining whether the conceptual simulation model is an accurate representation of the system under study. If the model is a valid then decision should be similar to the physically experimenting with the system.

**What is Credibility?**

When a Simulation model and its results are accepted by the manager/client as being a valid one then it is called credible.
PRINCIPLES OF VALID SIMULATION MODELING

Example:
A Company builds a simulation model of its Manufacturing line which produces 1 million cans a day. Can we simulate that?

General guidelines:
- Define the issues to be investigated, measures of performance for evaluation in a manner the model will be used and evaluate alternate system configuration of interest.
- Models are not universally valid
- Specify measures of interest
- A great model for wrong problem will never work.
- Use of Experts and Sensitivity analyses to help determine the level of model detail
- Start with a moderately detailed model which can later be embellished
- Level of model detail should be consistent with the type of data that are available
- Time and money constraints
- Use a coarse simulation model if the number of factors is large
- Start simple and build upon that by validating each step when possible

VERIFICATION OF SIMULATION COMPUTER PROGRAM:

Eight possible techniques:

Technique 1:
Write and debug program in modules or subprograms.
Example: See bank teller M/M/1 queue example

Technique 2:
More than one person should read the program, called as ‘structured walk through’

Technique 3:
Run the Simulation under a variety of settings of the input parameters and check to see that the output is reasonable.
Technique 5:
Model should run under simplifying assumptions for which its true characteristics are known.

Technique 6:
For some Simulation models it may be helpful to observe an animation of simulation output.
Example: Simulation model of a network of Automobile Traffic Intersection.

Technique 7:
Write sample mean and sample variance for each simulation input probability distribution and compare with desired mean and variance.

Technique 8:
Use a simulation package to reduce the required number of lines of code.
Simulation model of a complex system can only be an approximation to the actual system
Simulation model should be developed for a particular set of purposes
Assumptions of Simulation model should be updated on regular basis and then final report should be made.
Simulation model should be validated relative to those measures of performance that will actually be used for decision making.

THREE STEP APPROACH FOR DEVELOPING VALID AND CREDIBLE SIMULATION MODELS

1. Develop a model with High Face Validity:

Primary objective is to develop a model with high face validity.
- Conversation with experts
Example:
Modelers should obtain information from various sources while modeling a Manufacturing System
- If the system similar to one of interest exists then data should be taken from it.
- One should use his experience or intuition to hypothesize the operation of system.
- It is extremely important for a modeler to interact with the manager/client on a regular basis throughout the course of a simulation study.
- Modelers should perform a structured walk through of the conceptual model infront of the audience of all key people

2. Test the assumptions of model empirically:
- To test quantitatively the assumptions made during the initial stages of model development.

Example:
Testing of time to failure and repair time data for identical machine.
- Sensitivity analysis
Example:
Simulation Model of the cigarette filter rod.

3. Determine How Representative the Simulation Output Data Are:
The Simulated model should be similar to the proposed one.
Example:

For ISEM simulation model of the US Air Force Manpower and Personnel System.
- Sometimes field tests are used
- Model can be Calibrated

STATISTICAL PROCEDURES FOR COMPARING REAL WORLD OBSERVATIONS AND SIMULATION OUTPUT DATA

1. INSPECTION APPROACH:
- There might be an inherent danger using the basic inspection approach.
- Better approach can be:
- System and model be compared by driving the model with historical system input data rather than samples from the input probability distribution, and then comparing the model and system outputs.
2. CONFIDENCE INTERVAL APPROACH BASED ON INDEPENDENT DATA

3. TIME SERIES APPROACH:
   - Spectrum Analysis:
   - Computes the sample spectrum of each output process and then using existing theory
to construct a confidence interval for the difference of logarithms of the two spectra.