A Tour of a Simulation Project

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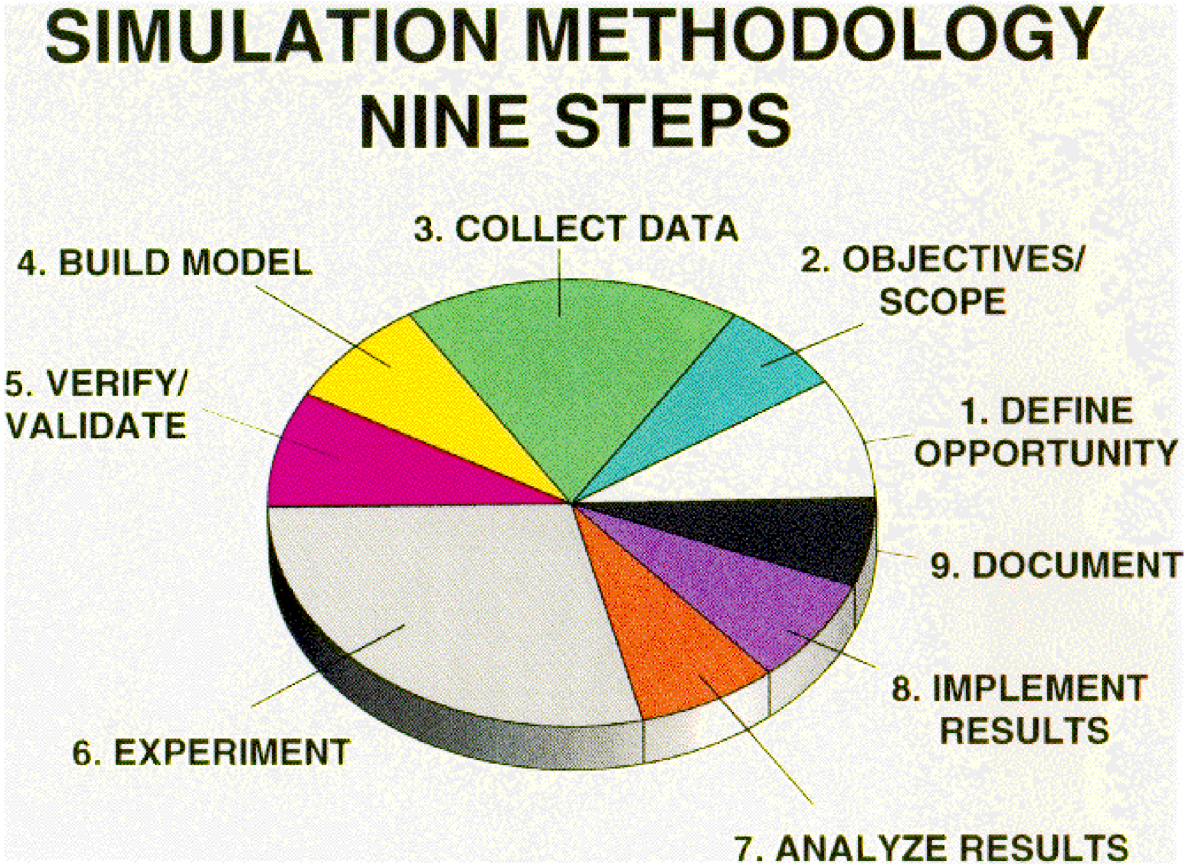
The Nine Steps of a Successful Simulation Study



1. Define Opportunity

- What is the client’s pain – “Where does it hurt?”
  - High inventory
  - Low throughput
  - Poor customer service
  - Underutilized resources
  - Severe bottlenecks
  - Long queues
  - …..

Define Opportunity

- When proposing or beginning a simulation project, we must always have a coherent, convincing answer to the question “Why should the client spend time and money for our undertaking of a simulation study?”
- Projects routinely should provide client with 10× ROI
- Some projects provide 100×

2. Objectives/Scope

- Objectives:
  - What questions will the model answer for the client? We must know what these questions are, and these questions should preferably call for quantitative answers.
  - What decisions is the client about to make, and how will the results of our study provide guidance to this client as those decisions are made?

Example Objectives Questions

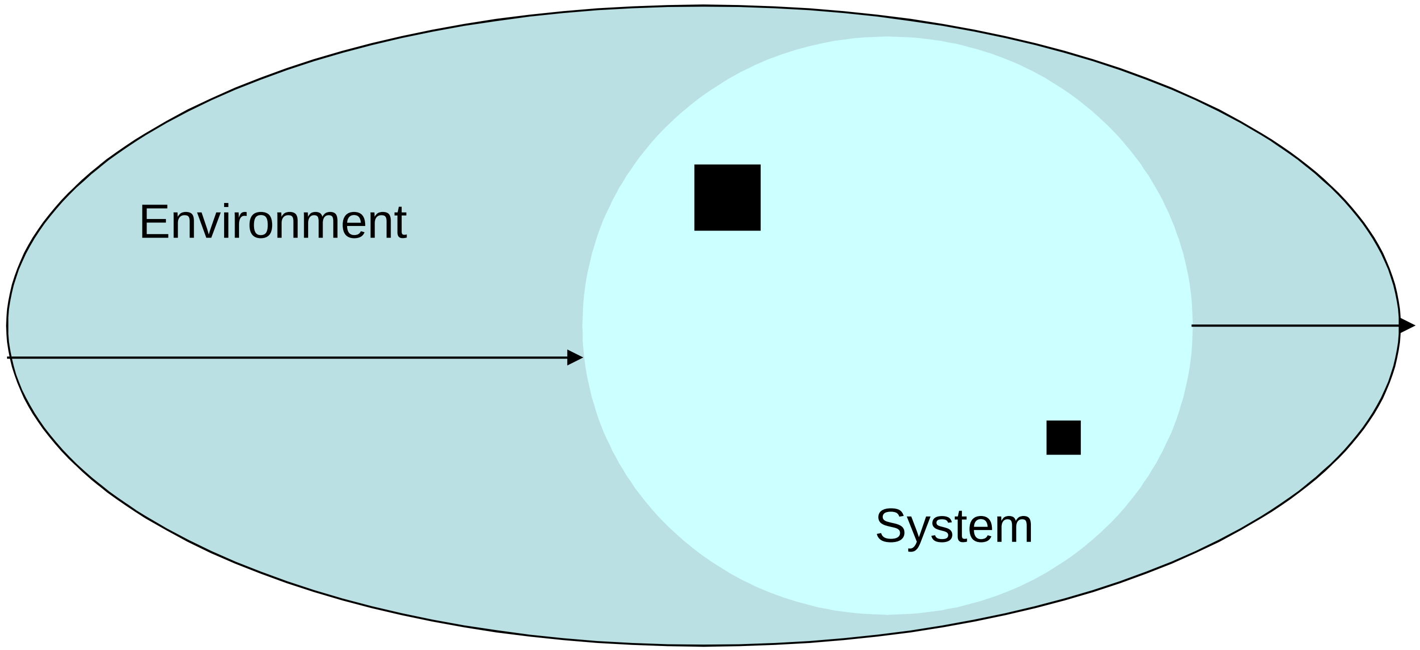
- Will the plant produce 58 JPH on average?
- Will the utilization of (expensive) machine X be between 0.65 and 0.85?
- Will the proportion of customers waiting more than 10 minutes be less than 0.1?
- Will configuration B produce 5 more JPH than cheaper configuration A with probability 0.9 or higher?

Example Objectives Questions

- Will line X stop for want of parts from upstream less often than once/160 hours?
- What is the reduction in time a truck awaits repair if we have a 4^{th} mechanic?
- At what level of staffing does the maximum number of patients in the waiting room remain below 6 for an entire month?

The Concept of Scope

- How much is system (modeled) and environment (*not* modeled)?



For example, the System might be the maternity clinic; the Environment might be all the rest of the hospital.

For example, the System might be one production line or department; the Environment might be all the rest of the factory. And it may be appropriate to “black-box” various entities within the system.

3. Collect Data

- What data is required?
  - Operating logic
  - Cycle times
  - Downtimes and their frequency
  - Resource levels
  - Arrival data
  - Transit times (or distances and speeds)
  - Etc.

3. Collect Data

- How much of it is already available?
- How can we collect unavailable but needed data as quickly and unobtrusively as possible?
- How can we estimate needed data not yet available? (Hint: sensitivity analyses)
- Remark: Data belongs in an Excel® workbook, not in the model itself

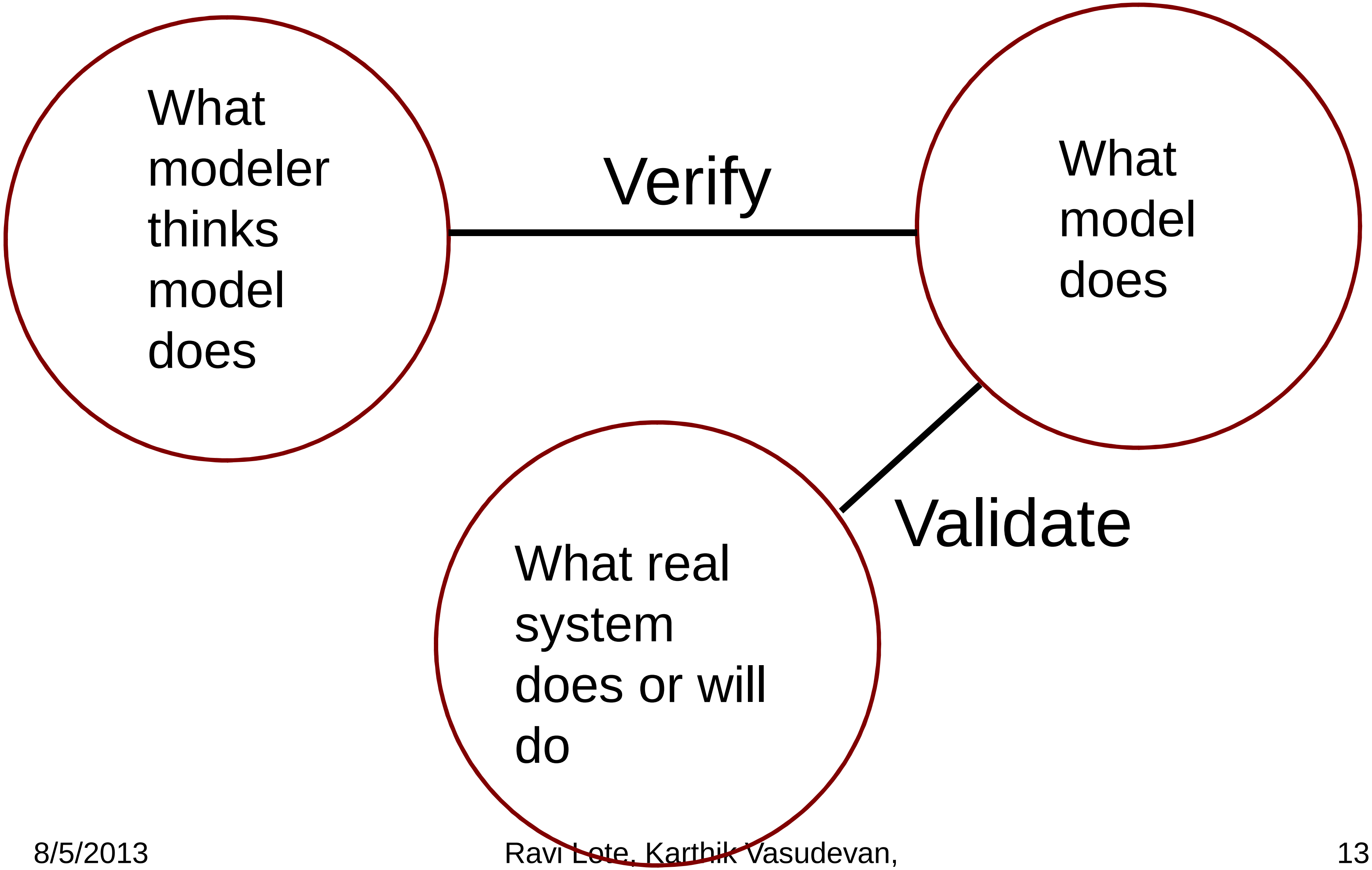
Analysis of Input Data

- Have we checked for errors and outliers?
- Will we use an empirical distribution or a fitted distribution? Hint: Answering this question requires that we have a distribution fitter available, and know how to use it and interpret its results.

4. Build Model

- Recheck the choice of software
- Know the details of using the software
- Build the model

5. Verify/Validate



Verification Methods

- Recheck the internal logic, especially where code was written
- Put ONE entity (work item, load, part,….) into the model
- Remove all randomness
- Put more entities in:
  - Does every part of model get visited?
  - Does anything come out?
  - Does animation act sensibly?

Validation Methods

- Involve the client!
- Do some Turing Tests
- Check output percentages against routing logic probabilities
- Check the animation (e.g., Are pallets being created from nothingness? Do vehicles pass through each other magically?)

6. Experiment

- Up to now, we, and the client, have *invested* time, expertise, and money in the model. Now, we begin *receiving* ROI
- Decide on run length, warmup time (zero for terminating systems), and number of replications
- Run scenarios as needed, developing new ones based on engineering judgment of results

7. Analyze Results

- Build confidence intervals for performance metrics
- Conduct Student-*t* tests (hypothesis tests) to compare alternatives in pairs
- Design experiments (one-way, two-way, factorial, fractional factorial) to compare many alternatives
- Conduct response surface analyses
- Search for optima under constraints

8. Implement Results

- Working with the client, provide assistance and consultation in implementing results
- Remain alert for ways to provide further benefit by integrating techniques of lean, value-stream mapping, work measurement, ergonomic analysis, and other IE techniques into the study

Simulation does not exist in a vacuum! It is part of a stable of powerful IE horses.

9. Document

- Gather and organize all the documentation you have sensibly produced all along – both user and technical
- Provide the client oral and written reports (these are *always* a key deliverable)
- The job isn't done right until the client can articulate clearly what you did, how you did it, why you did it, and how the client benefits from what you did

References

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journals and conference proceedings

Questions and Discussion