9 steps for simulation

1. **Define the problem**
   - Is there a problem?
   - Top-down approach: start with a general approach, then narrow down definition if necessary.
   - Always approach problem using worst case scenario.
   - Don't build a model with the idea that you will figure out what problems to solve at a later time!
   - A model that represents all aspects of reality for your whole system is either impossible or far too expensive.
   - Make a model that is purposely designed to solve a specific problem.

2. **Set your objectives**
   - Objective must be clear, unambiguous, feasible and workable.
   - The objective is your guide through each step of the project.
   - Discuss the following objectives:
   - List key performance measures
     - throughput
     - utilization
     - lead time
   - List possible alternative experiments
     - Define alternatives early
     - Alternatives will affect how you design the model
   - List all preconditions for the simulation results

3. **Describe the system**
   - Resources
     - processes
     - queues
     - transports
     - shared resources (operators)
   - Products
     - arrivals
     - Pre-stock
   - Product routing
     - merges
     - diverts
   - Product transformations
     - attribute changes
     - assembly
     - splitting
   - Product flow control
     - forced stops
     - controlled release
     - batch flow
   - Resource down times
     - planned
     - unplanned

4. **Collect data and gather detailed information**
   - Input parameters and results (to compare to model outputs)

- Measure
  - time studies
  - multi-moment sampling
- Estimate
  - based on expert knowledge or experience
  - trial and error (match known inputs/outputs)
- Assume
  - if data are not relevant (incorporated in other times)
  - if you are only interested in a relative answer (if A increases, B and C decrease)

5. **Build the model**
   - Keep objective(s) in mind
   - Build small "test" models of difficult parts.
   - Build in stages, getting each stage to work before proceeding.
   - If model is large, possibly make several models of same system, each with different abstraction levels and each with different decisions regarding what can and cannot be left out.
   - As Einstein said: "Keep it as simple as possible, but not simpler."
   - Avoid too much detail: detailed models are not transparent and make it harder to see relation between input and results.

6. **Verify model and validate results**
   - Verification
     - model coincides with the model you wanted to build
   - Validation
     - model coincides with the actual system
   - Ways of judging validity
     - results match system results?
     - behavior correspond with theory?
     - is model capable of predicting?
     - is model accepted by other simulation modelers?
   - 100 % certainty is impossible – at best, we make sure that the behavior of the model is not contradicted by the facts.

7. **Experiment**
   - Run multiple iterations of each experiment and calculate confidence intervals for key performance measures.
   - In each experiment, change only one parameter, otherwise it will be difficult to separate cause-effect relations when analyzing results.
   - Try to optimize iteratively

8. **Analyze the results**
   - Focus on your performance measures
   - Remember your objective
   - Avoid "analysis paralysis" due to data overload
   - Make charts and graphs
   - Look for trends in data
   - Translate results into financial advantages

9. **Report and presentation**