Chapter 2: Introduction to Simulation Modeling

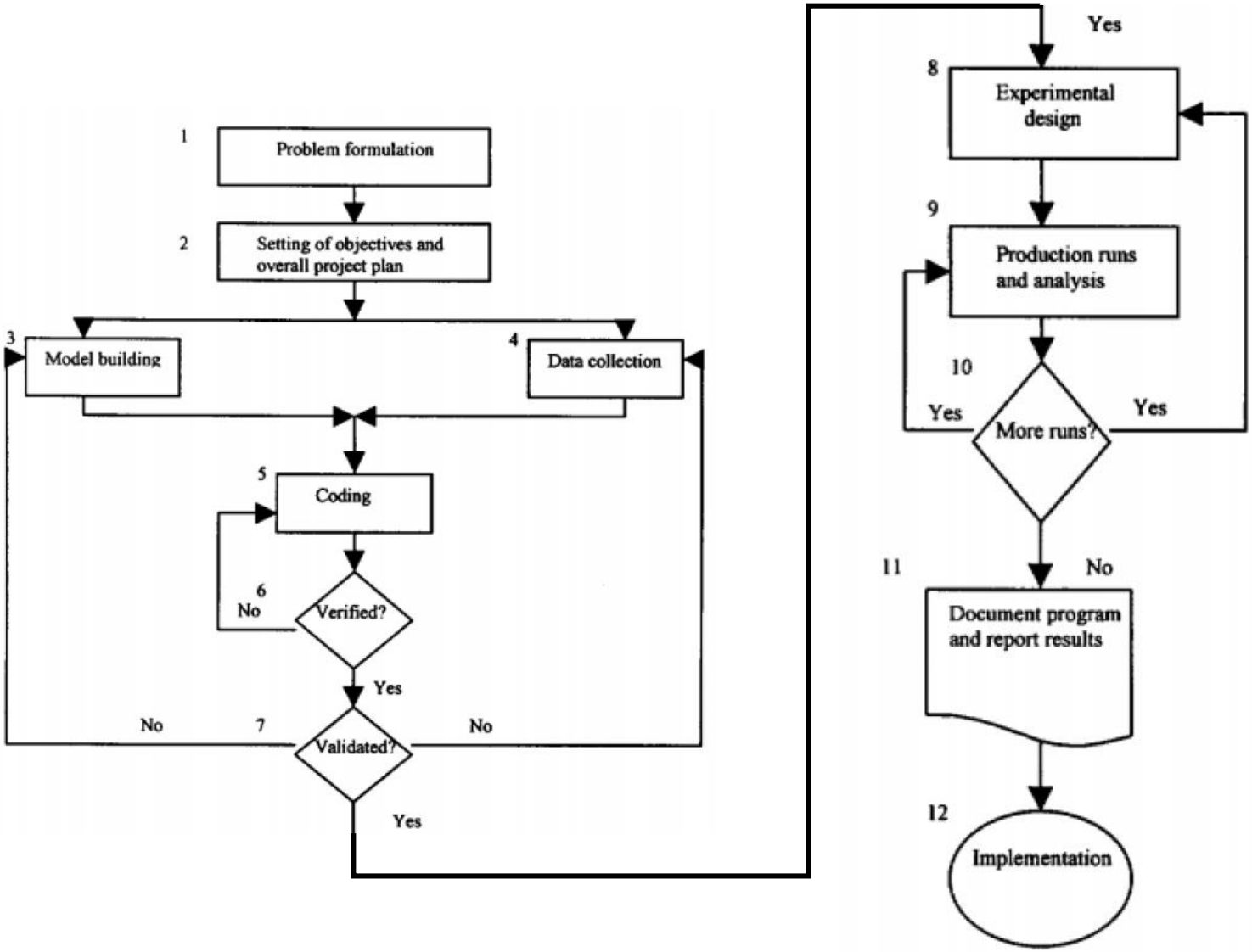
Refer to Text Book:

- "Operations Research: Applications and Algorithms" By Wayne L. Winston ,Ch. 21
- "Operations Research: An Introduction" By Hamdi Taha, Ch. 16

Review Last Lecture

Today’s Lecture Plan

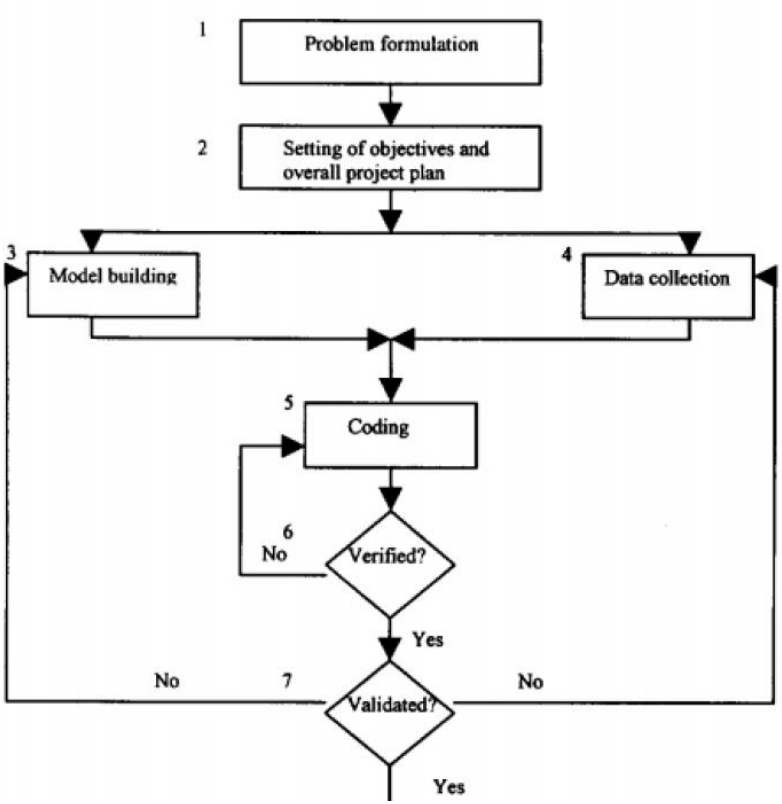
10. Steps for Simulation Modeling



10. Steps for Simulation Modeling

1. Problem formulation

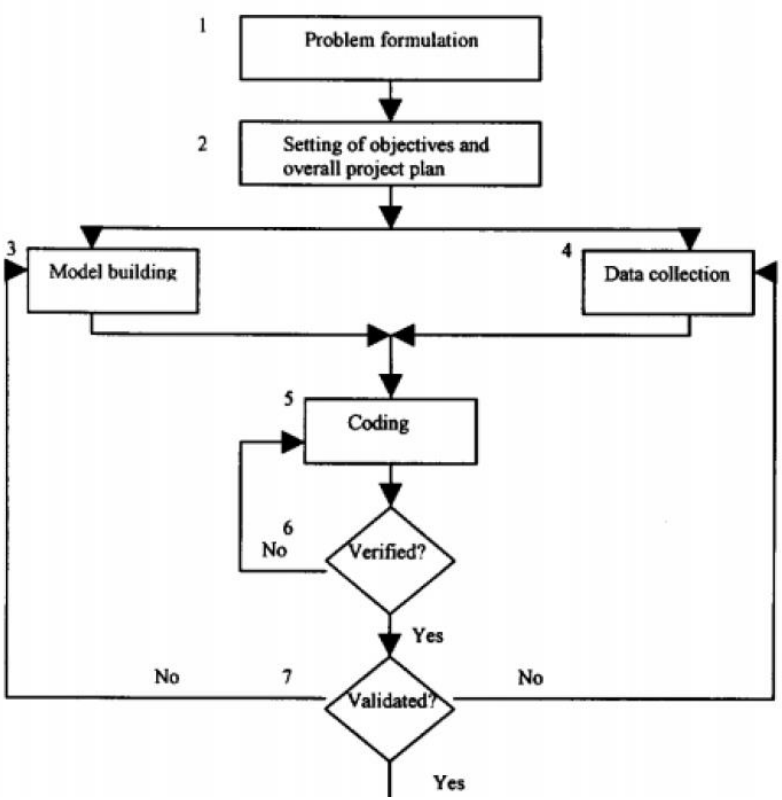
- Statement provided to the analyst by the client who has the problem.
- the simulation analyst must take extreme care to fully and clearly understand the system and its details.
- Analyst prepare the problem statement and must be sure that the client understand it and agree with the formulation.
- The suggested set of assumptions must be prepared by the analyst and agreed by the client.
- Even with all of these precautions, it is possible that the problem will need to be reformulated as the simulation study progresses.



10. Steps for Simulation Modeling

2. Setting of objectives and overall project plan

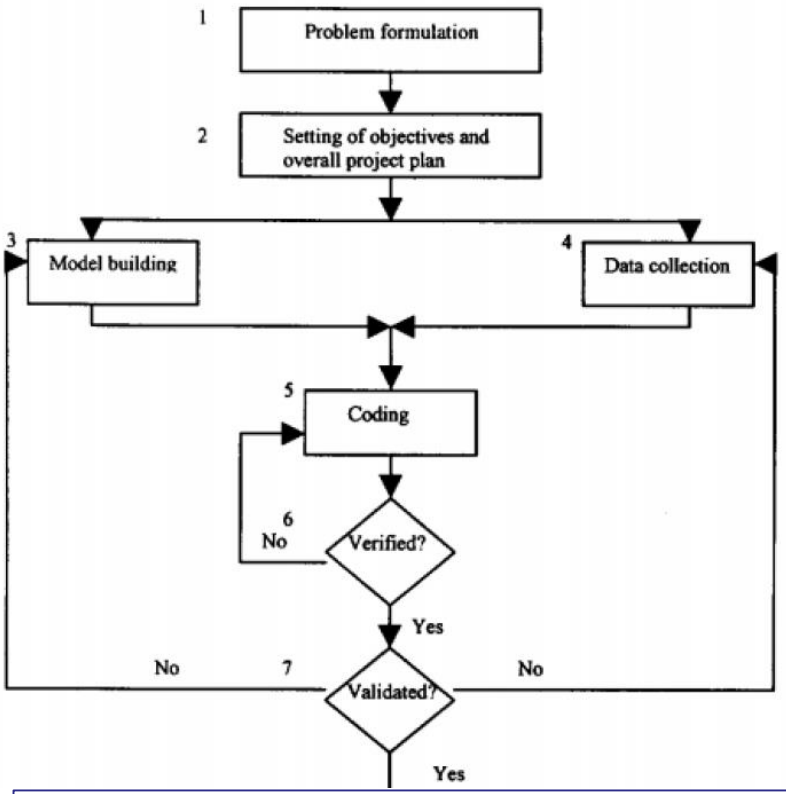
- The objectives indicate the questions that are to be answered by the simulation study.
- The project plan should include a statement of the various scenarios (alternatives) that will be investigated.
- Indicate: the ***time*** that will be required, ***personnel*** that will be used, ***hardware*** and ***software*** requirements if the client wants to run the model and conduct the analysis, stages in the investigation, ***output*** at each stage, ***cost*** of the study.



10. Steps for Simulation Modeling

3. Model conceptualization

- Building series of mathematical and logical relationships concerning the components and the structure of the system.
- Modeling begin simply and that the model grow until a model of appropriate complexity has been developed.
- Finally, add the special features. Constructing an unduly complex model will add to the cost of the study and the time for its completion without increasing the quality of the output.
- Maintaining client involvement will enhance the quality of the resulting model and increase the client's confidence in its use.

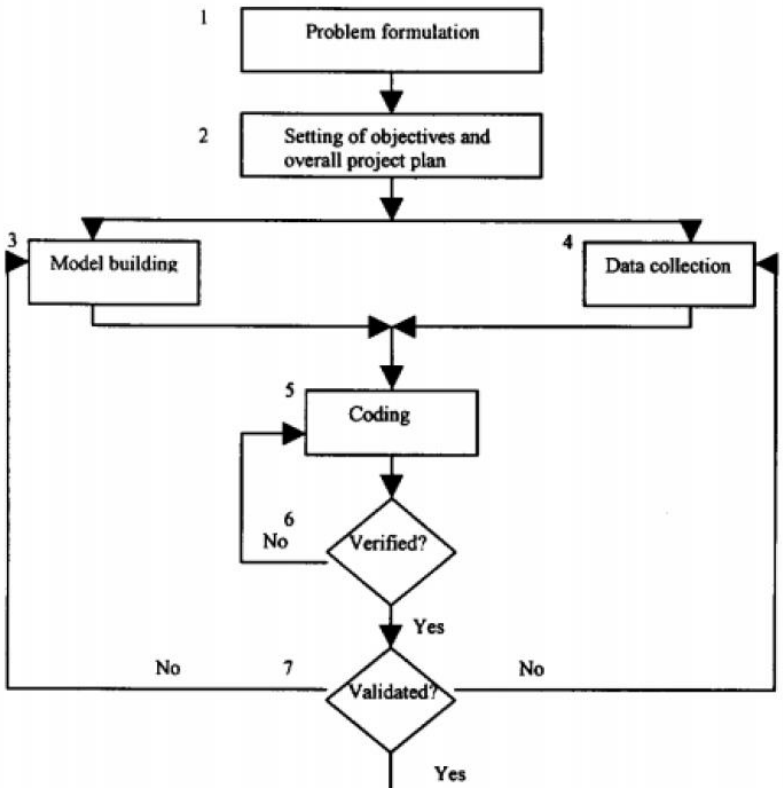


For example, model of a manufacturing system. The basic model with the arrivals, queues and servers is constructed. Then, add the failures and shift schedules. Next, add the material-handling capabilities.

10. Steps for Simulation Modeling

4. Data collection

- After the proposal is "accepted" a schedule of data requirements should be submitted to the client.
- Usually, the client has been collecting the kind of data needed in the format required.
- If the required data are indeed available but different than anticipated which it is needed to be analyzed and prepared.
- Model building and data collection are shown in same level to indicate that the simulation analyst can readily construct the model while the data collection is progressing



For example, in the simulation of an airline-reservation system, the simulation analyst was told "we have every bit of data that you want over the last five years." When the study commenced, the data delivered were the average "talk time" of the reservationist for each of the years. Individual values were needed, not summary measures.

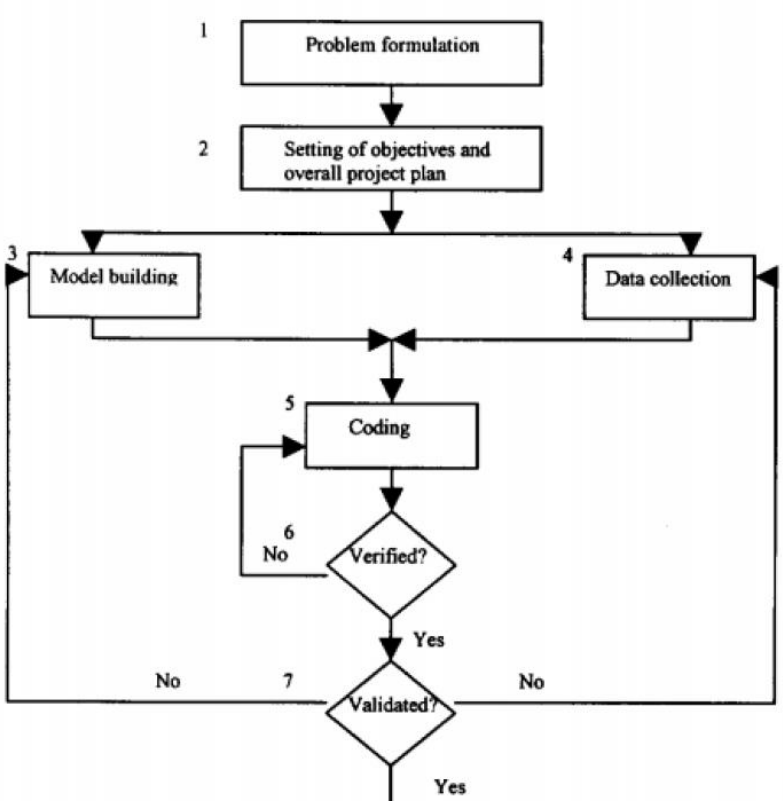
10. Steps for Simulation Modeling

5. Model translation

- The conceptual model constructed in Step 3 is coded into a computer recognizable
- form, an operational model

6. Verified?

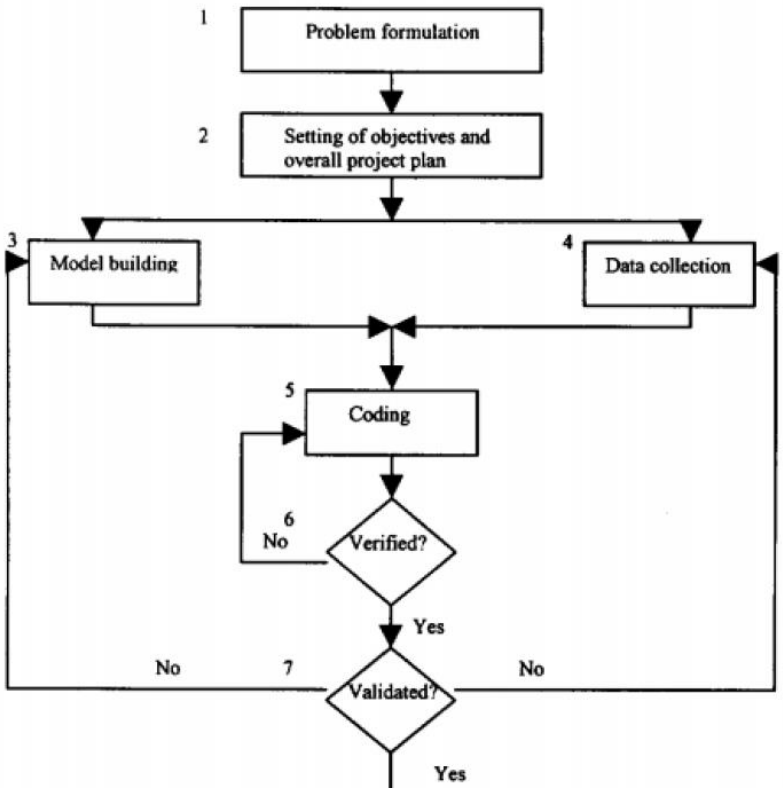
- Verification concerns the operational model.
- Is it performing properly? Does the program run and provide results?
- The simulation analyst wait until the entire model is complete to begin the verification process.
- Also, use of an interactive run controller, or debugger, is highly encouraged as an aid to the verification process.



10. Steps for Simulation Modeling

7. Validated?

- The determination that the conceptual model is an accurate representation of the real system.
- Is the logic of the model correct? Are the entities move in the model as expected?
- Can the model be substituted for the real system for the purposes of experimentation?
- Are the assumptions accepted for the real-system?
- There are many methods for performing validation.



10. Steps for Simulation Modeling

8. Experimental design

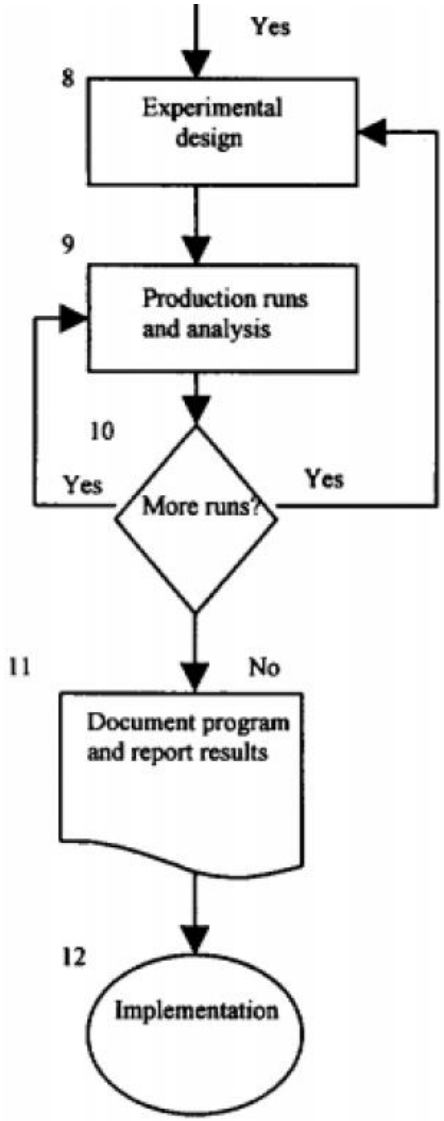
For each scenario that is to be simulated, decisions need to be made concerning the length of the simulation run, the number of runs (also called replications), and the manner of initialization, as required.

9. Production runs and analysis

Production runs, and their subsequent analysis, are used to estimate measures of performance for the scenarios that are being simulated.

10. More runs?

Based on the analysis of runs that have been completed, the simulation analyst determines if additional runs are needed and if any additional scenarios need to be simulated..

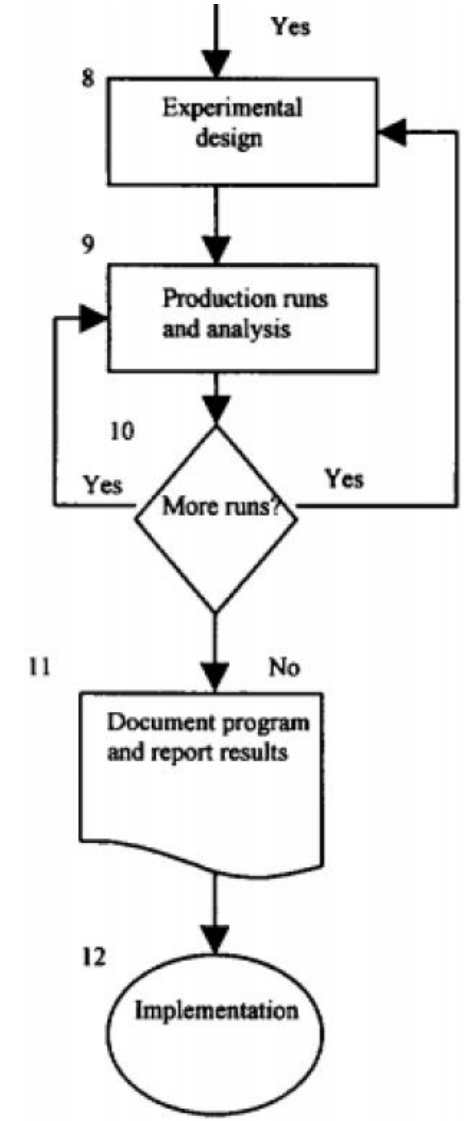


10. Steps for Simulation Modeling

11. Documentation and reporting

Documentation is necessary for numerous reasons.

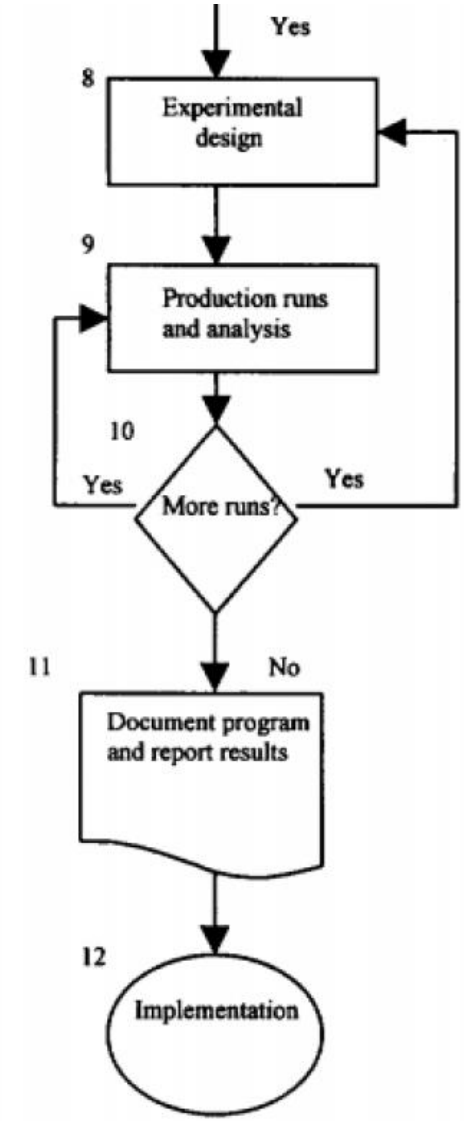
- If the simulation model is going to be used again by the same or different analysts,
- it may be necessary to understand how the simulation model operates.
- This will enable confidence in the simulation model so that the client can make decisions based on the analysis.
- If the model is to be modified, this can be greatly facilitated by adequate documentation.
- The result of all the analysis should be reported clearly and concisely to enable the client to review the final formulation, the alternatives that were addressed, the criterion by which the alternative systems were compared, the results of the experiments, and analyst recommendations, if any.



10. Steps for Simulation Modeling

12. Implementation

- The simulation analyst acts as a reporter rather than an advocate.
- The report prepared in step 11 stands on its merits, and is just additional information that the client uses to make a decision.
- If the client has been involved throughout the study period, and the simulation analyst has followed all of the steps rigorously, then the likelihood of a successful implementation is increased



10. Steps for Simulation Modeling

- **Example:**

Consider a bank with multiple number of servers. The manager is receiving many complains about the long waiting time in line.

1. Problem formulation

- meeting with the manager, the servers and the customers to fully understand the system and its details.
- Prepare a report as follows:
  - The details of the recourses available in the bank
  - The details of the processing and the procedures of the bank
  - Quantify the problem of the long waiting time
- Check if you understand the system correctly with the manager and staff.

10. Steps for Simulation Modeling

2. Setting objectives of the manager

- What are the objectives of the manager and the priorities:
  - Increase efficiency and quality of service
  - Reduce cost
  - Increase customers
  - Reputations

- From the objective develop the project plan
  - various scenarios (alternatives) that will be investigated.
  - Indicate: the ***time*** that will be required, ***personnel*** that will be used, ***hardware*** and ***software*** requirements.

10. Steps for Simulation Modeling

3. Model conceptualization

- What is the arrival pattern of the customers to the bank
- What is the service pattern of the servers
- What is the behavior of customers in line
- What is the affect of the design of the waiting space.
- Is there any mathematical model for this system.
- What are the parameters needed for the model

4. Data collection

- Arrival time of each arrival is needed
- Service time of each arrival
- Waiting time for each customer

Are these data available or start collecting the data manually

10. Steps for Simulation Modeling

5. Model translation

- Build Arena model or GPSSH model

6. Verified?

- Verification concerns the operational model.
- Is it performing properly? Does the program run and provide results?
- The simulation analyst wait until the entire model is complete to begin the verification process.
- Also, use of an interactive run controller, or debugger, is highly encouraged as an aid to the verification process.

7. Validated?

- Do you see customer move in he model the way the move in real model.
- Are the assumptions for arrival pattern or service time distribution accepted for the real-system?
- If you assume no customer leave without service, is it OK?
- If you assume all customers are the same class, is the close to reality?

10. Steps for Simulation Modeling

8. Experimental design

For each scenario that is to be simulated, decisions need to be made concerning the length of the simulation run, the number of runs (also called replications), and the manner of initialization, as required.

9. Production runs and analysis

Production runs, and their subsequent analysis, are used to estimate measures of performance for the scenarios that are being simulated.

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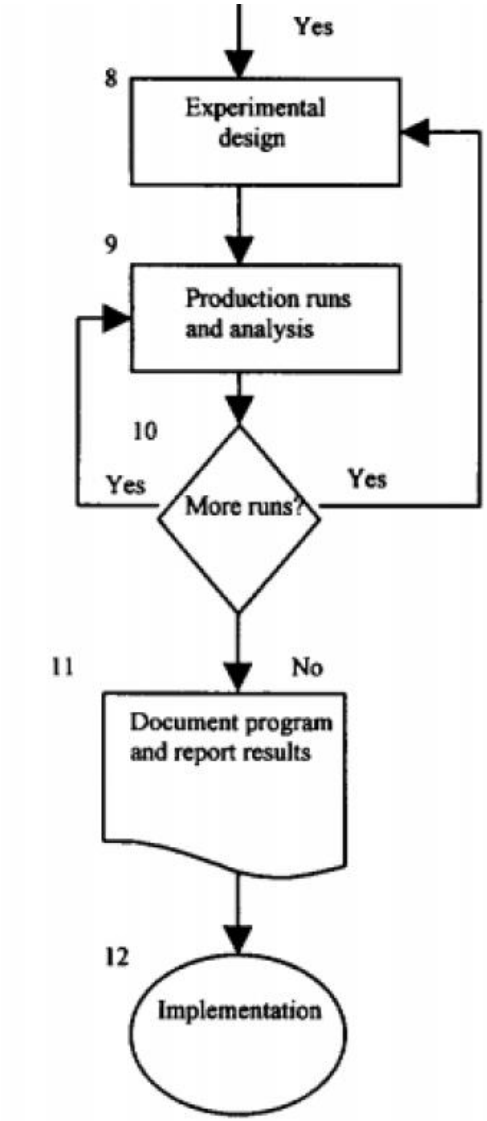

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