

# Simulation in Food Processing - A Review

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**Abstract:** Simulation is very helpful & valuable work tool in manufacturing as well as food processing and packaging. Simulation provides low cost, secure & fast analysis tool. Excellent strategic tool for improving or determining the performance of a current or proposed system. Topics to be discussed include: application, methodology steps in simulation, software & benefits of simulation. This paper provides a comprehensive literature review in simulation.

**Keywords:** Arena Software, Simulation, modeling, Simulation software.

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## I INTRODUCTION

Simulation is the imitation of the operation of a real world process or system over time. Whether done by hand or a computer, simulation involves the generation of an artificial history of a system, and the observation of that artificial history to draw inferences concerning the operating characteristics of the real system [1]. The behavior of a system as it evolves over time is studied by developing a simulation model. Once developed and validated, a model can be used to investigate a wide variety of “what-if” questions about the real-world system [1].

Simulation is used before an existing system is altered or a new system built, to reduce the chances of failure to meet specifications, to eliminate unforeseen bottlenecks, to prevent under or over-utilization of resources, and to optimize system performance. For instance, simulation can be used to answer questions like: What is the best design for a new telecommunications network? What are the associated resource requirements? How will telecommunications network performs when the traffic load increases by 50%? How will a new routing algorithm affect its performance? Which network protocol optimizes network performance? What will be the impact of a link failure? [2]

Implementing change can be a difficult task for any organization, big or small. For this purpose modeling of complex systems such as manufacturing systems is an arduous task. Simulation has gained importance in the past few years and allows designers imagine new systems and enabling them to both quantify and observe behavior. Whether the system is a production line, an operating room or an emergency response system, simulation can be used to study and compare alternative designs or to troubleshoot existing systems. With simulation models, how an existing system might perform if altered could explore, or how a new system might behave before the prototype is even completed, thus saving on costs and lead times. Modeling and simulation are emerging as key technologies to support manufacturing in the 21st century. However, there are differing views on how best to develop, validate and use simulation models in practice. Most development procedures tend to be linear and prescriptive by nature. Several researchers have studied performance by using simulation techniques with the first uses dating back to at least the early 1960`s. Detailed discussions of simulation. In general, may be found in Banks, Carson, and Nelson [1] and Law and Kelton [3]. A practical discussion of the steps in a sound simulation study is given in Law and McComas [4].

## II TYPES OF APPLICATIONS

The first three application areas of simulation, namely; manufacturing, material handling, food & beverages and warehousing and distribution systems, have been the most popular ones among simulation applications if one looks at the published material to date. The following are some of the specific issues that simulation is used to address in food processing:[5]

- Number and type of machines for a particular objective
- Number, type, and physical arrangement of transporters, conveyors, and other support equipment
- Evaluation of a change in product volume or mix
- Evaluation of the effect of a new piece of equipment on an existing manufacturing system
- Labor-requirements planning

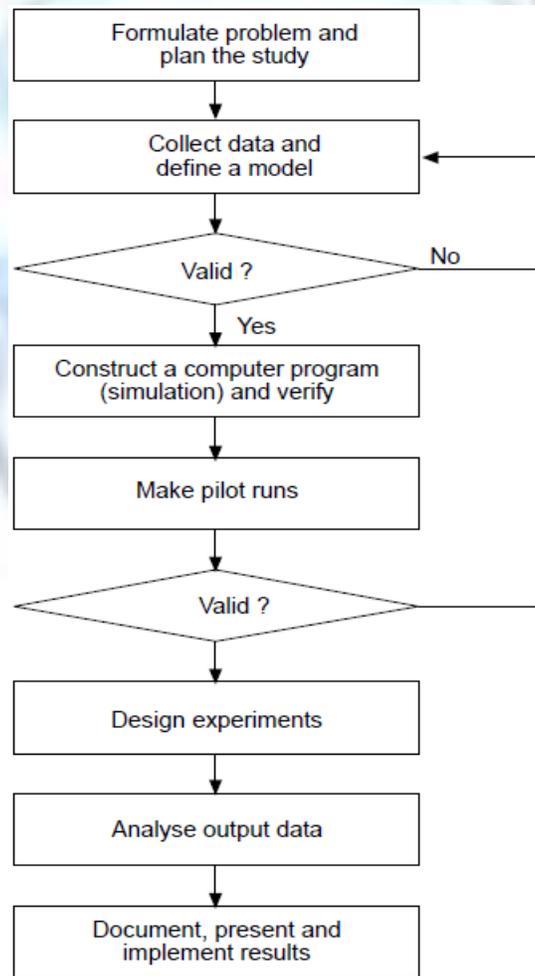
- Bottleneck analysis
- Production scheduling
- Inventory policies
- Throughput
- Time in system for parts
- Times parts spend in queues
- Queue sizes
- Timeliness of deliveries
- Utilization of equipment or personnel

### III METHODOLOGY

Study the current working practices.

- To collect the data.
- Modeling of the current manufacturing scenario.
- Analysis of the bottlenecks.
- Improvement methodologies.
- Modeling different process scenarios to suggest the best practices.

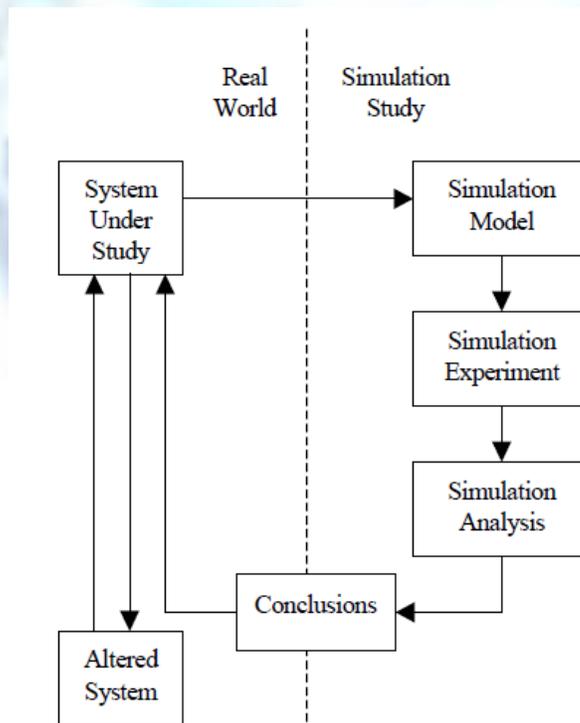
**Tools : Arena 14.50 Software.**



**Figure: Simulation study approach [6]**

#### IV THE SIMULATION STUDY

A simulation of a system is the operation of a model of the system. The model can be reconfigured and experimented with; usually, this is impossible, too expensive or impractical to do in the system it represents. The operation of the model can be studied, and hence, properties concerning the behavior of the actual system or its subsystem can be inferred. In its broadest sense, simulation is a tool to evaluate the performance of a system, existing or proposed, under different configurations of interest and over long periods of real time. Simulation is used before an existing system is altered or a new system built, to reduce the chances of failure to meet specifications, to eliminate unforeseen bottlenecks, to prevent under or over-utilization of resources, and to optimize system performance. For instance, simulation can be used to answer questions like: What is the best design for a new telecommunications network? What are the associated resource requirements? How will a telecommunication network perform when the traffic load increases by 50%? How will a new routing algorithm affect its performance? Which network protocol optimizes network performance? What will be the impact of a link failure? The subject of this tutorial is discrete event simulation in which the central assumption is that the system changes instantaneously in response to certain discrete events. For instance, in an M/M/1 queue – a single server queuing process in which time between arrivals and service time are exponential - an arrival causes the system to change instantaneously. On the other hand, continuous simulators, like flight simulators and weather simulators, attempt to quantify the changes in a system continuously over time in response to controls. Discrete event simulation is less detailed (coarser in its smallest time unit) than continuous simulation but it is much simpler to implement, and hence, is used in a wide variety of situations. Figure 1 is a schematic of a simulation study. The iterative nature of the process is indicated by the system under study becoming the altered system which then becomes the system under study and the cycle repeats. In a simulation study, human decision making is required at all stages, namely, model development, experiment design, output analysis, conclusion formulation, and making decisions to alter the system under study. The only stage where human intervention is not required is the running of the simulations, which most simulation software packages perform efficiently. The important point is that powerful simulation software is merely a hygiene factor - its absence can hurt a simulation study but its presence will not ensure success.



**Figure : Simulation Study Schematic [2]**

The steps involved in developing a simulation model, designing a simulation experiment, and performing simulation analysis are:

- Step 1. Identify the problem.
- Step 2. Formulate the problem.
- Step 3. Collect and process real system data.
- Step 4. Formulate and develop a model.
- Step 5. Validate the model.
- Step 6. Document model for future use.
- Step 7. Select appropriate experimental design.
- Step 8. Establish experimental conditions for runs.
- Step 9. Perform simulation runs.
- Step 10. Interpret and present results.
- Step 11. Recommend further course of action.

Although this is a logical ordering of steps in a simulation study, much iteration at various sub-stages may be required before the objectives of a simulation study are achieved. Not all the steps may be possible and/or required. On the other hand, additional steps may have to be performed. The next three sections describe these steps in detail [2].

## V SIMULATION SOFTWARE

Although a simulation model can be built using general purpose programming languages which are familiar to the analyst, available over a wide variety of platforms, and less expensive, most simulation studies today are implemented using a simulation package. The advantages are reduced programming requirements; natural framework for simulation modeling; conceptual guidance; automated gathering of statistics; graphic symbolism for communication; animation; and increasingly, flexibility to change the model. There are hundreds of simulation products on the market, many with price tags of \$15,000 or more. Naturally, the question of how to select the best simulation software for an application arises. Metrics for evaluation include modeling flexibility, ease of use, modeling structure (hierarchical v/s flat; object-oriented v/s nested), code reusability, graphic user interface, animation, dynamic business graphics, hardware and software requirements, statistical capabilities, output reports and graphical plots, customer support, and documentation. The two types of simulation packages are simulation languages and application-oriented simulators (Table 1). Simulation languages offer more flexibility than the application-oriented simulators. On the other hand, languages require varying amounts of programming expertise. Application-oriented simulators are easier to learn and have modeling constructs closely related to the application. Most simulation packages incorporate animation which is excellent for communication and can be used to debug the simulation program; a "correct looking" animation, however, is not a guarantee of a valid model. More importantly, animation is not a substitute for output analysis. Most organizations that simulate manufacturing or material handling systems use a commercial simulation software product, rather than a general-purpose programming language (e.g., C). Furthermore, the two most common criteria for selecting simulation software are modeling flexibility (ability to model any system regardless of its complexity or uniqueness) and ease of use. The major types of simulation software for manufacturing are defined now.

**Table 5.1 Simulation Packages**

Type Of Simulation Package	Examples
Simulation Languages	Arena (previously SIMAN), AweSim (previously SLAM2), Extend , GPSS, Micro Saint, SIMSCRIPT, SLX <b>Object- oriented software:</b> MODSIM 3, SIMPLE++ <b>Animation software:</b> Proof Animation.
Application Oriented Simulators.	<b>Manufacturing:</b> AutoMod, Extend + MFG, FACTOR /AIM, ManSim / X, MPSIM, ProModel, QUEST, Taylor 2,WITNESS <b>Communications/computer:</b> COMNET 3. NETWORK 2.5, OPNET Modeler, OPNET Planner, SES / Stranteizer, SES / workbench <b>Business:</b> BP\$SIM, Extend + BPR, Process MODEL. Sevice Model, SIMPROCESS,

The programs provided in this table are chosen among the software that has a considerable share in the market. [7]

## **VI BENEFITS OF SIMULATION STUDY**

- 1) Excellent strategic tool for improving or determining the performance of a current or proposed system.
- 2) Evaluate where to focus process improvement initiatives by seeing effect on overall system.
- 3) Design your system correctly the first time including convey or lengths, accumulation sizing, and sensor positioning.
- 4) Easier-to-use flowchart-style, object-oriented modeling environment is the ideal way to bring the power of modeling and simulation to business process improvement.
- 5) Using the virtual Packaging Edition can reveal the impact of a proposed change on your throughput, operational effectiveness, and profit margins.
- 6) Helps you predict system performance based on key metrics such as throughput, utilization, blockages / starvations, and effective run rates.[8]

## **CONCLUSION**

The simulation model recreates all the operations in a three-dimensional virtual environment giving the possibility to see, during the animation the human models performing the required operations. In such context the simulation has been used as cognitive tool. In fact the validation of the simulation model has required detailed discussions with system's experts as well as iterative integration of sequence motions. On the other hand, simulations of these kinds of systems generally begin with the system in an empty and idle state. This results in the output data from the beginning of the simulation run not being representative of the desired "normal" behavior of the system. Therefore, simulations are often run for a certain amount of time, the warm-up period, before the output data are actually used to estimate the desired performance measure. The use of simulation to check out and validate process automation systems, perform software acceptance tests and train operators provides numerous benefits to companies in the process industries. These benefits are from enhancing operator performance to incident avoidance.

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