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# CHALLENGES OF INTRODUCING SIMULATION AS A DECISION MAKING TOOL

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## ABSTRACT

Over the years, simulation models have been successfully built to observe the behavior of systems. Despite advances in the field and its growth in popularity, when simulation is to be introduced to an organization, there are challenges to be met including acceptance by staff, availability of staff to describe the various operations, existence of useful data, and management expectations. Organizations are continuously collecting data, which may lead one to believe that developing stochastic models of an organization's activities should be easy. However, elicitation of useful information may end up being a major bottleneck because usually the information system collecting such data is not designed for stochastic modeling. Unrealistic management expectations may result in simulation modeling being thrown away when these expectations are not met. Success in introducing simulation modeling will depend heavily on how well these challenges are addressed and managed.

## 1 INTRODUCTION

Introducing simulation modeling to an organization is not a trivial task. Challenges are found at the various stages of the simulation modeling process (SMP) (Figure 1), and include acceptance by staff, availability of staff to describe the various processes, existence of useful data, and management expectations. Many a times, the first simulation study is conducted by an external consultant in part because in-house staff is not familiar with the technique, and in part because the staff is busy with every day tasks. Yet, staff members must interact with the consultant to describe the operations that are to be modeled. Organizations collect tons of data; this may lead one to believe that developing stochastic models of an organization's activities should be easy. However, elicitation of useful information may end up being a major bottleneck because usually the design of the information system collecting such data ignores the requirements of stochastic modeling. Unrealistic expectations from management may result in simulation modeling being considered as an empty promise tool. Hence, the effective and continuous use of simulation modeling will depend heavily on how well these challenges are addressed and managed.

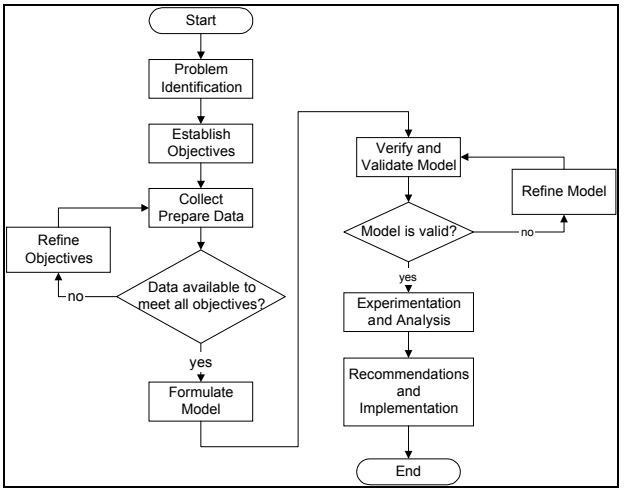


Figure 1: Simulation Modeling Process

In this paper, we discuss how these challenges present themselves and how they can be addressed. Experiences from several real-world cases are used to exemplify these challenges and the responses to them.

## 2 GETTING READY TO USE SIMULATION

The desire to use simulation modeling usually starts with one person in the organization who ran across a publication, a case study or, a simulation expert. Depending on his or her position, this person may assign someone to be the champion of simulation studies, or he or she ends up being the champion by acting as a point of contact to external consultants as well as internal project manager. A lot of the success of the simulation studies will be due to the diligent work of the champion in securing funds and other resources necessary. Although it is not necessary for the champion to be thoroughly knowledgeable about the simulation modeling process (SMP), it is paramount that he or she be well acquainted with it.

The first hurdle that the champion will face is securing funds to hire a consultant, to acquire a simulation tool, or to obtain simulation know-how. To convince upper management in appropriating such funds, the champion must acquaint him or herself with the SMP (Figure 1) and with the advantages (Table 1) and limitations of simulation (Table 2). Maintaining communication with a potential external consultant facilitates the task of learning.

Table 1: Advantages and Disadvantages of Simulation

| **Advantages of Simulation** |
|---|
| o Once a model is built, it can be used repeatedly for various analyses.<br>o Simulation data is usually cheaper than data coming from the real system.<br>o Simulation Methods are usually easier to apply than analytic methods.<br>o Simulation models do not require the many simplifying assumptions of analytic methods. |
| **Disadvantages of Simulation** |
| o Simulation models may be costly to build.<br>o Because of its statistical nature, many runs of the same model are necessary to achieve reliable data.<br>o Once the methodology is well understood, there is the tendency to use it even though analytic techniques would suffice. |

Table 2: Simulation Capabilities and Limitations

| **Simulation Can:** |
|---|
| Provide *estimates* of measures of performance, e.g.:<br>o Time in the system.<br>o Worker / machine utilization.<br>o Number in the queue.<br>o Time in the queue. |
| Evaluate the *effect of changes* to system operational parameters:<br>o Changes to system inputs / resources such as rate of arrival, rate of service.<br>o Number of trucks available to move material from one work station to another. |
| **Simulation Cannot:** |
| o It cannot optimize your system's performance; it can only describe the results of "*what-if*" scenarios or questions.<br>o It cannot give accurate results if the inputs are inaccurate.<br>o It cannot describe characteristics that have not been explicitly modeled.<br>o It cannot solve problems; it can only provide information from which solutions can be inferred. |

Once the funds have been secured, the champion must decide on an overall strategy for the introduction and use of simulation. In deciding such strategy, he or she must answer questions such as: *will there be several simulation studies? What will be more cost effective, hire an external consultant or develop in-house simulation capability? What is the time frame to demonstrate the potential of the simulation modeling technique? How receptive is upper management to the introduction of new modeling tools and techniques?* Depending on the answers, the champion will be confronted with different challenges. If the decision is to hire an external consultant, then the champion must research who offers the most expertise at a reasonable price. This is not a one-day activity as there are many consulting firms. One way to screen out these companies is to request references from the consulting firm's past and current customers. If the decision is to develop in-house simulation expertise, then the champion must research which university or consulting firm offers intensive courses at a convenient schedule.

A word of caution: *time is of the essence!* Doing a thorough research is wonderful, but delivering an acceptable decision in a timely manner is priceless ☺! Hence, the first simulation study must be chosen carefully to ensure that the study itself is completed successfully and that the results obtained from the study are meaningful and useful to decision makers.

The simulation team must be aware that as part of that critical first study, they must include an educational track to explain what the power and limitations of simulation modeling are. In many organizations, current staff members are excellent professionals that have moved through the ranks, and in recognition to their valuable contributions they are promoted to management. For example, in hospitals, their background is medical and they have not necessarily being exposed to many of the existing modeling and analysis techniques. In the aerospace industry, many staff members are highly trained design engineers, but not necessarily stochastic modelers. When the technique being used for modeling and analysis is not intuitive, the analyst faces the up-hill battle of gaining the buy-in of those who, in the end, will benefit from it. Consequently, this educational track should be geared to upper management as well as floor staff. Educating the involved parties tends to ensure continued support, and it helps in building confidence in the results of the model as well as of the technique.

Our experiences with various companies, as well as the experiences of others, documented in the literature, indicate that there are at least four possible attitudes that one may find when introducing simulation to an organization:

- *Total Skepticism:* This can be noticed when staff begins expressing phrases such as "it will not work because the procedures we use are too complex," "every case is unique, so it is not possible to generalized," "patients are supposed to be on time, but they are not," "there is no pattern as to when a

they are not," "there is no pattern as to when a Problem Report will occur," "you cannot predict unplanned work," "we are doing fine the way it is."

- *Magical Excitement:* This is a tricky attitude because it is not readily seen, but the staff begins to form expectations that dwell on the magical. Simulation is perceived as the magic wand that will solve all problems. Either upper management or other staff members tend to think that once the model is built, it will be able to represent any and all areas of company, without major changes to it. In other words, they expect a reusable simulator.
- *Uncommitted Support:* Staff is interested, sees the potential, but believes it has no time or resources to support the effort. The need to have simulation models is in many cases well understood, but either skepticism is getting in the way, or there are political and budgetary forces working against it.
- *Supportive:* Staff recognizes the value of it and is willing to support the effort in as much as they can

Skepticism is the toughest attitude to encounter; however, if the analyst goes in aware of it, he or she can address it in several forms. He or she may take the educational approach as to what simulation can do in general, and from there proceed to a what simulation can do for them in their department. The key is to create an environment of dialog, informative, of questions and answers. The words "exploratory study" are of great value when trying to overcome skepticism. Skeptics tend to be so because they really do not know much about the topic, but once they understand it, and see the value of it, they may become the strongest supporters of it.

Magical excitement may be a double jagged sword. Individuals form extremely high expectations, and when the simulation study does not delivers them, total discontent sinks in. Having some one with this attitude is a golden mine though, if and only if it is tapped to promote the study, but at the same time the individuals are educated as to the limitations of the simulation technique.

Uncommitted support is a natural attitude in very stringent and demanding work environments. These environments are typically found in hospitals, emergency rooms, JIT, high volume manufacturing. Even though staff may recognize the value of using simulation, they also realize that the day only has 24 hours, and that committing to one more thing is just simply impossible. In these cases, the champion and the analyst should work together to ensure that the staff assigned to the project gets the appropriate release time to work on the simulation study.

In every group of people, there are those individuals that are visionaries. They tend to be proactive in their approach to their work; hence, they have an open mind to new ideas and new approaches. The analyst must nurture these individuals, so that they become the support point to reach the rest of the staff involved and affected by the project.

## 3 UNDERSTANDING THE OPERATIONS TO MODEL

It does not matter how great the internal or external consultant is, nobody knows the operations as those who one them. Once moderate to strong support has been attained, the process of understanding the business practices as well as operations becomes the issue. Typically, visits to the facility and interviews with staff are necessary. The availability of personnel may go either way: available on demand, or not available.

Regardless of which one is the case, champion and analyst must be prepared to elicit *crucial* information regarding operational issues. Assuming that he staff being interviewed is highly cooperative, there is the possibility that the original operations are being executed differently due to budgetary or political factors. For example, in simulation the operations of the Operating Room at a hospital, it was revealed that the source of perceived problems was not the lack of resources only. The interviews revealed that the problems within the OR environment were rooted in factors such as the poor scheduling of other departments, the late start of the first cases within the OR, the poor scheduling of procedures, which leads to equipment delays, and the use of common staff to transfer patients. In simulating the allocation of quality inspectors at an aerospace company, the initial interviewed showed that the way the operations were done varied from department to the department as well as from inspector to inspector.

As interviews with the process owners proceed, one may find that staff seniority, changes in company's goals, and reduction in staff size may have affected the way the operations are done significantly. Caution must be used so that it is clarify if the simulation model will represent the "theoretical" operations or the "real" operations.

In response to these challenges, one must interact with the staff and with the champion on a continuous basis until a cohesive flowchart of the operations is developed and agreed upon. Use of tools such a Visio or Flowcharter to develop the chart and then sit down and discuss it with the staff. Without these charts, you may end up building a model of the wrong process! ☺.

## 4 FROM DATA TO MODEL INPUTS

Many organizations utilize databases to collect data and generate information. In many instances, these databases are constantly being populated, but the information does not necessarily end up in the bucket! For example, a company that paints a protective coating to large structures may find itself collecting data at three different places: prespraying operations go in one system, spraying operations

data goes in another database, and inspection data goes into a third different place. To further complicate matters, these different storage medium may not be compatible. AS another example, a large medical facility may have an extensive database describing the various activities within the Radiology Department. Records from this database can easily be extracted, but analyzing them to establish probabilistic models for the inputs of the simulation model may be a challenge.

These scenarios are not that rare in industry. They happened because the operations generating data require the use of heterogeneous and diverse equipment. In the first example, the robotic arm used to do the actual spraying may be utilization proprietary, manufacturer's software and database. In the second example, the database may be accepting inputs from several departments.

A first hurdle that one has to deal with is the vast amount of records. Even for a small department, we are talking thousands of records. Once the means to extract and manage these records has been established, the second hurdle shows up: quality of the data. Quantity does not mean quality. It is relatively easy to populate a database, but to populate it with the correct data is another story; hence, a thorough analysis of the records must be done to ascertain which records are good, and which records should be discarded (Figure 2).

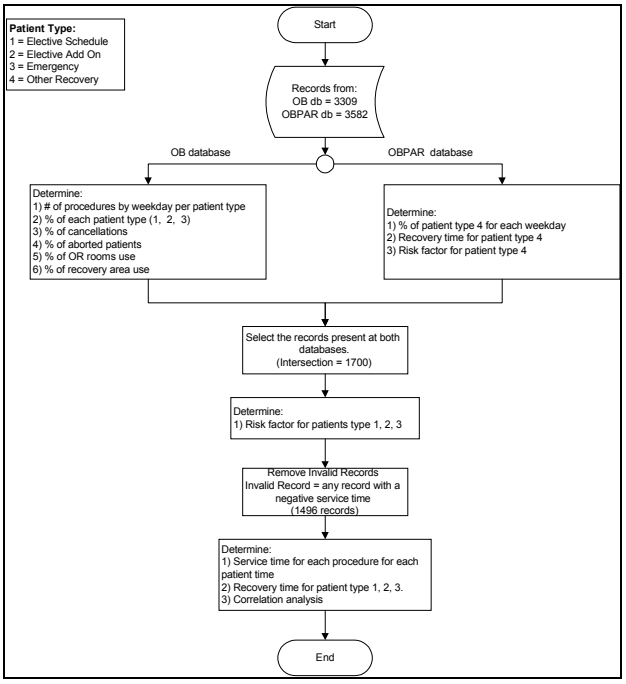


Figure 2: A Sample of Record Filtering

Filtering records out can only be done if there has been enough candor during the interviews with the staff. Staff tends to be cautious about what they say if the data entry process is their responsibility. It is human nature to be quick to tell on others, and to shy away when it comes to us. Sources of data as well as the filtering process must be carefully documented so that at a later stage, the process can be explained to interested parties.

Once the good records have been selected, the analysis begins and the focus turns to explaining why the data values vary so much, and establishing percentages as needed. For instance, in one study, we identified that special and neuro procedures do not occur in a steady fashion; thus, they had to be treated as special cases that occur with a certain percentage. Further, we found that the data varied significantly due to the subjective nature of the procedures. Some physicians take longer than others and may have different methods of performing the procedures.

In the end, existing databases should lead to a good set of inputs to the model. Of course, it is possible that one finds little or no data at all. In these cases, sound and feasible objectives become highly critical as they determine data needs. If not careful, one may find oneself spending at least twice the amount allocated to data collection and analysis. Furthermore, if there is no data to support the objective, the study will fail as the model may end up being a nice toy good for nothing ☺!

## 5 THE SIMULATION PACKAGE

Researching for and purchasing the right simulation tool for the institution is also a critical decision that a simulation team must make before they even engage in doing any simulation.

The market has many reliable simulation packages to choose from. Each package tend to have an orientation or strength. Find out which one each of these packages have. Then decide which one to use. Ability to do input analysis, output analysis, as well as animation capability are some of the factors to consider. There are magazines that every so often do a major evaluation of market characteristics. Use these reviews to help you in deciding for a package (Swain (2001), Elliot (2000)).

## 6 MODELING AND ANALYSIS

Modeling enables the mimicking of reality. A model must be certified as an accurate representation of such reality. Without such certification, the results of any and all experimentation with the model may be questionable.

There two aspect to obtaining such certification: verification and validation. Of the two, verification is the easiest one as it simple requires checking out that the model has been built as one intended it to build; whereas, validation is the process of insuring that the model truly represents the real world. The *customers* of the model must believe the model for them to accept the recommendations. Validation may be done by observing the behavior of the model through animation, and by looking at the results and

ensuring that the processing times, waiting times, number of patients per day, etc. gave reasonable results. Practical ways of validating the model include 1) the utilization of constants in lieu of distributions, 2) enabling traces over time, 3) engaging in a *walk through* of the model to ensure that patients are routed correctly through the system. But of all the empirical techniques, there is nothing like animation to achieve customer buy-in that the model is valid. Seeing the patients as well as the resources flow through the system on the screen really makes a lot of believers.

Once a model is considered valid, the experimentation begins. This is the fun part! Based on the objectives of the study, several alternatives are studied. Tons of output is generated by the simulation model, and then these outputs must be analyzed to make sense of them. Yes, … You must use statistics! A lot of support has been developed in the last decade for this activity, so do not panic just yet.

The major challenge on this aspect is avoiding running out of time for the final analysis. At times, model builders fall so much in love with the model that they keep on refining it and refining it! Then, time is up and the presentation to management is upon him or her! As soon as the objectives are set, start thinking about the various experimental conditions. Poor planning for the analysis phase may lead to a disaster.

## 7 SUMMARY

Simulation has proven to be a useful and powerful tool for modeling operations in several types of industry. However, it is not necessarily a tool without risk. This risk is not unique to simulation, but if you are in charge of introducing it an organization you must be aware of the various challenges.

Although there is no recipe to ensure success, there are several things that you can do to promote it:

- Become or assign a champion to the effort.
- Establish clear objectives.
- Plan carefully.
- Develop a realistic timeline.
- Review and reassess continuously as the projects evolve.

The effectiveness and acceptance of the technique, however, requires patience and an understanding of the psychology of medical personnel. The simulation analyst must be prepared to deal with skepticism. The analyst should be ready to educate the staff otherwise the project may fail.

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