Introduction

There are many kinds of simulation. We've all seen examples of flight simulators. You can walk down to your local computer gaming store and get any number of political simulations such as SimCity™. These are all called 'simulations' because they imitate reality. A computer simulation model can be thought of as a virtual representation of a system or process where the goal is to mimic, or simulate, a real system so that you can explore it, perform experiments on it, and understand it without having to make changes to the real system. This, of course, translates into the ability to identify bottom line opportunities for system improvement without spending a fortune in the examination process. It also allows you to examine the expected behavior of systems that have yet to be created.

Simulation is used to help people make decisions and to communicate the effects that those decisions have on the given system. It allows the comparison of different sets of scenarios so that the decision-maker can formulate judgments after considering all possible angles. Simulation languages, such as SIMUL8, show the flow of work through a system, one event at a time, with all the key interactions shown graphically on the computer screen. These graphics can be animated and the results output in hardcopy for analysis and examination.

Simulation is well-suited to any situation involving a process flow. Because it is not dependent upon any particular analytical formula, simulation is not limited by restrictive modeling assumptions. Instead, it can be used to represent complicated dynamic interactions. Perhaps the greatest strength of simulation, however, lies in its ability to accurately reflect the randomness that we see in the real world. Some of the areas naturally involving randomness include arrival patterns, service times, travel times between stages in a network, and many more. The ability to model this variation, therefore, allows us to better understand how a system will function under a variety of scenarios.

As an example of how important randomness can be in a system, consider a grocery store line with a single cashier. If we know that customers arrive exactly every 10 minutes, and that the cashier can process a single customer in exactly 9 minutes, it is easy to see that no troublesome line would ever form. As we all know, that's not what happens in the real world. Instead, there is wide variation both in how customers arrive and in how long they take to be processed. At 5:30 p.m. on a weekday, customers arrive much more frequently than normal. In addition, they arrive with a varying number of groceries in their carts. Customers range from someone stopping by to pick up a gallon of milk, to a customer stocking up for the week. The length of the cashier's line will vary dramatically depending upon how many items each customer has, and the order in which the customers arrive.

As you can see, randomness is responsible for creating the variations in the length of the line. Simply replacing a random process with its mean provides very misleading results since it isn't average service times or arrival rates alone that cause the lines and waiting times to fluctuate. As an introduction to the world of discrete event simulation, we would like to walk you through an overview of what we mean by the term 'discrete event simulation,' and how this type of simulation is used.

We will be using a very specific kind of simulation known as discrete event simulation (DES). The first two words of that term are very important, yet often overlooked. In DES, everything is event driven, and each event is treated individually. Because events are individualized, it is possible to have enormous control over the way in which each event and the associated items flow through the system. This control, in turn, makes it possible to create very accurate models.

What, then, is an event? That all depends on the system you are considering. If you are modeling a telephone contact center, for example, an event could be the arrival of a customer's call into the system, or an agent picking up a call, or a customer choosing to abandon a call. A manufacturing model, on the other hand, might involve events such as passing a certain raw material through a tooling machine, or moving an item from a finished goods inventory to the shipping department.

There is no doubt that the field of discrete event simulation is currently enjoying a period of exploding popularity and awareness. In fact, we commonly see it referred to as a new, or emerging, technology. While it is true that simulation is seeing use in more industries and applications than ever before, it is far from new, having already enjoyed a long and distinguished past.

Simulation has been used, especially in manufacturing, for over 30 years. As the awareness of simulation technology has increased, it has seen application across an increasingly broad range of industries. Some selected examples and typical questions answered include:

- Supply chain and logistics analysis – What is the effect of various shipping policies on cost, delivery lead times, and inventory levels?
- Call Centers – What kind of service level, average waiting times, abandonment levels, etc. can I expect given a particular staffing plan and set of call routing scripts?
- Healthcare – How should clinics be managed to balance patient service levels versus organizational health?
- Manufacturing – If I redesign the process, what effect will it have on cycle times, costs, and inventory levels?
- Capacity Planning – Given several distinct and competing demand patterns, along with operating procedures, determine whether planned capacity will be sufficient.

Simulation provides tremendous value to any organization in which the balance between workflow and capacity must be optimized, and usually "pays for itself" very quickly. Simulation has been known to save our clients millions of dollars by determining bottlenecks in the current system or eliminating the risk of improper implementations in a proposed system.