The Three Reasons Why Simulation Fails

No matter how hard people may try, simulation often fails to catch on, or even be welcomed into the operations roster of companies. Simulation is one of the most innovative, cost effective and rewarding ideas to come down the pike in many years. Then why doesn't it receive wider acceptance? The answer deceptively simple according to the experts. Simulation fails due to three reasons—salesmanship, education and time.

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As a managerial tool, it's probably the single most innovative, cost effective, and rewarding idea to come down the assembly line since the Model T. Used correctly, it can save a company thousands of dollars by identifying errors in manufacturing layout, balancing, technology selection and so on, well before they become locked in concrete. More importantly, using it can be both fun and insightful even under the worst of circumstances. Yet, despite all of this, it seems like more new enthusiasts, innovators, and just plain doers who have stumbled on the potential value of simulation for their companies, fail at some stage of implementing their discovery. The big question isn't "how" but "why?"

As simple as the question sounds, you'd think that someone would have addressed it by now. In fact, a few academics have tried but not with much success. You see, the problem is only partially academic and true industrial users rarely are. So, purely academic answers don't always fit. Well recognized authorities have certainly covered everything from the pitfalls of correct distribution selection to the wisdom of flow analysis but none of them has really touched on the bare issues of why we can't make such a valuable tool work much less gain corporate acceptance. When you look at it in the proper perspective though, the answer is deceptively simple. Judging from the feedback from a rather large array of "users", there are really only three reasons simulation fails to catch on: salesmanship, education and time.

Salesmanship

The first and most critical step in establishing simulation as a recognized managerial tool is to get it in the door. The old idea that all organizations (and their managers) resist change has merit and can't be ignored. Couple that with the "chronic skepticism" in which most bureaucrats find no little measure of solace and you've got a pretty good barrier to innovation. . . particularly if it costs over $10. The idea of selling problem solving through simulation successfully then, goes beyond the realm of just good presentation technique and well into the arena of just plain common sense. The fact of the matter is that you have to become a guerrilla of sorts to get your point across and to be a good guerrilla you've got to know the rules. Fortunately, there are only a few simple rules to know and they are the "four pillars of simulation salesmanship."

Be selective about your audience: No guerrilla force attacks all targets and every target with equal vigor. If they did there would be a lot less guerrillas to contend with and that's a fact. What makes them successful (when they are) is their careful selection of the right target and the right time. In this respect, most employees would never dash into the CEO's office with a new or revolutionary idea regardless of its intuitive merit. The opportunity for failure is just too great and the accompanying embarrassment too prohibitive. In fact, it's far more beneficial to start at a much lower level. . . much lower than you might think.

The basic message here is that we all crave recognition and, to a certain extent, glory. That's human nature. Sharing ideas that might produce such glory with subordinates and peers isn't human nature. But, it's the best idea for selling the use of simulation. Like guerrillas, people who build internal coalitions of support for their ideas generally get farther than those who don't. Guerrillas appeal to the populace first and you should too. If you can get a peer's attention and his willingness to simply consider your idea, you can get his support. After that, there will be two of you selling the idea and that makes a far more formidable force for others to contend with.

The key here is, **No Hard Sell!** That's the fun part of simulation. For example, with the right kind of sample problem, anyone can sell the wisdom of simulation. With the right kind of graphic display, simulation will sell itself. Admittedly, it's the wrong use of graphics, but it works because the process entertains the viewer and appeals to more than one sense.

Now, how do you know who to approach in the first place? Well, the best idea is to stay away from people that are less busy than you are, give a general appearance of being disinterested in anything beyond next week's ball game, or think that "technology" is a subject taught only in a university in Georgia. Anyone else is basically fair game as long as you remember the old adage about "casting your pearls. . . ." In the final analysis, all you really have to learn is who to avoid.

Select the proper explanation: As strange as it may sound, there are quite a few people who simply don't fully understand what simulation is. To them, investigative or experimental simulation and training simulation (e.g. a flight simulator) are often thought of as one and the same when, in fact, they're not. To be an effective training device for example, a simulation must contain all necessary responses in both direction and degree for any given set of inputs that the trainee is expected to provide. In other words, the training simulation is purely deterministic. . . there should be no surprises! No matter how the trainee acts, the trainer should know exactly what the simulation's response will be. By contrast, investigative or experimental simulations can render not only surprise but somewhat unpredictable results as well. In this case, exact outcomes are rarely anticipated and it's not at all unusual to obtain an outcome that's relatively unexpected. In essence, training simulation seeks to represent the results of a pre-determined cause and effect relationship whereas investigative or experimental simulation seeks to explore both the existence and degree of a relationship. It's just that simple (tongue in cheek!).

Select the proper benefits: Once you've raised the issue of the value of simulation as a decision support tool, someone will undoubtedly ask about it's merits and benefits. . . someone always does. As strongly as you may believe that it's the best thing since sliced bread, there are probably better ways of putting it. In fact, there are three important things to remember. Probably better than any other method, simulation improves (1) insight, (2) comprehension and (3) communication concerning a system's performance. These are the real benefits of simulation and you ought to commit them to memory. Here's why.

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First of all, simulation is unique in that it allows you to view a dynamic system in a way nothing else can while simultaneously providing insight in ways traditional methods of analysis cannot. This is the real strength of simulation and ought to be emphasized. At the same time, simulation is multi-faceted. Not only does it allow the user to go easily beyond the general limits of elementary comprehension when analyzing a system, it gives a good picture of how the system behaves and what factors represent REAL performance indicators under different circumstances. This one characteristic alone can add a whole new dimension of understanding, enthusiasm and excitement to problem solving. Yes, excitement!. . . the one element that adds vitality to discovery and makes each day a pleasure!

Finally, no matter what the length of your company's planning horizon, simulation can be your crystal ball. It can be used not only to discover but to communicate to others what may be on the other side of the "fiscal" hill — from potential obstacles, problems, and threats to opportunities for improvement and new strategic advantage.

Follow-up: The key to all successful salesmanship is follow-up. Ideas and innovations are the flowers of their sponsors and, like flowers, require attention. Follow-up is the fertilizer of that hypothetical garden and provides the nourishment to keep ideas growing. That's probably all that needs to be said except. . . don't over-fertilize!

Education

All inquiry begins with an individual's perception of the difference between something he has assumed to be true and the way it actually is. The greater the difference, the more immediate the perception - assuming, of course, that the individual has the tools to detect a difference. A first time bowler for example, may be convinced that rolling a straight ball with sufficient power should yield the greatest number of pins. That is, until he watches the smooth, comparatively effortless curve ball delivery of a seasoned professional. Education tempered with experience provides the basis for detecting the difference while wisdom provides the incentive to change. Wisdom is knowing what to do and then doing it. Education is knowing how. The problem with simulation is that we tend to let wisdom substitute for education. Unfortunately, there's the problem. You can't. There are certain skills you must have to simulate successfully and they are the "four educational pillars of successful simulation."

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Statistics: You don't need a Master's degree but you do need enough to recognize the difference between distributions, the value of a confidence interval and the reason sampling theory is so important. If you don't recognize these concepts, you don't have enough statistics under your belt and probably marvel at the "accuracy" of a single run of a model. If you fit that description, find an introductory course in experimental statistics at your local college and take it. It probably won't give you enough information about all of the distributions used in simulation but it will give you a foundation to build on. Oh, by the way, if the only one you can find is taught in the school of mathematics and has a course number higher that 300, you probably ought to avoid it. At the same time, it's a good idea to stick to the statistics courses taught in the schools of business and industrial engineering where the instructors are more likely to speak your language.

Experimental Design: In the vernacular of the statistical world, the outcome of a single run of a simulation model is an event within an experiment. Unfortunately, as revealing as a single run might seem to be, the probability of the outcome of that single experiment repeating itself exactly in either the real world being modeled or the experiment per se is fairly remote. Since random variation is present in almost every activity regardless of the controls imposed, it's far better to make multiple runs of an experiment to create a distribution of outcomes from which certain measures of central tendency and dispersion may be obtained. So far so good.

At the same time that random variation is affecting the general results of an experiment, other factors, both internal and external to the model, may be at play to further confound outcomes. Interestingly enough, many of them are often undetectable especially when results mirror a modeler's expectations. As long as a model is being used solely to "visualize" a system or to simply establish the nature and characteristics of its distributions, experimental design isn't of great concern. However, as soon as the model is employed to evaluate the comparative difference between choices or the impact of decisions on outcomes where multiple factors are a consideration, experimental design becomes an important part of the modelers tool chest. Simply put, how he elects to control or not control for the unplanned influence of external factors or account for the myriad of elements characteristic of a multivariate environment, can have a critical influence on not only the outcomes of an experiment but the manner in which they are interpreted.

Again, if this is puzzling, you probably need to do a little reading in the area. If your statistics course was comprehensive enough, you already have an idea of where to begin. If not, try any textbook you can find with the word "simulation" in the title. Even though most of them shy away from a good discussion of experimental design you should get an appreciation of what it is and when it's important. If you don't, go back to your statistics book and re-read the part about ANOVA.

Process/Product knowledge: This is the least difficult aspect of the educational quartet to obtain and probably requires the least amount of explanation. Still, it's not unusual to find process/product managers (and an occasional engineer) who have difficulty explaining the relative mechanics of the function they supervise - in simulation terms, that is. Simulation requires an in-depth knowledge of not only the product/process itself but the mechanical decision rules that make up the process used to manufacture it. In this respect, you have to see the manufacturing function as a series of decisions with all of their accompanying outcomes rather than as a product passing through a series of stations.

Even more importantly, you can't afford to get lost in a level of detail that is insignificant for the simulation of the decision process under study. If some aspect of a manufacturing process has no bearing on the outcome of the simulation, omit it. If its actions are relatively constant regardless of circumstances, include it, but not in any great detail. Whatever the case, it's important to learn to discriminate between the two. Misplaced precision in simulation simply eats up time and rarely achieves any great benefit. Perhaps a better way of putting it is, "there's really no percentage in trying to model the flies in the factory!"

Courses of study that will improve your ability to visualize a system as a series of decisions or in the correct level of detail are rare. To a certain extent that's the "art" side of simulation and simply requires practice. However, when you hit a mental snag concerning the translation of a manufacturing process into a simulation you can minimize your own mental "downtime" by adopting the practice of describing the system you're trying to simulate to the nearest willing listener. If you can find one, pick someone who knows as little as posssible about the system in question. It will force you to be a little more articulate and ultimately improve your own understanding of the task at hand.

Logic: As Shakespeare might have put it, ". . .herein lies the rub." In and of itself, the ability to envision the dependencies and relationships within a system logically is probably the single most important and yet difficult to achieve simulation skill. This is because "logically" doesn't necessarily mean "directly" or as a linear array of connected activities. In fact, many operational aspects of a system exist in parallel with often transparent or intangible connections that must be reflected in the simulation if it is to correctly represent the system under study. In this respect, the ability not only to "see" such connections, but to describe them, as they change and vary over time, requires more than an understanding of the process or product itself. It requires the ability to think of two or more linked activities, in different time periods and in different stages, simultaneously.

As challenging as the idea might sound, getting a better handle on the nuances of logic associated with simulation need not be an impossible task. This assumes, of course, that the individual has some ability to think abstractly in the first place. Unfortunately, not everyone does. A good test of your ability can be found in most college level courses in a highly structured computer language like FORTRAN. At the same time, the identical course taken in the school of engineering rather than that of computer science should provide a fairly sound introduction to logic in its basic form. Again, this advice presumes that you can tolerate the nature of the engineering problems that accompany such courses. The best approach is to stay with any course that has the word "introductory" in its title.

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Time

As tempting as it might be to start a discussion of time requirements by saying that there's simply never enough of it, the truth of the matter is that that's really not the issue. If you want to simulate something badly enough, you'll find the time. The real issue has to do with the fact that there are some serious misunderstandings concerning the nature of simulation and its ease of employment.

The truth of the matter is that there's no such thing as "simple simulation." It's a myth often inadvertently perpetrated by manufacturers of simulation software and professors who want their students to believe they're learning an easier alternative to tools like linear programing. They probably are but that's not the point either. The real issue is that simulation software is generally based on a set of complex rules or a syntax that reflects the way the author of the software thinks about things. If you don't buy this logic, visit the myriad of software booths at any simulation conference and listen to the explanations of how model parameters are encoded. In the final analysis, how well you understand this syntax has a direct effect on the time it will take you to plan, create, encode and debug a model.

Combine the time it takes to achieve this "understanding" with the requirement spelled out above concerning logic and you begin to get an idea of what is meant by the phrase "time-consuming." Like any tool of a similar nature, simulation can be intensely time consuming and the best approach is to assume that almost any model will take you twice as long to complete than you expect. So, don't make promises concerning model completion times and don't take short cuts. It's these time-avoiding shortcuts that are the point here and they represent "the three syndromes of time abuse." By the way, none of this discourse is intended to imply that simulation can't be simplified. It can; and some software programs do make it a great deal easier to encode and change models at will. Still, they seem to be the exception rather than the rule.

Data collection vs. guess work: — sometimes called the "what do you think, Jack?" syndrome.

There are still a few stalwart souls who believe that the time spent collecting data is the most satisfying and exciting part of any investigative project. As you might expect, most of them are undergraduate students who, fortunately, envision the information arena as the last romantic frontier of research. That's great because there are more than a few others that don't. No matter what your position, however, data is vital to the simulator and the simulation.

Unfortunately, data collection is also very time consuming (not to mention expensive) and, as such, the use of true data in the construction of distributions and numerous mathematical relationships within the simulation is often replaced with a form of guesswork. Simply put, the modeler asks someone else what he or she thinks a distribution may look like and then employs the answer in the simulation. Practitioners of this particular art often refer to the technique as a "modified Delphi." In fact, it's really nothing more than guesswork.

As inviting as the technique may appear, it's probably wise to avoid it. The degree to which a model represents a specific system is only as valid as its content and structure. When you unnecessarily guess at those aspects you have every right to anticipate misleading results. A better message might be to anticipate the data collection requirement early in the modeling effort and be certain that all applicable costs are included in any and all budget submissions for either money or time.

The "single run" and "convenient truncation" syndrome: Two major questions raised during almost every simulation are, "How many times should we run it?" and "How long should we let it run?" Unfortunately, a not uncommon answer to both questions is, ". . . until the model gives you the answer you expect."

The truth of the matter is that there are fairly rational answers available to both of these questions. In fact, the answers are vital to the modeler assuming he is at all interested in statistical precision or the minimization of bias within a given simulation. The unfortunate side of this issue is that the answers are often "encoded" in academic notation that is difficult, if not impossible to understand without a degree in mathematics. If you've experienced this, you've discovered one aspect of the ever present gap between the world of academics and shop floor.

In fact, these are not questions that should be left to chance. Unfortunately, there's no one answer that satisfies all simulation parameters or circumstances. As such, the best advice is to get the help of a statistician with some experience in simulation long before you begin distributing your first simulation results. It'll save you embarrassment, time and headaches in the long run.

The "computer wisdom" syndrome: We've all witnessed this syndrome in action at one time or another. It manifests itself when output finally arrives at the printer and everyone gathers around for a glimpse of the "results." As radically different as they might be from any aspect of what might otherwise be expected, they are easier to accept than the suspicion that the simulation might be flawed. The fact of the matter is that there is no scientific, logical, or romantic basis for the assumption that because a model compiles and runs, it is therefore correct. Interestingly enough, more analysts have fallen on their proverbial petard over just such results than is generally pleasant to think about.

The bottom line is that every model deserves to be verified and validated. If the initial results make you uncomfortable, the best assumption is that there's probably something wrong. Before you waste everyone's time, check the model.

So what?

So what indeed. So, forewarned is forearmed. Simply put, there are a few simple things you just can't afford to ignore and we have tried to cover some of the important ones. In the final analysis however, your efforts to improve matters through simulation will be far more fruitful if you recognize some of the common problems others have encountered and managed to overcome. We haven't mentioned all of the problems, just some of the big ones.