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PRACTICAL ADVICE FOR ORGANIZATIONS NEW TO SIMULATION

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ABSTRACT

Many organizations know the benefits of simulation and desire to add this business intelligence to their organization's process improvement toolkit. However, challenges exist that prevent these organizations from actually executing and successfully bringing simulation into their organization. From the lack of the right model building resources to missing upper management support to not having robust software, simulation initiatives can dwindle for various reasons. This paper will address why simulation is important, what makes a good project, who should build the model, the expected return as well as common pitfalls. Practical advice for organizations serious about developing internal expertise and conducting simulation projects will be provided.

1 INTRODUCTION

While there are many disciplines of simulation, this paper references discrete-event simulation (DES). With DES, analysts model a system along with the associated events and variability, in a computer model, for the benefit of understanding how the system works and how various changes will impact system performance. For example, a manufacturing facility with 5,000 different products, over 100 employees and 50 different workstations might be looking to automate an aspect of their plant. They execute a simulation project to understand how changing a manual process to an automated process will impact their entire system by comparing key performance measures such as throughput, cycle time and work in process. The simulation will help them make critical decisions: whether to automate, what equipment will be necessary, what resources are needed, etc. DES truly is one of the most powerful tools for predicting future system performance. Millions of dollars are at stake when designing and re-designing complex systems and simulation studies will provide an insurance policy against major changes.

Most often, business problems are addressed using common desktop tools such as Microsoft Excel® and Microsoft Access®, or resorting to the gut feel from senior process owners. These methods are familiar, inexpensive and readily available, so it is no surprise that they are heavily relied on for key decision making. However, most organizations are missing a tool in their toolbox. Think back to your last major project. What would you have done differently? Did you plan for too much capacity or too little? Did you have all the right staff and other resources in place? What if you could have predicted the design flaws before they occurred? A simulation study of a complex system will always allow analysts to go beyond static calculations and provide accurate insight into the true performance of operations. If simulation is so powerful and important, why isn't it a standard practice in every organization? It should be. Basic queuing theory and stochastic nature are part of every system and should be understood by all process improvement professionals. This paper will provide practical advice for organizations on how to introduce simulation and how to benefit from project outcomes within their organizations.

2 IDENTIFYING A GOOD SIMULATION PROJECT

It is important to be able to identify when the use of simulation is appropriate. Many problems can be sufficiently addressed with simple spreadsheet calculations. Understanding if the project you are working on will benefit from a simulation study is step one. Table 1 provides common characteristics of systems that might benefit from a simulation study.

Table 1: Typical System Characteristics for a Potential Simulation Project

Characteristic	**Description**	**Example(s)**
Highly Variable	Variability disrupts systems and makes outcomes difficult if not impossible to predict. Simulation allows analysts to understand the impact of variability on a system.	Variability may be in the form of equipment reliability, manual operations, supply chain hiccups, demand variability, product defects, arrivals to a system or seasonality issues, to name a few.
System Interactions	Understanding the interdependencies among processes in a system is critical. Independent time studies of single operations are not sufficient when planning major changes in complex systems.	If changes are made to the upfront scheduling operations in a manufacturing environment, analysts must consider the ripple effect of these changes on the entire line.
Complexity	If you are having trouble wrapping your mind around the processes, business rules and overall system operations, simulation is likely a good analysis tool. With robust simulation packages, if you can describe the system, you can model it.	Consider an airline baggage-handling process. At one airport, thousands of bags move from the check-in to departing planes, from arriving planes to other departing planes or terminals. Determining the best staffing, routing and other business rules is a daunting task.
Capacity Constraints	Systems have bottlenecks that affect the performance of the entire operation. With a limited budget to invest in people, equipment, inventory and space, simulation provides accurate information such as queuing and resource utilization statistics for effective decision making.	An emergency department has frequent patient complaints regarding wait times to see physicians. A simulation study might reveal that the hospital needs to hire more physicians based on the demand, or the study might uncover that more physicians will not reduce the wait and that unexpected bottleneck is the true issue in the system.
Need Management Buy-in	In order to build a case for a capital-intensive change you need good data and evidence on why the change is necessary. Simulation models backed by real data provide compelling arguments. They provide a very accurate representation of the future condition. The simulation animation also proves extremely powerful in gaining buy-in.	A plant manager might be lobbying to replace an old piece of equipment on a manufacturing line. A simulation model of the line showing increased throughput and reduced product cycle time with the new piece of equipment will be powerful in getting management to invest in the equipment.

Here is a general rule of thumb, if a major investment is pending and your system is highly complex such that you can't quite visualize how various scenarios will impact the system overall, you should consider investing in a simulation project.

3 DETERMINING WHO SHOULD BUILD YOUR MODEL

Once you identify that simulation is a good fit for a particular project, your next question will likely be – how do we execute a simulation study? Organizations have two basic options: they can build models internally or they can outsource model development.

3.1 Building the Model Internally

Developing internal expertise will require several key components; a discrete-event simulation software package, a simulation champion and dedicated model builders.

There are many discrete-event simulation tools on the market. You should pick a tool that is intuitive and easy to use, but robust enough to address your problem. This paper recommends Arena® simulation software from Rockwell Automation.

The simulation champion will be the person with the greatest stake in the upcoming process change. This person is the primary lead for the simulation project. He or she understands the problem and has determined that simulation is an applicable tool to help make the right decisions regarding the operation. This person will be the key link between the model results and implementing the change suggested by the model. As noted by Martha Centeno and Manuel Carrillo, "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" (Centeno and Carillo 2001).

For a simulation project, it is typical to have one primary model builder. Depending on the size of a project, the model building might be divided between two modelers. It is not recommended to have more than 2 model builders on a single model. Each model builder will have their own style and approach. Consequently, the more modelers on a single project, the more difficult it will be to validate and verify the model. Multiple model builders might actually increase the model development time and time until useful results are available.

When developing an internal simulation group within an organization, the total number of simulation specialists will vary depending on the size of the organization and the number of projects expected annually. If you expect fewer than three projects per year, a single model builder would be sufficient. Large organizations may have 10 or more modeling experts throughout their organization.

The next step is to determine who the model building experts will be. Any software endeavor includes a learning curve and simulation is no different, so it is better to select a smaller group of folks knowledgeable or skilled in simulation rather than a large group of folks who know only a little about simulation. An ideal candidate will have an industrial engineering or operations research background and already be familiar with simulation. Model builders should be able to pick up processes quickly and be strong in statistics. No matter what software package is selected, software training should be considered as an integral phase. Most vendors will have formal training classes for new and advanced users. Engaging with experienced users is the best way to speed a new modeler through the learning curve. Often new users will take a training class and assume that they are all set to kick off their first project. While skill levels will vary among users, most will benefit greatly by further engaging with simulation experts. Moving through the stages from the description of a system to design and execution of a simulation model can be daunting. An investment in additional mentoring, or "project jumpstart" consulting, for new users should increase the likelihood of a successful first project. It is highly recommended that "the project be conducted by an experienced analyst (or team). This factor is probably the single most important contributor to project success. Without a level of experience, every project may be at risk no matter the other characteristics." (Gibson, Medeiros, Sudar, Waite and Rohrer 2003). Good planning should include a budget for software, training and additional mentoring by seasoned simulation experts. While pricing will vary, organizations should expect to invest anywhere from $10,000 - $50,000 or more on initial software, training and consulting fees. Current user experience, scope of project initiatives and complexity of models are major factors that will impact the initial simulation investment.

If you are tasked with building an internal simulation group at your organization, you will want to make sure the group is sustainable. You do not want to invest thousands of dollars and resources and complete a first successful project only to have your software package be shelved and allow resource skills to fade. You also do not want to apply simulation to projects that don't need it. However, large and small organizations undoubtedly have countless potential simulation projects and would benefit from a well-planned program to identify the best potential projects. In order to sustain a simulation group and keep skills fresh, leaders should continuously promote their successful projects as well as solicit potential projects within their organization. A one-page project summary highlighting the problem, solution and savings is a good practice to follow. Summaries can then be distributed throughout the organization to educate co-workers and uncover additional opportunities, as well as serving to document the project for historical purposes. It is also recommended that within organizations "avenues such as corporate intranet postings, company newsletter articles, internal knowledge exchange programs, best practices events, Kaizen processes, etc., must be leveraged to promote simulation and its potential impact on driving value." (Gibson, Medeiros, Sudar, Waite and Rohrer 2003).

3.2 Outsource the Model-building Effort

Not all organizations have the time or resources to develop internal simulation expertise. When an organization has a specific project initiative, a short time frame for a decision and no internal resources available for building models, they should consider outsourcing the project. Consultants can provide turn-key model-building services. Here the organization provides all the details regarding the system, including project objectives, process flow, all the raw data needed by the model, scenarios to be run and key performance measures. The consulting team will then translate the description of the system and scenarios into a working model where the organization can run and evaluate their different scenarios without the need to become experts in the simulation package. With a turn-key approach to a simulation project, the organization gains the benefit from implementation of a simulation solution without requiring either the resources or experience needed to generate the simulation model themselves.

Many organizations choose to outsource initial simulation work and to partner with the experienced simulationists as a way of developing internal expertise. This form of mentoring allows for the execution of a pilot project under the guidance of the consultants. Once the project is complete and the benefits of simulation are assessed by the organization, they may move forward with additional formal training and development of an internal simulation team..

4 DETERMINING THE RETURN ON INVESTMENT AND GETING INTERNAL BUY-IN

Whether an organization decides to develop internal expertise or outsource the model building, getting internal buy-in for simulation is often a great hurdle. There is no doubt that building an internal practice and/or outsourcing a project costs money. You will have to spend money to save money with simulation. How can you predict the return on investment (ROI)? To many, simulation may be regarded as insurance for the millions of dollars already invested or for the monies that are anticipated to be spent on new systems, processes and resources. The truth is, you do not know the ROI of your simulation project until the project is complete. Often the return on portions of a simulation project cannot necessarily be quantified. Each project will result in different "savings." For example:

- The simulation model results might suggest that you should invest in additional equipment in order to meet your goals. You might spend $100,000 on capital improvements in order to increase throughput, leading to increased revenue of $1,000,000.
- The simulation project might result in capital expenditure avoidance. Here your savings is pretty straightforward; your simulation project resulted in $500,000 capital avoidance.

Even so, you might be asked to provide hard ROI numbers for your organization. When trying to calculate a potential ROI from your simulation project, first consider your project goals. For example, we need to:

- reduce inventory levels by 3%
- increase throughput by 5%
- reduce our overall costs by 2%
- reduce our WIP by 3%
- reduce the customer wait time by 10%
- reduce labor costs by 4%

Now quantify what it would mean to achieve these results. This would be your quantifiable expected return. Returns are typically very high when simulation is used during major capital expenditures projects. When used judiciously, the actual cost to conduct the project is minimal when you consider what could go wrong if changes are not planned appropriately.

5 COMMON CHALLENGES AND PITFALLS

While simulation makes perfect sense to those familiar with the tool and who know its proven benefit, bringing simulation into an organization and sustaining simulation initiatives is challenging.

5.1 Lack of Management Support

Management support will be critical to pursue simulation initiatives effectively. You may be a model builder and be very comfortable with simulation and the benefits it provides. However, before you can get the tool in-house, you need to get approval for the simulation investment. Educating management teams on what simulation is and the benefits it can provide is a very important, and sometimes difficult, task. The better your management team understands the solution, the more likely they are to investment in the initiative. Schedule time to present a well-thought-out plan to management teams. Clearly articulate what simulation is, its advantages over other analysis methods and, most importantly, convey the value it can deliver. It may help if you can site specific case studies and even build a small example model specific to your organization. The more you can educate the team, the more likely you are to get their buy-in.

5.2 Model-development Time and Effort is Underestimated

Most organizations underestimate the time and effort it will take to complete a simulation project. There is an art to modeling. No matter what tool you select, if your system is complex, it will be complex to model. It is important to understand your project timeline prior to a simulation endeavor. Do you have enough time to train a new user and execute the project in order to get the information you need to make a better decision? “A successful simulation project is one that delivers useful information at the appropriate time to support a meaningful decision.” (Sadowski and Grabau 2003). If you choose to build models internally, make sure that you budget for appropriate training and guidance to help ensure that you are able to meet your project timeframe. Organizations often fail with simulation when they fail to understand the relationship between simulation modeling and the time frame for its development.

5.3 The Wrong Problems Are Addressed

As mentioned, not all issues are appropriately addressed using simulation. It is important for any process-improvement professional to have myriad tools and approaches to solve a particular problem. Simulation should be considered to be another tool in your toolbox. Before you even start building models in a software product, make sure you have clearly defined the problem, the project objectives, process flow, scenarios you want to test and key performance measures. If you cannot clearly communicate the objective of the model and the scenarios you want to test, you should not simulate.

6 CONCLUSION

Simulation is a powerful technology that will provide your organization with a competitive advantage over companies not using this technology. If your organization is serious about simulation, the following actions are recommended. First, select a robust simulation tool that is also intuitive and easy to learn. Decide whether your organization has the resources and experience to build models in-house or would benefit from outsourcing the model-building effort. Select appropriate model builders and simulation project managers. Select an appropriate project for the initial simulation. With the right project, people and simulation tool in place, your organization will be in the best position to achieve success with simulation.

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