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CONDUCTING A SUCCESSFUL SIMULATION PROJECT

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ABSTRACT

Project success comes with improving system performance. Knowing the technical fundamentals of simulation is not enough to guarantee this success. In practice, sound management methods are also required. Management guidelines are provided in this paper that relate to the process, the model, and the people associated with a simulation project.

1 INTRODUCTION

Simulation projects provide many significant benefits. Across a broad range of systems, they allow you to diagnose problem areas, generate and experiment with new ideas, and identify the most complete solution. They also avoid much of the confusion and frustration associated with designing and operating these increasingly complex and integrated systems.

Unfortunately, not all simulation projects are successful, that is, result in system improvements through the implementation of the project's recommendations. Some projects never finish. Others finish, but not with enough credence to persuade the customer to take action. And still others fail to finish in time to make a difference.

While success cannot be guaranteed, conducting a simulation project according to certain guidelines can improve your chance of implementation. The guidelines presented here are straightforward, even commonplace, actions that have repeatedly proven their value. They emphasize common sense and sound management methods -- essential ingredients of any simulation project. They do not address the technical fundamentals of simulation. This is not to minimize this important body of knowledge, for knowing the technical side of simulation is a necessary condition for success. Instead, the purpose is to emphasize the role that practical management and personal interaction play in every successful project.

The guidelines are grouped into three general categories: process, model, and people. Collectively, they prescribe an approach. This is neither the only approach nor an exhaustive list. It is merely a suggestive set of principles that will hopefully stimulate you to review and evaluate your own project techniques.

2 PROCESS

A simulation project is a process of interpretive, developmental, and analytical steps (Pritsker, Sigal, and Hammesfahr 1989, Banks and Carson 1990, Law and Kelton 1991). These steps, which are intrinsic to all simulation projects, generally include problem formulation, model conceptualization, data collection, model building, verification, validation, analysis, documentation, and implementation. The following guidelines assist with the execution of this process.

2.1 Work on the Right Problem

Nothing is less productive than finding the right solution to the wrong problem. While this is usually not one's intention, it happens more frequently than it should. Often, this is due to misunderstood or poorly stated objectives.

Establishing sound objectives is critically important. You greatly increase the difficulty of a project when working with obscure objectives. Objectives need to be precise, reasonable, understandable, and action-oriented to convey a proper sense of direction and to distinguish between primary and subordinate issues.

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Fuzzy objectives lead to unclear successes.

2.2 Communicate

Poor communication is the single biggest reason projects fail. There is simply no substitute for good communication.

Start by reaching an understanding with the customer about the project. Settle on objectives, scope, assumptions, how the system functions, key questions to be addressed, model input, and output. At this point, you want everyone to understand clearly the project team's collective knowledge and intent.

Next, orient the customer by establishing a project plan. Gain the customer's support by explaining how the project will proceed and what to expect. Emphasize the benefits associated with doing the project as planned and prepare the customer for potential problems. In short, give the customer a "road map" of the project. By knowing what is coming and why, the customer is in a better position to lend support. Without this knowledge, the customer may unintentionally work against you.

Finally, keep the customer informed. People like knowing where they are. Have plenty of "sign posts" along the way. Easily identifiable deliverables are excellent for this.

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Communicate, Communicate, Communicate!

2.3 Predict the Solution

In the beginning of a project, people often miss an excellent opportunity to properly set the stage. They are too eager to get started. As a result, they fail to do a simple, yet effective, exercise.

Before you even think about logging onto the computer, ask the customer to conduct a quick, even crude, analysis of the problem. This does several things for you. First, it gets the thought process started. The customer begins to concentrate on the problem and not the model. It also gives you an idea of where to look for insights into the problem. Caution is advisable, however. Preconceived ideas can restrict thinking. Don't let this happen. Keep creativity alive. You want this exercise to initiate the thought process, not stop it.

Second, a starting solution provides a base for comparison. If the project's results turn out differently, you arouse interest. This leads to a search into the reasons why these differences exist and, eventually, to an even deeper understanding of the system.

Finally, predicting the solution establishes where your thinking was at the beginning of the project. Eventually, you want to judge how the project changed your thinking. Without this beginning reference point, you have no way of doing this. Accordingly, you could end up discounting the project's true value.

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Only by knowing where you started
can you judge how far you've come.

2.4 Manage Expectations

Successful studies require continuous management of the customer's expectations. It is important to have these expectations agree with the project's objectives. Otherwise, you can find yourself obligated to perform tasks only to satisfy an expectation, not an objective.

Start by setting the correct expectations upfront. Make sure the customer understands what issues the model will and will not address. It is far better to discuss restrictions from the beginning than to state them for the first time when you present the results.

Then, continually manage the customer's expectations. Quickly throttle any unrealistic hopes or ideas. Don't let the customer assume you are delivering capability you cannot or do not intend to deliver. Work together to understand each other's viewpoint and come to a mutually acceptable resolution.

If you cannot reach agreement immediately, postpone the discussion or find a way to work around the issue. You want to keep the project moving forward. If the issue is technical, consider using the model to explore options or to bound the problem to see if the issue really matters.

Maxim

It is easier to correct an expectation now
than to change a belief later.

2.5 Question the Data

Challenge all data you get for the model. Do a quick audit. Consider the source, what was collected, and how it was collected. Does the data make sense? Is it representative of the process? Is it at an appropriate level of detail? Is it within the scope of the project? Is it going to bias the results?

Strive to get all the data you need, but be open to compromising the model (and the outputs) to better suit the data you can get. Then, test the sensitivity of the outputs to the full range of possibilities. If sensitivity exists, you now have good reason to get the data you need.

Maxim

Don't take data for granted.

2.6 Maintain Momentum

A simulation project is a journey. Along the way, it is important to give the customer a reading of where you are. By showing progress and having the customer acknowledge this progress, enthusiasm for the project is kept high.

One means of doing this is by having frequent deliverables. These need not be major pieces of work. The best deliverables are easy to accomplish, hold value for the project, and are clearly identifiable. Examples include a project plan, a model specification, prototype demonstrations, model delivery, model acceptance, animations, training, analyses, documentation, a final report, presentations, and progress reports. Spreading these deliverables judiciously over the project and delivering them on time give the customer a reliable measure of progress.

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It's better to work with many intermediate milestones than with one absolute deadline.

2.7 Report Progress

Progress reports provide an important, written history of a project. They give a chronology of work done and decisions made. This can prove to be invaluable as you endeavor to keep the project on course.

Reporting should occur at least monthly. People not directly involved in the project's day-to-day activities can then stay involved. By knowing the project's status and plans, they now have the opportunity to further the project and your chance of success.

Regular reporting also surfaces misunderstandings early in the process, when problems first arise. You cannot afford to have problems fester. Give them immediate visibility. Handling them without delay minimizes their impact.

Keeping a project log is also important. The log provides a comprehensive record of accomplishments, noteworthy problems, change requests, key decisions, ideas for follow-on work, and anything else of major or even minor importance. This can be indispensable when developing a historical record of the project.

Maxim

Document, Document, Document!

2.8 Sell Success

Selling the value of a project continues throughout its life . . . and beyond. It starts with the proposal and continues past implementation. Seize every opportunity to explain the value of what you are doing. Aggressively pursue these opportunities. Success will not come to you; you need to go after it.

Learn to accentuate the positive. You will have enough support in exposing the negative. Moreover, sell success, not underachievement. Compare your progress to where you were, not to where you are going. You will always be short of your objective until the end. Continue to remind everyone where the project started and how far it has come. At every opportunity, make known what you have accomplished.

Maxim

Report successes early and often.

2.9 Control Changes

Change requests are inevitable. Therefore, expect them, plan for them, and, most of all, control them.

Begin by being smart from the start. Don't accept a small change just because the project is going well now. Stay true to the project's objectives and scope. Argue against a change that is not in line with the objectives or within scope. The true implications of a change show up during verification, validation, acceptance testing, and implementation. Large costs and delays can easily result from even a minor change.

Agree to a change only if you must. When you do, be aware that you open yourself to more changes, with possibly even bigger consequences. Therefore, proceed with caution. Remember also that changes can delay deliverables that others are expecting. Consequently, be sure to communicate in writing to all affected parties the implications of each change, especially the added time and costs.

Consider delaying changes by moving them to a follow-on project or another phase of the current project. Get baseline results out first. Then look to incorporate the changes you deferred. This allows you to show progress under the original schedule and still satisfy the request.

Make the handling of change requests a regular occurrence. Act on them even when no time or cost issues are involved. This helps demystify the process and makes it less dramatic and painful when timing and cost issues are involved.

Include the customer in change request meetings. This gets the customer to think occasionally about the project's objectives and scope. This should help the customer to begin to appreciate, in advance, the reasonableness of these requests and their impact on the project.

Get all change requests in writing. It is too easy to get lulled into verbally agreeing to changes. If you have no record of what you agreed to or, more importantly, what you did not agree to, you are more likely to consent to the change. A record of requests and judgments regarding these requests fosters good customer relations.

Be especially mindful of changes in project personnel. If possible, argue against them. However, if you have no choice, immediately hold a project meeting. Review the team's accomplishments, what tasks remain, and who needs to be involved. Take the time necessary to properly transition the technical and administrative information. Make sure all team members know what this means to them personally. Poorly executed transitions can quickly cause an otherwise secure project to fail. Don't miss this opportunity to get the project back on track. At the end of the project, it is too late to take the time to do it right.

Maxim

Verbal agreements aren't worth
the paper they're printed on.

2.10 Question the Output

Challenge the model's outputs. Can you explain them? Do they make intuitive sense? Can you defend them without getting into technical details?

Believe in yourself as much as the outputs. If the outputs are counter-intuitive, check your work. Something is wrong! Examine your assumptions. Reverify and revalidate the model. There must be a rational explanation.

In the end, compare the model's outputs with the crude estimate you asked the customer to perform at the beginning of the project. Are they different? If so, why? If not, examine why you did a simulation study so you can avoid doing "confirmation" projects in the future.

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If it doesn't make sense, don't believe it.

2.11 Risk and Review

Strive to learn something new on every project. Make a commitment to break out of your mold. Try doing something different. Approach the problem in a new way; use an unfamiliar section of the simulation language; experiment with a new analysis technique. Doing this will put you in an even better position to succeed on your next project.

Also, take time to review the project while it is ongoing. Give yourself time to sit back and reflect, stepping outside the model. Unshackle yourself from the details of the model and simulation for a moment. Evaluate the significance of what you are now doing. If it is not advancing the project, stop! Reconsider. Direct all energies toward the project's objectives.

Maxim

Take time to review and redirect
both the project and yourself.

2.12 Focus on the Problem

Your general objective is to improve system performance. This must remain paramount in your mind. The simulation model helps solve the problem, but does not, by itself, satisfy your general objective. It only provides the means to do this.

Yet, many simulation projects concentrate more on model building than problem solving. Getting the model up and running becomes the overriding objective. Understanding the problem and deriving possible solutions become subordinate.

Consider, instead, spending more time modeling and experimenting, and less time building. Use the process of modeling to gain more insight into the problem and possible solutions. New ideas will come with the knowledge gained in modeling the process. You want to give the model a chance to contribute to the process of originating new ideas. Remember, building the model is not the main task at hand; implementing the right solution is.

Maxim

Focus on the problem more than the model.

2.13 Know When to Stop

You can always do more. For example, you can expand the model by adding detail, extending the model upstream and downstream, improving the data input scheme, and reformatting the output. You can also expand the analysis by testing the sensitivity of the results to boundary conditions, conducting a more rigorous statistical evaluation, examining other alternatives, and training the customer. The list is never-ending.

Prepare the customer for this eventuality. During the project, work with the customer to define a suitable stopping point. This is a judgment call, but one with which the customer must feel comfortable. You can help by instructing the customer on how to continue the

process. This could involve teaching the customer how to change input, modify the model, interpret the output, or decipher errors. The customer will deem the project far more successful if progress can continue following your departure.

Maxim

Ultimate truth is not affordable.

3 MODEL

The simulation model is integral to every simulation project. It provides the experimental medium for diagnosing problems, proposing and testing changes, and selecting the best overall solution. This model is formed using software. The type of software selected directly influences the model building process. For example, building a simulation model in a general programming language, like C (Kernighan and Ritchie 1988), involves a different development process than when building the model using a general application simulation system, like SLAMSYSTEM (Pritsker Corp. 1990), or a manufacturing specific simulation system, like FACTOR/AIM (Pritsker Corp. 1992). This is because simulation systems take advantage of their specific modeling and analysis domain, producing a more efficient process. Yet, regardless of the software selected, several modeling principles prevail.

3.1 Make Assumptions

Data collection will inevitably be on the critical path. Don't be held captive by the information you lack. Be willing to make assumptions to keep the project moving forward. Take an educated guess at what you don't know. Then, use the model to judge the sensitivity of this information. You may find it is of little consequence.

Making an assumption does not mean you must hold to it. Learn to revise your thinking and your assumptions throughout the project. Making unconfirmed assumptions are only a problem if you treat them as if they are fact. Be sure to validate your assumptions before presenting results.

Maxim

Be willing to make assumptions.

3.2 Start Simple

Use the model to reduce the problem to your ability to solve it. If you build a complex model, you undermine your ability to understand the outputs produced by it and, ultimately, your ability to arrive at a solution. Therefore, initially avoid making the model too complex. Try, instead, to capture just the essence of the system. Then, use your judgment skills to fill in the details.

Starting with a simple model also enables you to learn about the system in stages. By incrementally building the model, you better understand why things happen as they do and what the impact of each new stage is.

A simple model also helps you to avoid repressing the discovery process too soon. If you build a detailed model that now must be redone or significantly modified, you can find yourself arguing against change only because of the effort involved. It is best to maintain modeling freedom as long as possible by working with simpler models.

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Add complexity; don't start with it.

3.3 Curb Complexity

Complexity can easily creep into a model. With perfect information available, a model's control logic, for exam-ple, can become so sophisticated it shows the system performing better than what would be possible in practice. This level of knowledge and action can compensate for a fundamental design flaw. Seek to expose these flaws, not hide them.

In an attempt to arrive at the ultimate solution, you can lose sight of what is reasonable to implement. Sure, using an optimization routine to determine the next best job to run on a machine is powerful, but is it realistic? Can you implement it? Be ever mindful of what is practical. It can save precious time and effort.

Maxim

Don't let the model become so sophisticated that it compensates for a bad design, or so complex that it goes beyond your ability to implement.

3.4 Work the Model

A simulation model stimulates thinking. It acts as a catalyst, helping to generate ideas. If given the opportunity, it can lead to fascinating discoveries, each revealing additional insight about the system.

Think of the model as a window to the system. Use it to see the system from many different angles and in different stages of development. Learn to harness this power. The model can be invaluable if used in this way. You can explore new ideas, test the sensitivity of data, and examine what is important in the system.

Maxim

Use what you develop.

3.5 Understand the Model's Limits

At best, a model is less than reality. By its very nature, it is an abstraction of the system. This means a solution for the model is not necessarily a solution for the system. A degree of interpretation must accompany each analysis. Be careful not to stray beyond reasonable limits. Revisit the model's assumptions and inputs to help define what is reasonable.

Models do not replace individual thought. The customer, in the end, must rule on the worth of a particular solution. The model cannot do this. Its purpose is to support the thought process, not to supplant it.

Maxim

People decide; models don't.

4 PEOPLE

A simulation project is more than building a model or managing a process; it is working with people. You must be able to work well with people if the project is to succeed, for success is in the minds of people, not organizations.

4.1 Foster Teamwork

The project team must work together to be successful. If any one person dominates the process, the team is not taking full advantage of their collective talents. Learn to work as a unified body, with each member being aware of their role and importance to the general outcome of the project. By having the team search, discover, and grow together, you enrich the project and increase your chance of success.

Maxim

Focus on possibilities, not personalities.

4.2 Involve Key Decision Makers

Know who the key decision makers are and work to involve them in the project. Periodically meet with them to incorporate their ideas into the project and to allay any concerns. In the middle of the project, you do not want them coming in with a different set of expectations and suddenly taking control. This can be both costly and demoralizing.

Watch for signs of the project not being a priority, such as data gathering delays, end user difficulties, upper management unavailability, decision postponements, deadline slippages, and apathetic or even hostile attitudes. When these signs appear, call on the key decision makers to reset the priorities.

Maxim

Keep key decision makers personally involved.

4.3 Listen to the Customer

Good listening habits are essential for success. Learn to listen more and talk less. Work on suspending judgment until you better understand the system and the situation. Give the customer a chance to change your way of thinking. Focus on drawing out the facts and encouraging further clarification. Concentrate on what is, as well as what is not, being said. Remember, the goal is to solve the customer's problem, not yours.

Also, learn to be more circumspect. Continually sensitize yourself to the customer's needs, values, beliefs, and attitudes. Be on the alert for clues into how the customer views the problem and the project. Then, couch your comments, reports, documents, and presentations accordingly.

Maxim

Don't look for a solution
without first listening to the problem.

4.4 Be Mindful of the Customer's Perceptions

Through experience you develop a way of doing things that work well for you. You know what is important to establish early and what can be left for later.

The customer, on the other hand, may have a different viewpoint. That which is unimportant to you may be very important to the customer. A small programming error, for example, if left unattended, can greatly undermine the customer's confidence in the simulation model and the project. Therefore, quickly correct any mistakes the customer perceives as a problem.

Maxim

Customer perceptions require attention.

4.5 Advocate Improvement

If done right, a simulation project results in system

improvements through change. This change may be a new operating policy, a different cell configuration, or a new job allocation scheme. Whatever it is, expect resistance.

Take action to overcome this resistance. Enlist management support; educate those affected as to the value of the change; sell the project team on the importance of being pro-active and enthusiastic about the change; and educate the customer as to the benefits associated with implementing the change. People don't resist change; they resist being changed. By involving them in the change process, you help mitigate their resistance.

Success in making this change is heavily dependent on the customer's confidence to take action. Giving the customer a sense of control over the project helps to instill this confidence. Learn, therefore, to guide the simulation process without usurping the customer's control. With loss of control, the customer becomes either angered or uninterested. In either case, the project falls into disfavor, and any action to implement this change is unlikely.

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Be a change-agent; have a bias for action.

4.6 Present a Choice

The customer asks for a solution, but wants a choice. Therefore, present a range of possibilities to the customer. This gives the customer a sense of freedom and involvement, and a better understanding of why the best is best. Besides, with a choice, it is harder to find fault. It is much easier to dispute one solution, than a set of solutions.

Maxim

Make recommendations, not ultimatums.

5 CONCLUSION

Sound management methods are important in every simulation project. They help to guide the simulation pro-cess, properly control model development and analysis, and improve the working relationship with the customer.

The guidelines presented here are meant to influence the management methods you employ on simulation projects. They are presented with the full understanding that they could be accepted, debated, ignored, or rejected. The hope is they will inspire you to examine your own methods and, in turn, contribute to your continued success.

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BIOGRAPHY

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