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MANUFACTURING SIMULATION CONSULTANT'S FORUM

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ABSTRACT

Manufacturing simulation has been flourishing for a decade and as a result there are now a growing number of consultants who have considerable experience -- much of it learned through painful trial and error. Unfortunately, this hard-won knowledge is not being proliferated because product, industry, geographic and competition barriers isolate manufacturing simulation consultants from each other. This forum allows consultants to exchange views and information on topical consulting issues.

1 INTRODUCTION

To give structure to this year's forum, the theme: *Simulation Infrastructure Issues for Manufacturing Environments* has been selected. The intent is to share information on the organizational issues surrounding the use of simulation to support manufacturing. Specifically, we will focus on issues involving the support activities required to bring acceptance of simulation into a company's culture.

2 THE PANEL

The panelists, as evidenced by their biographies, are a diverse group of experienced manufacturing simulation consultants. Each of the panelists has selected a question related to the general theme and will moderate a discussion using the question as a departure point. The remainder of this section lists the topics and a brief position or background statement.

2.1 Brad Armstrong: What are the elements of a manufacturing simulation infrastructure?

2.1.1 Background

Based on my experience, a typical simulation usage cycle almost always starts with an internal champion (often working with a consultant) who demonstrates the value of simulation to a company. As shown in Figure 1, without some planning and control, initial success generates project demand faster than can be competently satisfied which leads to poor results and the collapse of simulation usage.

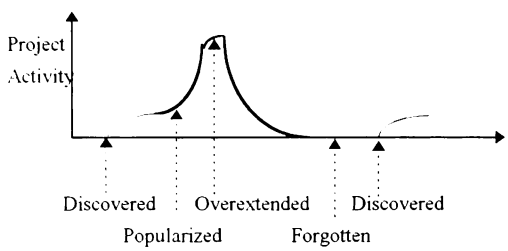

Figure 1: Simulation Usage Cycle

A company caught in this cycle receives minimal benefit while repeatedly paying expensive start-up costs (software and training). To break the cycle, upper management must adopt simulation (via money and support) as a strategic tool. The question then becomes how to integrate it into the company culture effectively. The answer (particularly for large companies) is a well designed simulation infrastructure, and management often turns to a consultant for the design.

2.1.2 Infrastructure Elements

My current approach to infrastructure design considers four main elements. I believe each is necessary to give simulation a chance of being integrated into the company culture. The elements and several sample issues are as follows:

Organization:

- What are the goals and objectives
- What are the internal champion duties
- Use a centralized or decentralized organization
- How will simulation resources be organized
- What standards will be established

Education:

- What training will be offered
- What about skill retention and expansion
- Should a newsletter be distributed
- Is a user group appropriate
- How will successes be made known

Application:

- Simulation should be linked to what other corporate initiatives/programs
- How will projects be organized
- How are projects funded
- What about consultant usage (internal and external)
- Will there be project guidelines/standards

Tools:

- What simulation products will be used
- What will be the simulation vendor relationship
- What about support software like animators, statistics, interfaces, etc.
- Will product extensions and customized applications be developed
- Who is responsible for maintenance

2.2 Stuart Gittlitz: What should be included in a corporate simulation training program?

The first in-house training class at Kraft was a three day course that included modeling, statistics, the simulation process, experimental design, and three hours of hands-on time. The students screamed out their displeasure. 'The first day was Project Management 101. Who needs that? We want more hands-on time."

Finally, we got the message. It corresponded to a problem we were having in launching our corporate simulation program. Models were being introduced into the plants. But, after an initial flurry of interest, the models were not being used. The problem was that the simulation results were difficult to interpret and we hadn't explained how to do it.

So, we created a new two day course focusing on implementation. We don't teach modeling in the new course. We teach how to obtain results from an existing model. In the course, we describe a production line that is operating at a low efficiency. We discuss the simulation constructs and demonstrate how to make changes and run scenarios. Then comes the game. And its all hands-on. The class is divided into teams of two. Their objective is to use simulation to find a way to improve the line's efficiency by 10%. They can add conveyor, speed up machines, buy more reliable machines, redesign controls, etc. However, any change costs money. Conveyor is priced at X dollars per foot. A new labeler costs $300,000. And so forth. At the end of the first day, each team presents the changes they made to the line. The winner is the team that met the efficiency target at the lowest cost.

By the end of the second day, the students are ready to play "what if" options with models of their own production lines. The response to this class has been excellent. It has also generated many exciting simulation projects at the plants.

2.3 Tom Gogg: How should an organization be introduced and educated about simulation?

Is it important to educate an organization about simulation? Most would agree that validation is a critical milestone in an analytical project. Validation implies that the decision makers and the people who will be impacted by an analysis all have confidence in the results being produced by the analysis. Confidence is a direct byproduct of understanding. It is often difficult to put trust into results of unknown derivation. Simulation is an unknown to many organizations. Education is a vital step for eliminating the unknown. It is a confidence builder. *Educating an organization on simulation fundamentals can embellish findings, reduce project durations and make selling and implementing solutions much easier.*

It is probably fair to say that very few people typically possess a firm grasp of what simulation is, how it works, or what it can do. Finding a training course that will satisfy the needs and desires of an organization can be a formidable task. The level of simulation aptitude within any organization is usually quite diversified. Some people have a strong background and others have no background at all. Some have a desire to learn and others could not care less.

When you try to force-feed simulation, it is usually rejected. It is generally better to provide a self-paced educational tool which will allow a person to obtain a level of simulation knowledge that he or she desires. Prior to providing this tool, it is essential to generate an interest in learning about simulation. This can be accomplished by providing a one or two day class which will give participants a basic overview of the key concepts, methodologies, and benefits associated with simulation.

Hand walk the participants through the basics always keeping in mind that your are trying to establish a fundamental understanding and a desire to learn more. Remember that simulation terminology can be quite intimidating for many people. Statistics, probability distributions, random numbers, and stochastics are just a few examples. The purpose of the training is to give the participants a comfortable awareness of these terms and an appreciation of their importance. It is not intended as a means of producing expert statisticians.

When the class is completed, provide each participant with a tool that will allow him or her to further educate themselves and others. Simulation training and education materials should be concise, direct, informative, and interesting.

2.4 Debbie Kotlarek: How should information be obtained to build a solid foundation for a manufacturing simulation model?

Making simulation a part of a company's culture is usually a gradual process, based on the perceived benefits, obtained from each model developed. Although there are many aspects to building a model, one of the most important is data collection. This establishes the foundation for a reliable model which can be used to gain insight into a system, evaluate alternatives, and make informed decisions.

Although the type and availability of data will vary depending on whether the system being modeled is in the design phase or if it is an existing system, it is still possible to summarize the data collection process as follows:

2.4.1 What?

The first step in obtaining information for a simulation model is to identify what data exists for the system or process being modeled. There are usually several different types of information that are required to develop a meaningful model. These may include the following:

Layout & Equipment Data:
- Dimensional layout drawings
- Equipment parameters (speed, acceleration/deceleration rates, cycle times, etc.)
- Equipment downtime (planned and unplanned)

System Control Data:
- Description of operation
- Material flow diagrams
- Work assignment algorithms
- Storage selection algorithms
- Dock assignment algorithms
- Order release algorithms

Operating Activity Data:
- Shift schedules
- Staffing levels
- Staffing assignments
- Product mix and activity rates

- Order information
- Operator task times and variances

2.4.2 Why?

While identifying what information exists, it is also important to keep in mind the questions of "Why do we need it; Why is it relevant?" This is necessary to avoid becoming totally consumed by the task of obtaining extremely detailed data. The establishment and periodic review of the simulation objectives can help guide the process and aids in making decisions as to when simplifying assumptions are appropriate.

2.4.3 Where?

The next step is to determine where the information can be found. Common sources include written specifications or descriptions of operation, equipment manuals, procedure manuals, system archive files, and the actual system itself. Another very common source is "in the heads of the designers, dreamers, and schemers."

2.4.4 Who?

Similar to the previous step, the simulation analyst must identify who can provide the data. It is important to solicit information not only from the designated project team members, but also from the people actually involved with the system or process. Common sources include equipment suppliers, control and software engineers, industrial and manufacturing staff engineers, facility management, operations and maintenance personnel, and computer support personnel.

2.4.5 When?

Most simulation projects have a schedule and a target date for completing the model. It is therefore necessary to establish when the data can be collected so subsequent phases of model development can proceed according to the schedule. A common problem associated with collecting data in a timely manner is the likelihood that some information for a new system is unavailable since it is still in the development/definition phase.

2.4.6 How?

Lastly, the methods of how the data will be collected must be defined. This is obviously dependent on where the information resides and who can provide it. The following techniques have proven useful in many simulation projects:

- Data sheets (fill-in-the-blank forms)
- Importing CADD drawings into a simulation package
- Review of any written specifications or descriptions of operation
- Structured interviews of cognizant personnel
- Extracting data from historical files (in either hard copy or electronic format)
- Videotape of existing operations
- Observation of the actual (or similar) system or process

2.5 Barbara Mazziotti: How can models be built for continuous use?

In order for simulation to become a regular part of the manufacturing business culture, there are many instances where the user and the model builder will not be the same person. Plant engineers usually have many responsibilities and do not have the time to become adept enough to create models on their own. On the other hand, the plant engineers are the ones who are asked to make recommendations for line changes, new layouts, scheduling changes, etc., where good answers could/should come from experiments with a simulation model. If you are charged with building a model for such a user, what should you include in the end product? First, it is important to recognize that it is a "tool" that is being requested. Manufacturing managers and engineers want tools to help answer their questions and solve today's problem today. If simulation can do that, great; but it must be quick, accurate and easy to try many alternatives. The need for continued analysis and multiple, changing scenarios is simple: the business world is changing at a break-neck pace. Philosophies such as "quick response manufacturing," "agile manufacturing," and "mass customization" are forcing manufacturers to constantly reconfigure their systems and adjust their policies. Therefore, their analysis tools must be just as agile and flexible.

For a simulation model to have life after an initial request it must have flexibility built into it. What if they add new equipment, what if they want to try a new scheduling policy; will your model need to be rewritten or can a simple data change allow the user to continue without your assistance? My particular interest is flexible decision-making, which could include: part or equipment scheduling choices, model builders have usually enumerated a small set of alternatives which users can select between. Making good choices requires tremendous insight and foresight. In contrast, I propose that developing rule structures, where users can select elements that build up new rules, can facilitate a wealth of choices the model builder could never anticipate up front.

Once flexibility is built into a model, how will you present your user with those choices? Do you teach him/her how to edit the actual simulation model? What if they delete something, or change something that affects the integrity of the model? Is it better to remove the user from the actual model constructs/code and provide an external interface? You can use spreadsheets, or text files, or provide prompts as the user starts to run a model, or you can create a custom application with a tool such as Visual Basic. A lot depends on your customers; who are they, what are their skills, how much information will they need to change for each scenario they might want to run, how much time and money do you have to create such an interface? This clearly extends to the output information provided. Can you control how long they run a scenario to guarantee reasonable statistics? Can you automate the process of selecting the best alternative? The value of addressing these issues is crucial: it will directly impact whether the customer will use the model or find other ways to get the answers he/she needs.

Considerations:

- Degree of model flexibility: system configuration, product routings, processing/scheduling rules, run length
- Type of interface to add to the model to allow user selections
- Control of output analysis

2.6 Edward Williams: How should simulation software be selected and supported?

2.6.1 Overview

Simulation model-building tools and languages are markedly varied, numerous, and powerful compared to even ten years ago. As an organization begins and expands its use of simulation, the issues involved in selecting and supporting the simulation tool(s) of choice assume high, ongoing importance.

2.6.2 Compromises Required

At the beginning of the selection process -- well before evaluation of specific tools -- the simulation model-builders and users within the organization need to reach consensus on the following issues:

- Where do we stand relative to the inflexibility of a single tool at one extreme, and the difficulty of supporting and transferring knowledge among a large number of tools?
- Is ease of learning and using a tool of greater or lesser importance than high power of that tool for modeling complex, non-canonical systems?
- What generic types of systems will we be modeling, e.g. push versus pull, material-handling, storage-and-retrieval, etc.?
- What interface do we need (e.g. to spreadsheets, databases, or CAD drawings) and on what platform(s) (e.g. DOS, Microsoft Windows, OS/2, UNIX)?

2.6.3 Selection Criteria

These criteria can be listed conveniently and weighted in matrix form to support comparative tool evaluation. Other criteria likewise deserving attention are:

- The quality of the software documentation
- The presence and quality of on-line tutorials and context-sensitive help
- The ability of the tool to support scenario management and in-line statistical analyses
- The degree of integration between model definition and animation construction
- The history of the tool in supporting the modeling of systems similar to the user's systems
- The degree of practicality, in both the technical and contractual senses, of building "executables" portable on behalf of usage by modeling customers unfamiliar with simulation detail
- The degree of similarity of usage (e.g. mouse and function-key conventions) between the tool and other software frequently used by modelers
- Levels of knowledge, responsiveness, and cooperation observed among the vendor's technical salespeople
- The vendor's size, longevity, and fiscal stability

2.6.4 Support Procedures

Having selected the tool(s), the simulation practitioners next need to consider ongoing support of the tool(s). Possibilities include:

- Designation of in-house experts as support persons
- Establishment of a help desk, possibly staffed by the vendor's personnel

- Organization of training classes
- Localized user group meetings to share information and experiences

These possibilities are synergistic, not mutually exclusive.

In view of steadily increasing business pressures for efficiency of operation and the near-certainty of continued advances in tool sophistication and power, the simulation users and customers within a company may confidently expect the tool selection and support processes to be ongoing.

3 SUMMARY

The panel's six questions present issues found in four elements of a manufacturing simulation infrastructure. Two deal with application elements, two with training, one with tool selection, and one with organizational issues. While some offer solutions, all give information rooted in experience and not textbooks.

As might be inferred from the wide range of topics and perspectives presented, the label 'Manufacturing Simulation Consultant" does not precisely describe an individual's experiences or activities. Historically, simulation has been introduced into organizations from the bottom up. This approach has caused consultants to have relatively narrow views of their business. Perspectives and opinions can differ radically because experiences differ based on the consultant's personality, age, training, geographic location, products used, industries worked in, and luck among other factors. However, the premise of this forum is that, in spite of these differences, there exists a set of core knowledge that is useful to all practicing manufacturing simulation consultants.

The ultimate goal of this forum is to broaden each consultant's perspective by sharing the insights of others and to start defining this core set of practical knowledge. Therefore, the real benefit of this forum does not lie within these pages but rather in the discussions the questions presented here trigger. If this year's forum is as well attended as last year's, there will be over 100 other consultants ready to use these questions as starting points for some valuable interactions. We look forward to seeing and hearing from you there.

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DEBBIE KOTLAREK is Director of Engineering Services at HK Systems, Inc. (Harnischfeger Engineers & Kenway). She has been responsible for the simulation activities at HKS for over 20 years, focusing on modeling the automated systems that are designed and implemented by HKS as well as independent simulation studies to support clients in a wide variety of industries. In this role she has developed computer models and coordinated numerous simulation projects using the GPSS/H, SLAM, and AutoMod languages. In 1991 her responsibilities were expanded to include additional support functions including the Computer Services and CADD activities. Debbie received a B.S. in Electrical Engineering and a Master of Business Administration degree from Marquette University.

BARBARA WERNER MAZZIOTTI is currently the Manager of Simulation Services at the Textile/Clothing

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EDWARD J. WILLIAMS holds bachelor's and master's degrees in mathematics (Michigan State University, 1967; University of Wisconsin, 1968). From 1969 to 1971, he did statistical programming and analysis of biomedical data at Walter Reed Army Hospital, Washington, DC. He joined Ford in 1972, where he works as a computer analyst supporting statistical and simulation software. Since 1980, he has taught evening classes at the University of Michigan's Ann Arbor and Dearborn campuses, including both undergraduate and graduate classes using GPSS/H, SLAM II, or SIMAN.