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PANEL DISCUSSION: BUSINESS PROCESSES FOR APPLYING DE SIMULATION EFFECTIVELY IN MANUFACTURING COMPANIES

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ABSTRACT

A panel of simulation managers from manufacturing companies discuss the following six topics: (1) How are managers responsible for manufacturing best persuaded to try simulation? (2) How can capturing the benefits of simulation best be made a regular process? What are the roles of model databases and reuse, input databases, standardization, change management, simulation project management, and training in such a process? (3) What other areas should one consider in addition to the ones listed in item 2 above in such a process? (4) Where should the Simulation Services Department reside in the organizational structure of a manufacturing company? Should it be centralized or decentralized? (5) How can simulation usage ("the first project") best be undertaken to be a success? (6) How can momentum best be maintained after simulation usage is accepted?

Q1: How managers responsible for manufacturing are best persuaded to try simulation?

Ed Williams: The proverbial hardest part ("getting the first olive out of the bottle") is the very first successful project. At Ford, we achieved that because plant X fortuitously had a manager who was well acquainted with simulation both via university education and his previous industry experience at another company. Using that successful project as a shoehorn, three Ford technology support engineers in manu-

facturing (I was one) publicized simulation and this success. We developed a one-day *non-technical* course providing an overview of simulation. This course described the successful project, giving the quantitative benefits it provided. Thus, slowly (time frame years, not months), other managers at other plants were persuaded to try simulation, with the technology support engineers openly and conspicuously available for over-the-shoulder guidance.

Roberto Lu: Many hard working managers in a manufacturing environment do not have the luxury to charter a simulation project for his/her processes. Very often, it's the simulation practitioners' interest to seek for opportunities to contribute. This includes taking proactive actions in earning support from maybe a paralleled organization. Once the simulation model presents meaningful information, it's easier for managers in a manufacturing environment to seek simulation modeling and results.

Scott Bury: I do not want to persuade someone to try simulation. I want to provide them with the right data to make the right decisions. "Simulation" is a vague term for a rich and varied technology, which depending on the background of the client, can invoke the full gamut of responses ranging from joyful acceptance to outright disgust accompanied with a full and complete accounting of failures and other war stories. Regardless of the client's previous experience if any with simulation projects, simulation needs to be considered as any other decision technology and implemented within a project and decision management framework. Without the framework, the effort to avoid failure will destroy any value to be gained from a simulation. Effective use of a framework will maximize the value the simulation project will deliver. There are a number of different frameworks or processes that can be readily adapted to a simulation project, e.g. Six Sigma DMAIC or DMEDI depending on the need. Many modeling and simulation books have convenient flowcharts of the simulation process that can serve as a template. The actual work process employed will be the one that integrates most smoothly into the companies' culture and manufacturing's way of doing business.

One framework we have found effective is an adaptation of the EPA's data quality objectives (DQO) process. The EPA's DQO Process is a systematic planning process for generating environmental data that will be sufficient for their intended use. For the simulation quality objective (SQO) we can restate this as the systematic process to insure that our client gets the right data to make the right decision from our simulation study. The SQO has the following steps,

1. State the Problem.
2. Identify the Decision.
3. Identify the Inputs to the Decision.
4. Define the Scope and Boundaries of the Study.
5. Develop a Decision Rule.
6. Understand how much Uncertainty can be tolerated in the Data.
7. Optimize the Simulation Design.

The clear problem definitions and the clear decision definitions are the key aspects of any simulation project. Quite frankly, if the client cannot (or will not) clearly define the problem, the decision to be made, and the data needed to make the decision then you should not waste time trying to convince them that a simulation project should be tried. If they are willing, then you are at least 80% of the way to success. This is the critical step in the simulation project as it includes establishing what is success and gaining agreement of the stakeholders. Should this progress estimate seem high, I invite the reader to reflect on the past simulation projects and sort them into great, ok and bad and perform a mental root cause analysis on the most important milestones in the project. Well planned and well defined simulation projects succeed and deliver. Rather than approaching a production manager with "We're from the Department of Simulation Studies and we're here to help", a more effective approach is to ask what are your decisions and what data do you need to make them. All that is left is to execute.

Demet Wood: Within a large corporation the subject matter experts have to provide actual results to prove the process and tools work. Outsiders need to have examples as close to the customer's reality as possible. Getting simulation accepted as a standard process is similar to starting a flywheel. The first rotation takes the most effort, the second and third takes less. After some point the momentum reaches a point such that stopping the flywheel is harder than keeping it running. First introduction of simulation will take persistence and trying different angles. Best method is to take a known problem and to provide solution using simulation. As we believe all simulation projects should be kept simple, the first one especially important to have done quickly, without putting burden on budget as well as the customer.

Q2: How can capturing the benefits of simulation best be made a regular process? What are the roles of model databases and reuse, input databases, standardization, change management, simulation project management, and training in such a process?

Roberto Lu: Simulation models must be constructed with the idea of capturing benefits in mind, or it is very challenging to capture any benefit on a regular basis. Simulation practitioners may want to have a structured data movement system and model input/output templates in place at all times. Hence, when there is an opportunity to model a process, maybe it will be easier to capture the benefits.

Scott Bury: The effectiveness of any work process or application of technology depends on the alignment to actually addressing manufacturing problems and delivering data and solutions. In the case of a simulation (or any model for that matter) designed for routine use, it will only be used if the client understands the benefits they get from using the application and they clearly see that it makes their job easier or better. You can have the best model and input databases available but if the individual client cannot link the use of the simulation application to their job scorecard then the simulation will fall into disuse. For simulations for design problems etc. the simulation work process needs to be integrated such that there is understanding of how it can be used to generate data to make decisions (see first discussion above).

Demet Wood: Back to the flywheel example; it will not become regular after the first use, however consistent use of simulation, communicating its benefits clearly makes it easier. One of the major factors that hurt simulation is the effort it takes to collect all necessary data and information. This process takes especially long time and requires customer's input if you are not familiar with the process being simulated. It is best if the first few projects are in an area simulation engineer has some knowledge to carry out the project with minimal customer input.

I believe that the training and standardized work associated with throughput simulation is about the application of the tool first. The WHY of the simulation. Training to use the software tool follows. Databases are a product of obtaining inputs that all parties to the analysis agree are valid, so as not to spend time recreating/reinventing or arguing about valid model inputs. Obviously, the more stable the process the more valid history (data) is available.

Ed Williams: After the process described in the previous question gained momentum, the support engineers developed a centrally available "simulation project book" in which each new successful project was documented. For each project, its input database, model, history of changes, and project timeline was available for examination or reuse in another project. These practices rendered both correct and persuasive the accounting argument "Investment in a proposed next simulation project will be (1) smaller because work and ideas can be reused and (2) amortizable over a longer period of time because projects still in the future can benefit from experience about to be gained in this one." As indicated in question #1, the time context here is years, not months.

Q3: What other areas one should consider in addition to the ones listed in item 2 above in such a process?

Demet Wood: Teaching TOC throughout the organization, not simulation. In addition, attending professional conferences such as WSC to expose success of simulation in other companies will accelerate the process. Also, use of student interns that are educated in the area to perform some of the projects can add to the momentum.

Ed Williams: A primary area to consider is whether to standardize (there's that word again) on one or several simulation software tools, or not. There are several alternatives: there may be no standardization, there may be standardization on *one* tool (the other extreme), on several recommended tools, or on one or two tools with provision to use others in special situations. Among these alternatives, the only one I would specifically condemn is the alternative of no standardization. The size of the company, the extent of its geographic and organizational dispersion, the extent of precedent in standardizing software for other purposes (e.g., project management), and the amount of variety in potential simulation projects are all factors deserving attention when the standardization decision is undertaken. Furthermore, since simulation software is rapidly evolving and developing, any standardization decision reached merits reexamination at least biennially.

Roberto Lu: Deep understanding what matters in the manufacturing business at the time of simulation. Maybe it's the capital budget planning, resource allocation, production system balancing, and/or rate of the throughput increasing. Sometimes decision making opportunities for leaders in the manufacturing can be important.

Q4: Where should the Simulation Services Department reside in the organizational structure of a manufacturing company? Should it be centralized or decentralized?

Ed Williams: Three basic alternatives are available: (1) all simulation work done at a central location; (2) all simulation work decentralized; or (3) an approach of interpolation between (1) and (2), wherein managers needing simulation work done can send it to a centralized location or ask that centralized location to support local simulation work. The Ford approach used alternative (3). This intermediate approach, my own recommendation unless the company is quite small, tends to retain the advantages and ameliorate the disadvantages of approaches (1) and (2). Specifically, centralization provides a repository for items mentioned in question #2 (e.g., models and input databases), provides an "umpire" for the standardization issues of question #3, and provides continuity of expertise. Giving other locations within the company the option of doing simulation at their own sites with support available as needed provides reassurance of local control and adaptability to local needs and considerations.

Roberto Lu: In my opinion: Centralized! Why? Most manufacturing teams on the shop floor have daily challenges and tasks to keep the money making production system going. Simulation modeling is like a language that if you don't speak it regularly, you lose the edge of it. In a centralized simulation supporting organization, simulation practitioners can both sharpen their skills together in a team and replicate what was modeled in one operation to another when possible.

Scott Bury: On one hand it is hard for the lone modeler to go it alone so that argues for a group. On the other hand, modeling groups can be easy targets for budget cuts. In my experience, a core group has the best chance of having enterprise wide impact. Extended networks can leverage best practices. The key to long term success is that the simulation technology needs to deliver value and that responsibility is

split between the simulation group's leadership and how they implement the chartering and management of the project, and the modelers who need to execute.

Demet Wood: Historically, Simulation has been an Industrial Engineering tool and I believe that is the best place, because IE tends to take more of an overall approach to Manufacturing. Manufacturing tooling, facilities, materials or whatever other engineering organization is there tends to focus in great detail on their specific cost and quality responsibilities, without the total cost picture in mind. In my experience a central simulation activity provides for the ability to keep a critical mass of simulation/throughput expertise with more flexibility to share work to deal with workload variation (after all, there is variation in our process too!). More people centralized provide more speed and buffer, with less downtime due to focused expertise. (I agree, however it does not hurt to state that, at GM, simulation has moved around organizationally and managed to succeed regardless.)

Q5: How can simulation usage ("the first project") best be undertaken to be a success?

Roberto Lu: Set expectations realistically, understand business needs, start for a high level model, seek help from those who have done it many times, agile modeling process, and frequent process check with stake holders.

Scott Bury: See answer to question #1.

Demet Wood: Keep it as simple as possible. the customer then better understands and buys in easier. The customer better understands and can shift direction easier due to the simple nature of the project. Complex studies are fun for the experienced modeler only. Fast and simple results (hence less cost) and answers are much more fun for the customer, who can then ask for more help in other areas and not be financially drained by one project. The risk of a late answer is too great with complexity. A late answer is worth nothing. In addition, listening to the customer needs is the key. Manage the project so that the results answer the question that customer needs answered. Another key point is to keep the customer involved from the beginning and to get buy in on assumptions that are being made. Even when it is one assumption that is disputed, and even if that would not have made a difference in the overall result, it is very easy to lose customer's confidence with an invalid assumption.

Ed Williams: Especially in view of question #1, this question is of utmost importance. Bringing new technology into a company (the context of this panel discussion) merits attention to the proverb so often quoted to graduating college students entering the world of job interviews: "You never get a second chance to make a good first impression." Likewise, it is essential that the first simulation project be a success. Therefore, all standard advice available in the literature should be scrupulously followed – for example, data should be correct and adequate for the demands of the model, verification and validation should be done rigorously, and modeling assumptions should be acknowledged and documented. Additionally, I urgently recommend that the first project be *small* – for example, one department, line, or work cell, not a whole factory or warehouse. Far better to begin with a small success than a large conspicuous failure! Furthermore, check whether "there is an elephant in the room." The "elephant," if it exists, refers to a thinly veiled threat posed by this first project. A project whose performance metric is "let's see if we can reduce worker headcount on this line" is a dangerous choice for the first simulation project.

Q6: How can momentum best be maintained after simulation usage is accepted?

Scott Bury: Documentation and clear maintenance plans for models that are designed as such.

Demet Wood: This is the easiest thing to do. If the tool and the process has been proven, then demand for more work will come automatically. Acceptance comes with the proper results. Again, I can't believe that anything is more important than the simplicity of the process. That flies in the face of many simulation practitioners that believe they need to get to the absolute perfect results/answer. That's fun for them, not the customer.

In my world, we have many happy customers because they get results quickly, with repeated high quality, at the level of detail they can plainly understand. They ask for more because they know it won't take long for results. In addition to the simplicity of the process, consistency is crucial. If you want simulation to be used as standard process you need to treat it as a standard work. Consistent report formats, consistent meetings, consistent assumptions all help make it a standard process. You can only do this if the process is simple. This is in contrast with the general nature of the people that are involved with simulation; highly creative, and want to work without boundaries.

Ed Williams: Visibility and publicity for the gradual growth of the simulation project book (question #2) helps maintain the momentum. Additionally, simulation successes should be prominently placed in a corporate newsletter and/or the company intranet. As favorable simulation awareness filters upward to higher management, I recommend those managers be gently encouraged to set quantitative annual performance objectives for their subordinates. Such performance objectives (e.g., Reduce dwell time in your manufacturing department by X%) not so subtly prod operations managers to use analytical techniques such as discrete-event process simulation. Establishment of a corporate simulation users group, such as the Ford Simulation Users Group created at Ford, also helps maintain momentum.

Roberto Lu: This has a lot similarity with the question above. I'd say frequent reporting out with updated simulation models is important. Follow-up on possible business decisions that were made based on simulation results is critical also.

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ONUR ULGEN, PhD, is a Professor of Industrial and Manufacturing Systems Engineering at the University of Michigan-Dearborn and also is the President of PMC, an industrial and operations engineering consulting firm. He has published more than fifty papers, book chapters, and manuals on the applications of simulation, scheduling, operations management, and lean systems. He has more than twenty-five years of experience in applying simulation and scheduling techniques in Automotive and other industries. Currently he is involved in writing a book on the applications of simulation using the WITNESS simulation software. He holds a BSME from Bogazici University, and MSc and PhD degrees in Industrial Engineering from Texas Tech University. Prof. Ulgen had been teaching at the University of Michigan-Dearborn since 1979 at the Industrial and Manufacturing Systems Engineering Department and he is currently the Co-Director of the Information Systems and Technology Graduate Program. He is also one of the founding members of the Michigan Simulation Users Group (MSUG). His email address is <ulgen@umich.edu>.

SCOTT BURY currently serves as a Principal Research Scientist at The Dow Chemical Company's Core Research and Development organization. This organization works across all of Dow's business and is at the hub of innovation and new technology for Dow. Scott has spent 18 years as part of Engineering Sciences working in diverse areas from environmental technology to plastics to biotech and photovoltaics. He has worked at all scales of production – lab to pilot to full-scale – with all types of data. Over the past six years he has expanded the use of discrete event simulation in support of Dow's manufacturing, reliability and supply chain. He is a certified Six Sigma Black Belt and helps to mentor and coach people on making data based and risk aware decisions. Scott received his BS in Biology/Biotechnology from WPI

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