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A proper simulation process, led well, can generate true organizational learning

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Simulation modeling provides an opportunity to assess complex and varied manufacturing systems with an objective, systematic and team-based approach. This mathematical and data-driven design tool requires all components and variables to be accounted for as the model is prepared. The model requires process definitions, transportation definitions, inspections, interferences, inventory allowances and all of the appropriate mathematical parameters. To ensure timely results, a systematic approach is required, including objective definitions, process mapping, data collection, model construction and simulation runs. Production simulations are intended to identify critical production constraints while balancing labor, asset utilization, inventory and lead-time. The end game for manufacturing simulation is to determine future production outputs.

But effective simulation modeling can yield more than mathematical findings. For the project team and others involved in the effort, the entire process enhances organizational learning by requiring everybody to understand all aspects of their process – or proposed process – at a level of detail that includes all interactions and interferences at a shop floor level.

The entire process drives unity and team effort. But to get the most out of simulation modeling, it is important that management and team members pick the right person to lead the team.

It's a team game

The team effort of modeling a future production design can be a complicated venture. However, that is precisely why it is an appropriate simulation application. The varied input and output expectations warrant a true team effort. Team members provide their parameter expertise, develop an understanding of the interdependency of the complex process characteristics and progress toward a common output.

The following six team characteristics are generally associated with any successful endeavor to simulate future production.

1. Detailed process flow documentation. A successful simulation effort requires a detailed process flow document. This should be developed by the team during the initial steps of the assignment, and it must include process steps, process times, input volume and mix, interferences, stochastic implications and other appropriate production characteristics. The process of integrating these variables and the implications they have for production will enlighten individual team members, providing them a perspective that will broaden their pre-conceived understanding of the system. After participating in this effort, the team members will be concerned about the entire process, not just their individual design concerns. The process of documenting the model flow will be the fundamental statement for the team and a constant reference for the simulation process.

2. Team understanding. The production design team should comprise personnel from manufacturing, engineering, management, materials control, quality control and other appropriate functions. Each person has his or her role and responsibility in the production system. These roles may be established along functional lines that go across all the processes, or the roles may be specific to certain segments of the process chain. The simulation modeling activity will encompass all of the functional areas as well as the entire process chain. As the process map is developed, team members discuss the production parameters and assess how to integrate all of the factors. The complexity of the entire system becomes evident to all involved.

Developing the process flow documentation will require input from all team members, varied sources of specific data, and statistical analysis of stochastic implications. It is critical that the entire team is involved with preparing this document. Tools such as brainstorming, affinity exercises and group facilitating skills will ensure that all team members participate and are committed to the working document.

It will be critical that you assign data collection and verification to team members who understand the role this data plays in the simulation effort. Team members must develop a consensus about the level of detail required to provide an accurate model, along with the right data set to establish a baseline model. Current production data, historical data and average data with statistical variation are examples of data sets that simulators commonly use to establish a baseline and validate the model.

3. Product mix, volumes, and sequence implications and understanding. Although they can seem obvious, the product mix, volumes and sequence of production offer an infinite number of variations within the production process. Future predictions of these critical production variables typically are based on average expectations and are ambiguous at best. Average expectations often are defined differently for individual team members and management. A successful simulation modeling process will ensure heated debate, understanding of variances and unified conclusions for these foundations of production.

Product mix and volumes will spark lively debate from the beginning. Although the customer supposedly establishes these variables, real production fluctuates due to factors that include seasonality, differences from day to day or shift to shift, transportation constraints, production issues and other customer demand requests. All of these issues will affect the evolution of the team's template of mix and schedule scenarios. This template will challenge the simulation model with an array of product volume and mix options along a varied sequence and timetable. New discussions regarding how to plan shifts, strategic imperatives, line balancing, relief labor options and flexible workweeks will challenge what was thought to be an established work plan.

These team efforts will provide meaningful understanding for all team members and offer options for greater production system performance and effectiveness. These variables can be overwhelming to manage, and it is critical that the team develops a systematic approach to testing them and presenting the results of the simulations.

4. New system performance cannot be dictated. Leadership has the responsibility of challenging the performance expectations of all production assets, resources and management. This responsibility encompasses many management styles, varied techniques for setting goals and different levels of participation. Often, leadership concludes by charging its teams to "make it happen." This leadership challenge usually is based on required production expectations. But such requirements are not realized easily. As industrial engineers know, the cumulative and sometimes negative effects of performance factors often lead to an unexpected performance level.

The production simulation process holds the team accountable to data-driven modeling and allows the team to present a unified demonstration of expected future performance. Individual process times, interferences, imbalances and inventory strategies are the type of data points that provide a basis for unbiased analysis and discussion. The team can provide an indisputable portrayal of what levels of performance are expected, the process redesigns required to meet those expectations, areas of concern and solid guidance on future operational execution. These factors can enlighten leadership about the challenges being faced, often to the point that leadership becomes engaged in the production design process.

5. Team organizational learning. Many elements of the production process seem to be obvious in nature and easily planned. But once team members drill into the details, particularly when it comes to areas outside of their functional concern, many of these things don't seem so simple anymore. During a solid simulation process, the team members will gain a more granular understanding of production terms such as standards, performance measurement, flow, capacity, space, inventory strategy and others. What these factors truly imply, combined with the resulting process design, will guarantee authentic organizational learning.

The organizational learning that occurs during a production simulation exercise is extraordinary. The discussions now include terms of efficiency, utilization, base standards, current standards, statistical variances, interferences, changeover, downtime, line balance, balance delay, tact time, response time, learning curves and other factors that affect production performance. Other concepts, such as flow, space, capital, expense, lean and shared support services, will require team discussion, furthering organizational learning.

6. Team unity. An effective simulation process requires an appropriate team of professionals committed to overall production success. Individual responsibilities are based on a "doing my job" type of attitude. As team members learn how these responsibilities are interdependent with each other, they become more in tune with the idea of total production success. The individuals now appreciate the challenges of the other team members.

This helps them unify their effort as individual responsibilities become team priorities, and they try to execute their efforts in a sequence that will ensure the best results for the entire program. The team will develop plans and actions while fully understanding how they affect the total system. Effective and contagious team unity often is a prominent outcome of the production simulation process.

Leadership requisites

A simulation modeling team has the opportunity to ensure an effective and sustainable production design and launch. But with any team, even one comprising intelligent and passionate individuals, leadership is important. The leadership associated with a simulation modeling effort must have a unique skill set, including process knowledge, facilitation, communication and presentation.

Many assume that the simulation programmer should be the team leader, but this is a major misconception. The leader needs to have a set of skills that go beyond technical understanding. Much of what we need from a solid team leader derives from the above list of characteristics that encompass a successful simulation effort, such as documentation requirements, cooperation and the details of the production process. When selecting a team leader, it is a good idea to keep the following six specific characteristics in mind.

1. Process documentation training and experience. Process documentation is perceived to be a relatively simple exercise of drawing characters, arrows and parameters. But the process document will be critical to understanding the challenges of the production design and the goals of this assignment. It is the team leader's responsibility to facilitate the production process documentation. The document will be adjusted throughout the assignment, and it should remain the key working document that signifies the model's flow and logic. Team members should be able to look at the process documentation and understand the overall model flow, key parameters for each process, process interactions and decision criteria.

This assignment rarely begins without some level of process documentation already in place. This provides a great starting point, but the key is for the team to use its growing understanding to elaborate upon the details, ensure the appropriate parameters and update this documentation in an understandable way.

2. Manufacturing and process understanding and experience. It is critical that the simulation team leader has a general understanding of both manufacturing and the specific processes being assessed in this undertaking. The general understanding includes processes, direct labor, indirect labor, shift strategy, raw materials, work-in-process, finished goods, efficiency, utilization, standards, production losses and more. This general understanding of manufacturing will prove critical as this leader deals with conflicting team member opinions and plans. The role is not to be the decision maker, but to ensure a general understanding that defines the issues clearly so that the team can develop options and conclusions.

It is crucial that the leader understands the specific manufacturing processes that pertain to the organization and plant. These specifics include how the processes function, process capability in terms of rate and quality, material handling strategy, containerization, automation and others. This knowledge can direct the team as it plans processes, develops strategies and assesses options, particularly when simulation results seem ambiguous. The leader must be able to interpret the simulation results to ensure that the model is valid, as well as lead the team as it interprets simulation output. This interpretation will be critical to understanding results, leading systematic improvement models and establishing credible and understandable output summaries.

3. Questioning and challenging attitude. The validity of any simulation model can be compromised by a strong voice, a supposed expert or a controlling dictator. The team leader must ensure that group dynamics are controlled to ensure genuine synergy. If initial model runs indicate unexpected baseline results, the team leader must guide the investigation to determine whether the model or specific inputs are the cause. The leader cannot allow the team to become discouraged and dismiss the effort. At this point, the modeling process often brings unusual or minimally considered interactions to light, interactions that negatively affect production.

SIMULATING THE BRAIN TO FIGHT DISEASE

The increasing power of supercomputers and open-source simulation software has combined to model human brain activity for the first time.

According to HPCwire, which covers the computer industry, researchers from the RIKEN HPCI Program for Computational Life Sciences, the Okinawa Institute of Technology Graduate University (OIST) in Japan and Forschungszentrum Jülich in Germany carried out the largest general neuronal network simulation ever performed.

They used Japan's K computer, the world's fourth fastest. It clocks in at more than 10 petaflops with 705,024 processor cores and 1.4 million gigabytes of RAM. The Neural Simulation Technology, or NEST, harnessed 82,944 processors of the K system to reproduce a complex network of 1.73 billion nerve cells connected by 10.4 trillion synapses.

Despite all that power, a single second's worth of neural activity took 40 minutes to calculate, HPCwire reported.

Still, the study showed the limits of simulation technology, and researchers can use this experience to guide future brain simulation studies. The hope is that advanced simulation with exascale computing allows for whole organ modeling of the heart, brain and other organs, leading to treatments for Parkinson's, Alzheimer's and other debilitating diseases.

By going through numerous simulation runs, the team will start to learn the good and the bad of each outcome and slowly build the most optimal model, weeding out the bottlenecks and obstructions and figuring out better ways to make production flow. It is the team leader's responsibility to ensure that when these new ideas are proposed, they are in the best interest of the team instead of favoring one specific department. The team leader is responsible for openly questioning what happens in these team discussions. This practice of questioning and challenging the team's ideas is an ongoing process.

4. Communication skills and discipline. The team leader must have the ability to communicate with the team throughout the assignment. This communication includes the initial process documentation, model reporting, complex output interpretation and team presentations.

To be successful in this written part of the program, team leaders should work hard to make sure all their communications are succinct and clear, whether they are imparting information via meeting minutes, action plans, status updates or project reports. In dealing with verbal communications, the team leader should strive for a consensus on ideas that are proposed during workshops and try to ensure definitive, nonargumentative feedback.

The team leader must be disciplined enough so that he or she can document the required model scenarios to allow for easy comparison and understanding. This may be in the form of a summarization matrix that defines key input parameter changes and one or two key objective measures as corresponding outputs. While detailed reports are beneficial for evaluating specific results, the summarization matrix allows the team to see how input variations directly correlate to improved results.

5. Team facilitator and motivator. The simulation modeling process will challenge the plans and thoughts of each team member. The team leader has the task of engaging the members in brainstorming efforts beyond revising working parameters, altering manufacturing processes or revising cycle times. To develop a successful model, the team leader must motivate the team to challenge traditional constraints while applying first-hand knowledge of the processes. Some team members may hesitate to challenge the status quo, but it is the team leader's responsibility to encourage open dialogue and welcome new ideas.

The team leader must also be encouraging about how the simulation tool is an appropriate means to reach success. Often, the model is delayed due to a lack of accurate data, work conflicts that delay participation from team members, and changing priorities. The leader must understand how to make sure the team progresses while demanding accountability for assignments. The successful team leader will ensure that meetings are effective, documentation makes sense and participants are responsible – ideals that are necessary to ensure a clear and concise statement of the exercise's objective.

6. A philosophy of simplification. The simulation team leader will be challenged with complex processes, modeling, statistics and, ultimately, complex production designs. This person's fundamental philosophy should encompass an attitude of process simplification. The modeling process should be narrowed down to inputs and outputs (or structures familiar to the team members). The model programmer is tasked with the logic and statistical preparation of the model, which can be mystifying. The leader should separate the model programming complexity from the production complexity. Familiar input formats are one tool to ensure this separation.

But outputs also must be presented to the team in familiar terms. Simple graphics that demonstrate how adjusting a variable can affect the results can help team members make the right decisions to improve the model. Sequential volume and mix scenarios, stochastic variable implications and cumulative variable changes all are appropriate output formats for interpretation.

The design of the manufacturing system that is being tested also should follow a philosophy of simplification. This is obviously an opportunity for great debate among team members; suffice it to say that the production system's components should be visual and understandable. These variables include process locations, flow, inventory strategies and labor assignments. The team can use the simulation model to understand where the complexity is within the production system and figure out ways to simplify the entire process.

More than an output generator

Production simulation modeling is an incredible tool that can predict meaningful outputs based on a series of complex inputs. But the process offers a much broader opportunity to ensure an effective production design, a unified team, improved organizational knowledge and a culture of data-driven production designs. It is essential that the simulation team pick a leader who has the attributes necessary to make sure that the effort leads to an optimal model.

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