Proceedings of the 1989 Winter Simulation Conference
E.A. MacNair, K.J. Musselman, P. Heidelberger (eds.)

OPPORTUNITIES AND CHALLENGES IN MANUFACTURING SIMULATION FOR BUSY PLANT ENGINEERS (PANEL DISCUSSION)

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STATEMENT OF PURPOSE

The purpose of this panel is to discuss both the attractive benefits and the difficult challenges of factory simulation. Our target audience is manufacturing and industrial engineers who are new to simulation.

Simulation has become a popular tool for engineers in making both strategic and tactical decisions. Typically, busy engineers in plants relied on corporate resources such as mainframes, general purpose simulation languages, and operations research specialists for their simulation requirements.

Breakthroughs in powerful microcomputers, menu-driven simulation packages, and graphical animation provide major opportunities for busy plant engineers to use simulation for factory planning. However, there are some tough challenges for engineers who wish to succeed with simulation.

Opportunities

1. Avoiding costs by quickly evaluating alternatives is, of course, the biggest opportunity in simulating manufacturing systems. Savings in manpower and equipment, reduction in cycle time and inventory, and increase in throughput are obvious benefits of simulation analysis.
2. Simulation, when performed during system design, highlights routing and scheduling problems before committing to system implementation. Making mistakes on the computer model rather than on the factory floor can save many careers and eliminate headaches. The opportunity for the plant engineer is to reduce the risk associated with automating a system - as well as not automating.
3. Significant factors affecting inventory, cycle time, and throughput can be determined by sensitivity analysis. This helps in educating financial management on the true factory performance measures. For example, a simulation model can be used to show that improving utilization of non-bottleneck resources may be degrading the overall throughput.
4. Simulation model development is an iterative process. During model construction, the modeler generates graphical, narrative, and tabular descriptions of the actual system. When reviewed for validation, these descriptions help everyone from production scheduling to quality control to understand how the system really works. Usually, this exercise results in immediate design improvements even before simulation runs are made.
5. Another major opportunity is improved communication between the factory floor personnel, engineers, and management. Especially with animated pictures of a model, operators and supervisors can be educated on how proposed plant changes will influence them and they can be consulted for ideas. Thus, operators develop a sense of ownership that they build into quality products. Also through animation, managers can be presented with alternatives. When they clearly understand the proposed alternatives, they are more likely to make sound decisions.
6. Simulation can also be a very effective sales tool in competitive situations. More and more plants are beginning to use simulation to prove to their customers that they have the capacity to handle new orders or that they can meet required delivery

schedules. Of course, this results in increased factory orders and gives you an edge over the competition.

Challenges

1. One of the most difficult challenges of a plant engineer is to balance the time spent between planning and carrying out daily production. Almost always, production takes a higher priority. Estimating and allocating the necessary time for a successful simulation project can be a tough challenge. One week is not long enough to learn a simulation package, gather data, build a model, and act on the results of that simulation study!

2. Another major challenge is selling the benefits of simulation. Simulation requires investments in hardware, software, training, and time to get results. It is unrealistic to assume that a plant can get into simulation with a $5,000 budget. When the plant manager asks for justification, ask him just how much it cost to move the same production line three times last year.

3. Identifying and purchasing the appropriate hardware and software may become a political battle or a nightmare. Most MIS managers question why plant engineers cannot use an IBM-XT to run simulation models! Regarding software selection, the key criterion should be "Which software suits our needs best?", not "Which software has the fanciest animation?"

4. Most plant engineers look forward to summer months when co-op students are available for part-time help. A co-op student may be familiar with a simulation software or perhaps quite proficient in programming. But, does the student understand the manufacturing system under study? Will the student leave you with a model that you can modify?

5. Understanding "what simulation is" and "what it is not" is extremely important. Unfortunately, sometimes simulation is perceived as optimization. Discrete-event simulation is dynamic, probabilistic and non-linear. A simulation model generates statistical and graphical information on plant performance measures like throughput and inventory under a set of given conditions. Simulation does not give the answer!

6. Simulation modeling is a combination of art and science. Modeling means representing a system -- not emulating it. The natural tendency for a plant engineer is to make a one-to-one mapping of the factory in the simulation model. This results in long model development time, long execution time, and long output analysis time. The challenge here is to model only the significant characteristics of the real system.

Panel Chair's Biography

KEN TUMAY is a manufacturing simulation consultant for Simulation Modeling Company. He received his B.S. and M.S. degrees in Industrial Engineering from Arizona State University. Over the past seven years, Ken has developed simulation models for companies including Baxter, Digital, IBM, Grumman, Motorola, and Philips and published many papers on production modeling. He is a member of APICS, IIE, and SME.

POSITION STATEMENT

John E. Lenz
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Simulation has the opportunity to become one of the principle decision support tools for factory planning. This technique of color graphic animation, statistical analysis of results, and data driven models has made simulation readily available to plant engineers. But the challenge is to provide timely-accurate results for the fast paced planning projects.

The trend is away from the high inventory unbalanced production environment, and low inventory balanced environments towards the low inventory unbalanced environment. In this environment, some form of flexibility (machine or labor) is used as a substitute for inventory to manage productivity levels. Material shortages and blockages are frequent occurrences during the factory operation and computer simulation is necessary to quantify these effects upon productivity.

But simulation comes with some "long lead time" characteristics. These characteristics are large data requirements, modeling, model verifications and validation, and control algorithms definition. The data requirements include process definition, routing, and layout. The modeling task can be reduced by use of data driven models but it still takes time to build confidence in the results. The selection of control algorithms can range from selection within a library of alternatives to programming specific decisions.

This challenge of reducing simulation lead time can be controlled and quite short for well designed data driven models. But where the risk remains, is in interpretation of the simulation results. Simulation is an unstructured tool usually solving an unstructured problem. When this condition arises the interpretation of results beyond "yes it worked" or "no it doesn't" is an unpredictable time consuming task. There is a need for a structured procedure for analysis of results.

One such procedure could use an integration of many tools into a decision support environment. These might include capacity analysis, feasibility studies, queuing models, data driven simulation models, and general purpose models. This hierarchy of models is intended to keep the engineer focussed on solving the "cause and effect" problem and not spending time misinterpreting results.

Panelist's Biography

JOHN E. LENZ, President, CMS Research, Inc. since 1980 and is chief architect of the MAST Simulation Environment. CMS Research, Inc. provides consulting services in Flexible Manufacturing and has several international offices.

POSITION STATEMENT

Robert Meyer
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Within an environment of intense global market competition, we find ourselves in the middle of a mad scramble to renovate, automate, and revitalize the way we produce goods. The University of Wisconsin-Stout has recognized and responded to the role educational institutions must play in this revitalization process.

Among the many outreach services UW-Stout provides to industry is assistance on simulating manufacturing systems. This assistance is typically in the form of either training on how to use simulation for industrial and manufacturing engineers or facilitating simulation projects, on site, with both faculty and student involvement.

Opportunities

For busy plant engineers, typical uses of simulation include evaluating alternative layouts, scheduling policies, staffing requirements; verifying performance of proposed material handling systems; analyzing buffer areas, and identifying bottlenecks. Other opportunities for modeling are determining the effects of equipment breakdowns or resource shortages, examining the effects of reduced set-up times,lot sizes, and scrap rates.

A variety of menu-driven packages sport many advantages including ease-of-use and speed of model development. The ease-of-use allows a novice simulationist more time to concentrate on the critical modeling issues such as data collection, analysis of output, and generation of creative "what-if" questions as opposed to being bogged down in learning the syntax of a general purpose language.

Most simulation packages, both languages and simulators, now support graphical animation as a standard feature. One advantage of animation is that it supports model "verification". Logic errors contained within the model tend to surface as visual bugs in the animation. I've also heard modelers refer to animation as adding a "sexy touch". Let's face it, it is a lot more interesting for a plant manager to see an animated picture of the model than to look at reams of statistical output.

Challenges

To properly use simulation requires a modeler with many talents including comprehensive knowledge of the modeling process and the system under study, ability to gather and prepare data or query the experts to glean such information, ability to generate valid models at various detail levels, and the statistical background to analyze the output of simulation runs.

Menu-driven packages allow for quick development of models with "rough-cut" to intermediate levels of detail. However, they are also inviting to rapidly build large models. Often, it is incorrectly assumed that greater model detail automatically equates to greater model accuracy. In fact, a good model must only capture details and factors which ultimately have significant leverage on the model's performance measures.

Since menu-driven packages must make assumptions about how the user may want to model a system, they may not always permit the models to adequately capture significant system details. For example, it may be difficult or impossible to model certain scheduling policies. In such cases, a general purpose language may be more appropriate.

There is a tendency to accept animation as the "final word" on the system performance. One must remember that each run constitutes the output for one "replication" of an "experiment". Drawing inferences based on one run's animation would be analogous to testing for a true coin with only one flip! Engineers should view the animation and output reports for several runs before drawing any conclusions.

I view animation as a task secondary to generating a valid model even though I see a lot of modelers spending a disproportionate amount of time on the animation versus the model.

Panelist's Biography

ROBERT MEYER is an assistant professor at the University of Wisconsin-Stout where he teaches industrial processes, design and simulation of manufacturing systems, industrial robotics, and Computer Aided Manufacturing. He received his B.S. in Industrial Education from UW-Stout and M.S. in Management Technology from University of Minnesota. Mr. Meyer has provided simulation and modeling assistance to many companies including J.I. Case, Control Data, Ford, Unisys, Allsteel, Hutchinson Technologies and Dairy Queen.

POSITION STATEMENT

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The greatest simulation related challenge facing busy plant engineers today is not how or what to simulate, or which package or language to use for modeling; it is believing that simulation is worth the trouble at all.

At Sun Microsystems, increased competition, technological advances, and proliferation of industry standards are combining to radically compress product lifecycles. Each new product is expected to be fully compatible with the customer's previous investments, while providing marked advances in price/performance. The rapid technological evolution which makes this possible also decreases the likelihood that subsequent products manufactured in any single facility will bear close similarity to its predecessors. Consequently, product-specific process design must be employed to maximize margins on very short term plant investments.

In-plant industrial engineers need to be broadly experienced generalists, capable of effectively leveraging the specialized technical design resources. Fewer and fewer opportunities for technical specialization can be afforded today's plant engineer at SUN -- the pace of product and process obsolescence precludes it.

As lifecycle compression occurs, plant design for specific products must take place prior to accumulation of meaningful manufacturing statistics. Volumes, cycle times, yields, utilizations, downtimes, delivery schedules, and other vital process statistics must be estimated for all planning purposes. Regardless of the tools employed in planning and design, guesstimates based on histories of relatively dissimilar products and shaky statistical relevance are typically the only design criteria available.

The combination of unreliable data during design cycles and the inability or unwillingness to develop engineers into specialized roles would seem to doom manufacturing simulation within SUN. Predictably, there has been an increasing dependance on simple models, spreadsheets predominantly, for most process planning activities. Simulation has been largely dismissed as being too time-intensive to develop within factory design cycles, too dependent upon the availability of accurate data, and as requiring too much specialized expertise to affordably dedicate to any single factory. While this position is outwardly logical, my opinion is that it ignores the most obvious benefit of dynamics simulation over static modeling -- the capability to analytically cope with statistical uncertainty in the planning process.

While static modeling using spreadsheets can be used for limited sensitivity analysis by varying a small number of independent variables, dynamic modeling will highlight the effect of simultaneous fluctuations in any number of variables over any range of statistical variability. By running models for sufficiently long periods and by intelligently varying variables, the engineer can confidently assess the risk of uncertainty in his/her design. This will help prepare operational responses in advance to probabilistic event combinations which adversely affect factory performance.

A unique advance simulation offers over static modeling is in the design of process interfaces -- the often ignored but essential design of queues, staging and storage areas, racks, shelves, and material handling -- while spreadsheet analysis entirely ignores interfaces.

Even when the benefits of simulation seem obvious, reconciling the time and resource constraints inherent to fast-paced plant design can be difficult. Compressed design cycles, unavailability of expert technical resources, and vague data may seem to pose insurmountable obstacles to incorporating simulation into process design projects.

In order to address these concerns, engineers and managers should carefully evaluate packages considering ease of training and use, flexibility, robustness, and reporting characteristics. The advent of simple graphical input and animated execution means that project timeliness need never be compromised for the sake of modeling, and also that non-programmers can easily gain and retain expertise. The challenge for busy plant engineers, then, is to have the courage of their convictions and continue to properly apply simulation despite pressures to the contrary.

Panelist's Biography

WALTER PRICE is a process engineering manager for Desktop Systems at Sun Microsystems. He received his B.S.I.E. degree from Stanford University. Before joining SUN Mr. Price held positions with IBM and Hewlett Packard where he was involved with simulation across a wide range of manufacturing and test projects. He is a member of IIE and the Council for Logistics Management.

POSITION STATEMENT

Matt Ricketts
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There can be a little doubt as to the benefits of putting a powerful tool in the hands of manufacturing and industrial engineers. The idea of a "no-programming" environment is enticing, and to a certain extent a good one. However, there are, in my opinion, three major challenges for busy plant engineers with manufacturing simulators:

1. Ease of abuse - With a conventional simulation language, a programmer is forced to determine detailed operational descriptions of the systems being modeled. Simulators tend to simplify the description, at the cost of detail. The user may be unaware of the simulator's handling of a particular logic and may draw incorrect conclusions from the model. The engineer's knowledge of the simulation process is also a major concern in this area. If he/she is unfamiliar with with the process but can still build a model, dangerous results are imminent. The concept of "no error messages equals a correct model" comes into play here.
2. Fitting the problem into the solution - There is a tendency to gloss over system details which may not be handled by a simulator. For example, if a simulator has no facility to model an AGV, the user may use some other simplified means to model movement. If the AGV system is the prime bottleneck in the system, the model will be unable to either identify the problem or analyze any solutions.
3. Horizontal Integration - Note that this is a challenge with languages as well. Primarily, we attempt to make simulation a part of the engineer's philosophy, but we provide no means of integrating it with his other activities. We, as an industry, have spent the last few years making simulation easy-to-use and fancy looking, but we have not done much significant advances to incorporate simulation into other design and analysis tools. As long as simulation remains an "island", and not an integral part of the manufacturing system design and analysis, the use of simulation will remain as an expensive nicety.

Panelist's Biography

MATT RICKETTS is a manufacturing technology specialist at Northrop's B-2 Division. Mr. Ricketts received his B.S. and M.S. degrees in Industrial Engineering from Oakland University. His primary responsibilities at Northrop include analysis of proposed manufacturing systems using simulation.

POSITION STATEMENT

John S. Zuk
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Overview

Today's Industrial Engineer is faced with many challenges in the manufacturing arena. Just in Time manufacturing, Total Quality Control, and Statistical Process Control are some of the concepts with which the engineer must be versed. Manufacturing simulation has likewise evolved to keep up with these emerging technologies. However, simulation technology has only started to address all issues involved in this changing environment.

Breakthroughs

There have been a number of significant breakthroughs in the area of manufacturing simulation. The most notable of these being the development of powerful simulation software packages which exploit the processing power and graphical ability of personal computers. However, these tools do not replace some fundamental modeling procedures, and can produce stunning graphics with ambiguous results. See below for more comments on this issue.

Opportunities

Model building may be considered an opportunity in that the plant engineer can improve his or her knowledge of the process by interacting with production staff on the shop floor. Often, model building also requires interaction with Information Systems staff, Production Control personnel, and even Management. Simulation model building may be considered a form of team building.

Comments

I believe that there are still significant steps required to bring simulation technology to a level where it may be truly exploited by the busy plant engineer. Software packages are limited in their applications - and they often fall short of helping the engineer in such ways as assisting in data management through some form of front-end database, allowing for automated (electronic) transfer of data from the shop floor to software input data files eliminating redundant data handling, and, providing guidance in other aspects of modeling such as model validation.

Deterministic studies are often sufficient to estimate roughcut capacity and identify bottleneck resources. Although most packages allow for deterministic variables, they still maintain the "overhead" of a stochastic model. That is, they require a great deal of time to run. Stochastic software packages which offer an alternative, deterministic engine, would provide greater flexibility and allow the (busy) engineer to perform quick analysis prior to any long, involved effort.

Panelist's Biography

JOHN S. ZUK is a member of technical staff in the Manufacturing Systems Engineering Department of AT&T Bell Laboratories. He received a B.S. in Mechanical Engineering from Union College and an M.S. in Industrial Engineering from Polytechnic University. Since joining Bell Labs, he has focused on modeling methodology as applied to product costs, shop capacity, and process improvement.