HOW SIMULATION GAINS ACCEPTANCE AS A MANUFACTURING PRODUCTIVITY IMPROVEMENT TOOL

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ABSTRACT

Simulation is well-recognized among its expert practitioners as a manufacturing productivity improvement tool. Achievements of simulation in reducing operating costs, increasing production quotas, reducing work-in-process inventories, eliminating bottlenecks cost-effectively, achieving efficiency of scheduling procedures, and otherwise improving performance metrics are well-known among simulation experts and well-documented in the technical literature.

However, within many companies, simulation is used only in unusual situations and when the need for efficiency improvements has reached a high level of urgency and visibility among managers. This paper describes procedures for upgrading the use of simulation to the status of "norm;" that is, making the exploitation of simulation's analytical powers a standard, expected step during the design, revision, or operation of a production system.

INTRODUCTION

Discrete simulation modeling, an experimental technique, can describe the behavior of systems, help construction of hypotheses explaining that behavior, and predict future system behavior with or without actual change to the real-world system (Centeno 1996). As such, simulation has a long-standing record of assistance to manufacturing operations; indeed, manufacturing is among the oldest and most frequent areas of simulation application (Clark 1996). Many interrelated techniques are highly useful to increase the ease and frequency with which a company gains manufacturing productivity improvements through simulation. Techniques discussed in this paper include:

· constructing a support infrastructure within the company for simulation
· disseminating awareness of simulation and its benefits throughout an organization
· documentation of successful applications of simulation and the benefits accruing from them
· organizing training classes and seminars in simulation
· evaluation, choice, and support of appropriate software tools
· evaluation and choice of simulation consultants and model builders
· maintaining knowledge of and enthusiasm for simulation within the organization.

For clarity of presentation, these techniques will be discussed individually; however, they work best (synergistically) in concurrency and co-operation.

CREATING A SUPPORT INFRASTRUCTURE FOR SIMULATION

The engineers and managers who first introduce use of simulation into the company successfully are

well-advised to capitalize on this success by creating a support infrastructure for simulation. Joint participation of analysts and managers encourages strategic linkage of technology (in this context, simulation) and its management to long-range business policy, as advocated by (Vernet and Arasti 1996). This support infrastructure then evolves into a group of simulation users and those who should become simulation users. The larger the company, the more important this infrastructure, inasmuch as engineers and managers with a common interest in simulation and its application may yet be very distant in the company's formal structure. The support group, with its meetings, newsletters, and electronic intra-company mail, thus provides a convenient forum for interchange of ideas and news, and a source of advice for newcomers to simulation (Williams 1996). Conceptually, such a corporate group and its objectives may be viewed as a microcosm of the continent-wide "Special Interest Group Simulation in Europe" (SiE-SIG) described in (Vangheluwe, Vansteenkiste, and Kerckhoffs 1996). Simulation project teams spawned by the corporate group in contexts of specific productivity investigations then find it natural to use simulation analysis tools as a communication bond. Experienced manufacturing simulation consultants stress the importance of this intra-team communication to capitalize on the varied perspectives and expertise among project team members (Armstrong et al. 1996).

EXTENDING AWARENESS OF SIMULATION AND ITS BENEFITS

Once formed, the simulation support group is well positioned to increase awareness of simulation technology and its potential benefits within the company. Simulation successes documented in the literature can be used as enticing illustrations relative to the company's most urgently perceived opportunity for improvement, whether that opportunity be ergonomics (Ehrhardt, Herper, and Gebhardt 1994), materials management (Brennan and Gupta 1992), line balancing (Holgate 1996), industrial transport (Bubnicki 1996), material handling (Bakst, Hoffner, and Jacoby 1996), scheduling (Ayadi et al. 1995), maintenance management (Wolf and Taha 1995), or plant layout (Fowler and Lees 1995). Managers can be encouraged to use simulation via oral and written presentations of simulation work and its resulting economic benefits already achieved within the company. Further incentives for simulation use arise from any obtainable evidence of its use among the company's competitors. Also, encouragement of simulation use among corporate suppliers leads to benefits shared by the company and those suppliers; more operationally and economically efficient suppliers can deliver materials and/or services with increased dependability and decreased upward pressure on costs. Willingness to share technology with suppliers is consistent with the strong trend away from adversarial negotiation and toward mutually beneficial co-operation between a company and its supplier company (Juran 1989). Similarly, engineers, analysts, and statisticians receive encouragement to use simulation in addition to (not instead of) techniques such as time and motion studies, linear and integer programming, and scheduling algorithms.

DOCUMENTATION OF SUCCESSFUL SIMULATION APPLICATIONS

The simulation support group spawns and maintains a company archive of simulation successes. These documented successes serve as economic enticement and justification for frequent, routine use of simulation as production processes are designed, implemented, or modified. This archive can conveniently be a notebook in which each simulation project is listed, with specification of the process modeled, the engineers and managers involved in the simulation project, and the benefits resulting from simulation. Such an archive merits confidentiality due to the details of processes and economic benefits included within it. This con-fidentiality in turn induces a sense of company pride in successes achieved with simulation. Annual updates of this archive call recent benefits of simulation to the attention of

employees new to the company or to their current position. The efforts required to build and maintain this "database of models" are amply repaid in awareness of simulation and also in the efficiencies accruing from reusing techniques or portions of one model within another model (Ülgen et al. 1995).

ORGANIZING TRAINING IN SIMULATION

In addition to the informal training which occurs at its periodic meetings, the simulation support group works within the company to establish and publicize more formal training as needed. Such training occurs at four levels: simulation awareness for managers, modeling methodology for simulation users, basic model-building methods for engineers, and advanced techniques for engineers already experienced in model building and analysis. The first two levels of training are best provided by the company's own experts within the support group; they have access to confidential corporate data and plans, as well as high credibility. The remaining two levels of training may be provided by experts from the software vendor(s) whose software tool(s) is (are) in use or by consultants familiar with the tools in question and capable of tailoring the training to emphasize the client's specific project objectives. If, as is likely in larger companies, a corporate training program already exists, the support group works with its personnel to avoid duplication of administrative effort. Responsibility for the material and topics to be included at each level of training rests with the support group. For example, at the "awareness" level of training, experienced analysts will include seminal reference works such as (Harrell and Tumay 1995), (Ülgen et al. 1994a), and (Ülgen et al. 1994b). Each of these works transcends analytical detail to specify the fundamentals of managerial and engineering practice necessary to simulation project success. These fundamentals include rigorous problem formulation, extensive communication between the production engineers and the simulation modelers, thorough and ongoing documentation (Musselman 1994), and support via management use of project management techniques for all these tasks within a simulation project (Nordgren 1995). At the second, "model-building" level of training, the instructor stresses required activities throughout the project life cycle. For example, model design includes identification of project goals and planning horizon, model development includes software-tool selection, verification, and validation, and project deployment includes output analysis, presentation of results to management, and subsequent maintenance of the model (Chance, Robinson, and Fowler 1996).

EVALUATION, CHOICE, AND SUPPORT OF SIMULATION SOFTWARE TOOLS

The simulation support group is well positioned and qualified to help simulation analysts within the company avoid two extremes, both potentially undesirable. At one extreme is the use of many different software tools, even to the point of a unique tool for each analyst or project. Support of an unduly large number of different software tools is difficult and time-consuming; further, analysts who move from one department to another must learn the use of a different software tool. At the other extreme is enforced standardization on one tool. Such standardization may work well in a small company with highly localized simulation usage, but poorly in a larger company whose simulation analysts have widely varying systems to study, questions to answer concerning those systems, and levels of experience and expertise in using powerful, complex simulation software languages and packages. Reference to the collective needs of all simulation analysts within the company allows construction of a list of criteria for software tools. Next, the group standardizes on a small number (perhaps more than one) of software tools by checking software against the criteria list, watching software vendors solve small versions of typical problems, searching the literature for case studies of similar problems solved with the vendor's software, checking vendor references, and attending users' meetings organized by the prospective vendor (Banks and Gibson 1996).

EVALUATION AND CHOICE OF SIMULATION CONSULTANTS

Simulation and its support group have accomplished much when upper management asks the simulation analysts "Now that simulation has become valuable and widely used, who [in view of typical constraints on hiring] will handle the increased demand for simulation analyses you've created?" Demand that cannot be accommodated within the company can then be accommodated by external consultants carefully evaluated for their ability to support continued simulation project successes. This evaluation requires examination of the prospective consultants' technical expertise, financial stability, responsiveness, depend-ability, and trustworthiness (e.g., in meeting delivery date promises, maintaining confidentiality of sensitive data, and correcting flaws that may appear in a model willingly and promptly). (Norman 1993) and (Williams 1993) contain detailed advice on selection of simulation consultants to become company partners in technology.

MAINTAINING KNOWLEDGE AND ENTHUSIASM

The investment of knowledge of and enthusiasm for simulation achieved by the above steps is well worth maintaining. To do so, the simulation support group encourages the participation of newly hired employees such as recent university graduates. Likewise, whenever a simulation analyst is promoted to a new position, especially a managerial one, he or she is urged to train the replacement employee in the usage and benefits of simulation. Simulation analysts are encouraged to attend simulation conferences, write papers for presentation at those conferences, teach simulation classes and give guest lectures on simulation at local universities, and participate in the annual users' meetings typically sponsored by simulation software vendors. Attendees of simulation conferences and users' meetings submit written and oral reports to the support group, thereby sharing new potential applications of simulation and new modeling and analytical techniques with their colleagues and managers.

SUMMARY

In summary, the techniques discussed above will guide managers and engineers in using simulation more frequently more effectively to prevent and resolve manufacturing productivity problems, thereby increasing corporate profitability.

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