MAKING SIMULATION A CORPORATE NORM

Edward J. Williams
Analytical Software & Operations Research
Ford Motor Company
Dearborn, Michigan 48121-2053, U.S.A.
e-mail: williame@umdsun2.umd.umich.edu

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ABSTRACT

Many companies have achieved high-value, conspicuous successes (cost savings or avoidance, workflow improvement, product-launch timing improvement) attributable to individual simulation studies. Fewer have achieved the ongoing, long-term benefits of making the undertaking of simulation analyses a "corporate norm." Strategies to enable this expansion of simulation's role are described.

1 INTRODUCTION AND OUTLINE

Ford Motor Company has steadily expanded the routine use of simulation for validation of production processes in manufacturing, warehousing and distribution, and assembly. Additionally, the use of simulation is increasing on behalf of workflow analyses for "office" tasks such as product design, product test, and engineering procurement. The "enablers" of this more broadly-based use of simulation techniques, to be described subsequently, characteristically involve:

- establishment of an internal support infrastructure on behalf of simulation methods and technology
- publicity accorded to simulation, among engineers and to management
- training, readily available at various levels (simulation awareness, basic model building methods, and advanced model building and analysis techniques
- synergistic alliances between simulation and related analytical tools
- assessment of support from vendors of simulation software tools
- assessment of support from vendors of model-building services.

2 A SUPPORT INFRASTRUCTURE -- USERS' GROUP -- FOR SIMULATION

This strategy for making simulation a corporate norm naturally comes first, since the following strategies have this infrastructure as their foundation. The recommended nucleus for this infrastructure is a simulation users' group founded by those who have achieved the company's pioneering successes in simulation. An effective users' group, formed with management sponsorship and concurrence, welcomes any employee, irrespective of whether that employee already is skilled in simulation or a newcomer to simulation interested in learning more about its benefits and methods. Likewise, the group's "welcome" sign is extended to employees irrespective of their corporate branch, division, or department membership. A simulation users' group fosters exchange of ideas for use of, knowledge of, and

expectations for simulation among employees having a common interest in simulation. Furthermore, in sharp contrast to the archetypal box on an organization chart, the communication lines of the users' group foster this exchange among employees whose large organizational separation might well prevent their ever meeting otherwise.Once formed, the users' group promptly forges alliances with users of analytical disciplines whose methods are allied with simulation. The most closely allied discipline is statistics: any simulation project requires statistical care and expertise to choose what input data to collect, to analyze those data, to design experiments based on running the model, and to analyze model output. Therefore, the new simulation users' group establishes liaison with statisticians and any in-house organization they already have.For maximum benefit, simulation should become, as indicated above, a standard task within corporate business processes, whether those processes are design, implementation, production, or distribution processes. To achieve this integration of simulation into business processes, the simulation users' group establishes liaison with the company's experts in using the discipline of project management.A vital raw material for any simulation study is accurate data. Therefore, the simulation users' group likewise establishes liaison with the company's database experts. These experts then provide simulation practitioners valuable assistance in designing databases, populating them with correct, timely data, and extracting those data from the database efficiently.The simulation users' group is now well prepared to extend awareness of simulation.

3 EXTENDING AWARENESS OF SIMULATION

Due to the far-ranging organizational extent of the users' group, it has ready access to all simulation successes already achieved within the company. These successes, documented in a notebook, are powerful testimonials in persuading additional managers to begin or extend use of simulation. The persuasion is especially strong when each project write-up documents its bottom-line time savings, expense avoidance, or increase in efficiency of capital investment.In addition to publishing the project notebook, the simulation users' group also provides newcomers to simulation with a concise road map to its proper use. A trustworthy road map, shown in Figure 1, quickly draws attention to several vital points:

- begin with a small success, not a large, conspicuous failure
- success begins with clear definitions of opportunity and objectives
- the seemingly esoteric step of building the model requires less investment of time than either gathering its data or conducting experiments using the model
- a well-documented model becomes a "living document" for the life of a business process, allowing the initial investment in the model to be amortized over a long period of time
- a successful simulation project is rooted in disciplined use of technology, not the choice of a particular software language, tool, or vendor (these roots must flourish prior to the latter choice).Furthermore, this road map documents investments of time (e.g., to gather data, to build the model, to analyze its results) and of cost (e.g., to purchase software and to fund any needed training) versus benefits to accrue from experimentation (process improvement, cost and time expenditures avoided) (Sadowski 1994). Also, this road map inherently explains how a project will proceed, helping the customer by providing news of what deliverables to expect in the form of many intermediate milestones instead of one absolute deadline (Musselman 1993).Having thus drawn attention to simulation technology and the benefits of its application, the simulation users' group next must make provision for the investment in training necessary to achieve these benefits.

4 ORGANIZATION OF SIMULATION TRAINING

The objective of training a new user of simulation may be either: (a) preparing that person to be a knowledgeable customer of simulation modeling and analysis services, or (b) teaching the person to build and analyze models, thereby making him or her self-sufficient in simulation. Achievement of the first objective is a prerequisite of the second, but not vice versa. Therefore, multiple levels of training must provide awareness for managers, modeling methodology for simulation users, and tool application for beginning and expert model developers (Ülgen et al. 1995).

4.1 Training the Knowledgeable Customer of Simulation

The users' group begins establishment of training by organizing an overview seminar introducing simulation to engineers and/or their managers. The curriculum of this seminar comprises:

- a definition of simulation, describing its benefits and acknowledging its limitations
- the road map, described above, followed by successful simulation studies
- illustration of simulation successes, using examples from the project notebook as case studies
- description of the interrelationships between simulation and statistics, and those between simulation and project management
- demonstration of software language and modeling tools useful in simulation.This overview seminar is best led by an experienced in-house simulation expert, not an outside consultant. First, the in-house person will put the participants at ease during discussion of potential simulation benefits whose quantitative details may be highly confidential. Second, he or she will be perceived as having no vested interest when making evaluative comparisons of software tools or model-building services. Third, the in-house seminar leader will inevitably have more company contacts available for participants wishing referrals to prior successful simulation projects.

4.2 Training the Self-Sufficient Model Builder

An engineer who has become a knowledgeable customer of simulation model-building and analysis services, either through experience or participation in the training just described, may subsequently need or want to learn to build and analyze models directly. To accommodate the requirements of this subset of simulation users, the users' group organizes and oversees classes which present the details of using a software tool to create models. Since students are encouraged to bring an actual problem from their work to class, the instructor helps them begin work on this problem, guiding them through the typical perspectives of the first-time modeler's experience (Stout 1993). These classes may be presented by either in-house experts in use of the tool or by vendor-supplied trainers. Model-building software tools are now sufficiently powerful and complex to justify two classes, a basic class and an advanced class whose prerequisite is the basic class or equivalent model-building experience.

5 ASSESSMENT, SELECTION, AND SUPPORT OF SOFTWARE TOOLS

To prevent uncontrolled proliferation of model-building tools and languages throughout the company, the users' group evaluates and recommends software tools.Viewing uncontrolled proliferation of tools in use as one (undesirable) extreme, the other extreme is mandated use of a single tool. The more variegated the simulation needs within the company, the less likely it is that "one tool fits all." The users' group assesses the match between tools and various users' needs using the following broad-based questions:

- is ease of learning and using the tool more important than the ability of the tool to model non-canonical, highly complex systems, or vice versa?
- will the users of the tool be analyzing "push" systems or "pull" systems?
- will the users of the tool typically conceptualize entities as active and resources as passive, or vice versa?
- what is the history of the tool in supporting the building of models similar to those the user needs?
- on what hardware platforms and configurations must the tool run?
- which interfaces (e.g., to CAD drawings and data, or to spreadsheets) are most important to the users?
- what statistical analysis capabilities come bundled with the tool?
- what is the quality of the vendor's documentation and support; will the vendor establish an in-house hot line or help desk?
- what is the vendor's size, longevity, and fiscal stability?Particularly with respect to the first five questions, users' responses may be highly varied. In this case, the users' group narrows the tool choices to a "short list." The length of this list is then greater than *one*; the list represents an effective compromise between brevity and accommodation of varying needs. The "leapfrogging" capabilities of competing software require ongoing re-evaluation of the recommended-tools list.

6 ASSESSMENT AND SELECTION OF MODEL- BUILDING SERVICES

Next, the users' group anticipates the question "When growing simulation work demands exceed in-house capacity, with whom will we share the work?" by assessing and selecting at least one qualified vendor of this service.Key factors in this assessment are (Williams 1993):

- is the vendor qualified to undertake data-gathering, statistical analyses, and documentation of the model and its results, in addition to building the model?
- unless the selection of software tools has been narrowed to only one, is the vendor able and willing to choose among multiple tools based on project needs and customer preference?
- how strong are the vendors' references?
- does the vendor have liaison with simulation and statistical experts at universities, who can then be "on-call" as needed?
- does the vendor view simulation as a team effort, stressing the importance of customer participation in describing the system, gathering data, and learning to use the delivered model for ongoing experimentation?
- does the vendor view simulation technology as something to be shared with and transferred to its customer, rather than hoarded?Additionally, an excellent set of searching questions, such as:
- how was the project cost determined (or estimated), and how will the prospective customer determine value for the cost?
- which system components will be simplified, which will be detailed, and why?
- how does the modeler assure the model is correct?
- what questions will the model *not* answer?
- what data will be required, and who will collect it?
- what experimentation with the model will be done?

- what is the timetable for periodic model review meetings?
- will the consultant present the model results to management?to ask the potential vendor of simulation services appears in (Norman 1993).

7 MAINTAINING THE MOMENTUM

Having achieved the entry of simulation into the company "mainstream" by the above steps, the users' group then keeps simulation active (steadily expanding in both scope of use and in technology used) in several ways.First, the timeliness of all materials must be rigorously maintained. For example, the users' group adds new documentation to the project notebook annually. Training materials likewise need even more frequent revision due to software upgrades and technology advances.Second, the users' group becomes a collective spokesperson to software vendors on behalf of the simulation practitioners and builders of models. Assumption of this role helps the vendors repair software deficiencies, upgrade documentation (both printed and on-line), and add the enhancements most needed by those model builders. Additionally, communication with vendors of tools *not* on the current "short list" both guides those vendors in making needed improvements and dissuades the vendors who are on the current list from becoming complacent.Third, the users' group has already anticipated the question alert management should and will ask: "If simulation indeed becomes as broadly cost-effective as the project notebook promises, where -- in view of finite internal resources -- will all the newly spawned simulation work be done?" This anticipation takes the form of liaison with a high-quality vendor of model building and analysis services (see previous section).Fourth, the users' group encourages management to establish rigorous operating procedures specifying when simulation will routinely be used (e.g., before capital-investment expenditures for production equipment are approved).Fifth, the users' group encourages newly hired personnel to become involved in simulation as users or modelers, by taking training in simulation use and methods. This training may effectively be incorporated within an orientation-training "curriculum."

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AUTHOR BIOGRAPHY

EDWARD J. WILLIAMS holds bachelor's and master's degrees in mathematics (Michigan State University, 1967; the University of Wisconsin, 1968). From 1969 to 1971, he did statistical programming and analysis of biomedical data at Walter Reed Army Hospital, Washington, D.C. He joined Ford in 1972, where he works as a computer software analyst supporting statistical and simulation software. Since 1980, he has taught evening classes at the University of Michigan, including both undergraduate and graduate simulation classes using GPSS/H, SLAM II, or SIMAN. He is a member of the Association for Computing Machinery [ACM] and its Special Interest Group in Simulation [SIGSIM].