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AN INDUSTRIAL PERSPECTIVE ON BUILDING A SIMULATION GROUP

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The ever increasing complexity of today's manufacturing systems has prompted many companies to turn to simulation as a means of better understanding their processes. This emphasis on simulation has spawned the need for groups internal to the organization to take on the responsibility of applying simulation.

While the simulation community has made significant strides in language development and analysis techniques, the management of this technology and of those who apply it has remained underdeveloped. Little is known about how to succeed at building and managing a simulation group. Yet, if simulation is to establish its rightful place within an organization, these non-technical aspects of simulation must be better understood and appropriately addressed.

The problems associated with managing a simulation group and the practical means by which one can alleviate some of these problems are the focus of this panel discussion. The panelists are all actively engaged in building and managing a simulation group within their respective organizations. Their position statements follow.

RON BAKSHI - CUMMINS ENGINE COMPANY

We are being challenged today to respond to the emerging manufacturing needs of Just-in-Time, PULL inventory technique, and Flexible Manufacturing Systems. As we modernize our equipment, we find it increasingly complex and higher in cost. More and more, the interdependencies of our manufacturing processes and utilization of resources need to be understood and properly managed. Computer simulation can be a nice tool in meeting these challenges and in analyzing and evaluating the impact of various changes, in a dynamic way.

Traditionally, simulation has been used in highly mathematical applications like finite element or stress analysis, and as such, professionals with a strong background in mathematics or engineering have been the developers of simulation models. Simulation in manufacturing is a relatively new phenomenon. Because of its potential benefits, however, manufacturing companies, like ours, would like to see a widespread use of it among the engineers and managers who need to see the impact of planned and unexpected changes in equipment, material and people BEFORE they actually happen.

The option of creating a Corporate or Central level "experts" (away from the factory floor) is probably the most common approach. But we, at Cummins, have chosen to make simulation a part of our manufacturing "culture". We are educating the managers, training our engineers, and sharing the results of our small successes to build a foundation for a widespread use.

Two persons on the Central Systems staff act as consultants, trainers and coordinators. Their goal or motto is to help the manufacturing people help themselves. Here are some of the issues that we are facing in "making it happen":

- TRAINING on the use of the package and discipline of analyzing the current operation, and gathering accurate data. Since the package runs under TSO, part of the training involves the use of TSO commands. We have implemented a user-friendly front-end to "hide" most of TSO from them.
- FOLLOW-UP and verification of the model and its results. Manufacturing people tend to be in a "fire-fighting" mode, and easily "lose touch".
- COMPUTER-PHOBIA is gradually diminishing in the manufacturing ranks, but is still a deterrent to a widespread use of the simulation package.
- SHARING OF WORK is a major issue so we do not duplicate our efforts across plants. The use of IBM network has been helpful in achieving what little success we have had so far.
- MISSING FEATURES in the simulation software to accommodate a process that is Cummins specific or the package does not deal with.
- USERS expect to be able to use simulation like a spreadsheet. We think we have an easy-to-use package, but they still find it cumbersome.

Obviously, some of these issues are a result of our goal of disseminating simulation knowledge to a large group of people, as opposed to limiting it to a group of "experts". We think it is doable because we feel we have the right software, and a strong motivation to benefit widely from simulation techniques.

MERRIEL C. DEWSNUP - EATON-KENWAY, INC.

BACKGROUND. Simulation at Eaton-Kenway, Inc. began in 1974 with consulting being provided by a faculty member from a nearby University using GPSS. This effort was successful and resulted in many models being built. Because most of the models were very similar, a GPSS subroutine library concept emerged along with a preprocessor approach resulting in a dramatic decrease in time required to build, debug, and run each model. The preprocessor was developed using SNOBOL. By this time simulation activity was at a sufficiently high level to justify both a full time in-house simulation analyst and the purchase of an IBM 4331 computer. The preprocessor was enhanced and color graphic output animation was also added further accelerating the demand for models.

At this point, demand for models was high and supply very limited. The ability to earn a large profit resulted in a small number of employees leaving Eaton-Kenway, Inc. and starting a simulation only company.

The in-house Eaton-Kenway, Inc. group continued to make improvements to the SNOBOL based preprocessor and moved from 2D to 3D color animation. The IBM computer was expanded from a one megabyte 4331 to a four megabytle 4361 and the staffing level was also increased to keep pace with the growing demand for modeling.

CURRENT STATUS. The general industry slowdown in automated system sales has decreased the amount of R&D funding available to continue improvement of the Eaton-Kenway, Inc. developed preprocessor and graphics. In order to remain competitive we have concentrated on expert application of simulation tools rather than development of new and better tools. We are also looking at easy to use tools to assist non-simulation engineers gain preliminary insight into system concepts.

NECESSARY SIMULATION GROUP MAKEUP. In our business, the makeup of the simulation group is very important. We need people with a very good understanding of GPSS, we also need persons with a healthy understanding of the hardware and operating system used to run the models which in our case is an IBM 4361 using VM/CMS and a Silicon Graphics IRIS 3030 using UNIX. Most importantly, we need simulation analysts who can relate to a customer and document the problem to be solved and conceptualize cost effective solutions. An understanding of statistics and experimental design is very helpful and the ability to make a professional presentation to high ranking corporate officers is essential. We have found very few persons with all of the above skills, so we have built a group with expertise in each of these areas. I doubt that serious simulation can be done by a single person or part time simulation support.

CHRIS V. KUHNER - DIGITAL EQUIPMENT CORP.

INTRODUCTION. Historically, simulation has encountered many barriers to its introduction to manufacturing environments. In 1983, we did a study to see why Digital's manufacturing engineers were, generally, not using process simulation. We found, at that time, that there was a lack of confidence in the methodology. Because our manufacturing engineers feared that they could not successfully build their own models, it was necessary to employ an expensive modeling expert from outside the company. This modeling expert had to communicate extensively with the process expert in order to glean the information required to build the model, thus driving up both cost and cycle time. Because the communication between the modeler and the process expert was less than perfect, models completed in this fashion often failed to generate measures of real world relationships. The time, expense, and lack of a guarantee of usable results made it extremely difficult to convince management to employ this technology. Cost and time constraints, combined with management's general lack of faith in simulation caused a potentially effective tool to go largely unused.

Based on these findings, we set out to implement a program that would make process simulation more accessible to DEC's engineers on a corporate-wide level. By making fundamental changes in the way simulation was traditionally undertaken, we found we were able to remove many of the barriers to entry into the manufacturing world.

WHO SHOULD DO THE MODELING? There is no one better prepared to build a system model than someone who is intimately acquainted with that system. The basis for our solution is that rather than teaching simulation specialists about the system we wish to model, we teach simulation to the engineers with the intimate knowedge of the system.

Generally, a simulation process is undertaken to obtain an answer to a specific question. As modeler, the process engineer develops simulation skills and, if the simulation is successful, arrives at a point solution; an answer to his question. However, the most important byproduct is the insight, relative to the system, gained through the simulation process. The modeler makes a series of small decisions, almost unconsciously, that could be critical to drive the analysis. There would be no way for an outside simulation expert to make these decisions because of a necessarily limited knowledge of the system being modeled.

As the modeler, the process expert is forced to look at the system in ways, perhaps, he never has before. No simulation takes place in a vacuum, and the knowledge gained by seeking one point solution could point to the need for other changes.

THE PLAN OF ACTION. We viewed the problem of technology transfer, bringing simulation into a corporation, as a classical marketing problem. Responding to our initial market survey (the needs and problems of the DEC manufacturing engineers), we developed a two part marketing plan. Part one was designed to increase the manufacturing engineers' awareness of, acceptance of, and skill level with manufacturing process simulation. In addition, we established a very close relationship with our vendors so that we help them meet our needs for easier to use and more functional tools.

WORKING WITH THE ENGINEER.

- <u>Increasing Awareness of Simulation's Potential</u>. Obviously, if a person is unaware of the existence of a tool, that person is unlikely to use the tool. We found that although most people had heard of simulation, few really understood its application to manufacturing.

  Because of the time, personnel, and computer resources necessary for a simulation study, managerial support is required. So, while targeting simulation users for information and education, we have also targeted their managers to increase their awareness of, and comfort with, the concepts of simulation and the benefits it has to offer. We have employed several tactics to increase awareness of simulation's potential.

- <u>High Level Introductory Presentations</u>. We made introductory presentations to anyone who would listen. We also established forums that allowed others, usually vendors, to make presentations to management on a high-level non-technical basis.

- <u>Successful Internal Point Solutions</u>. Point solutions are quantifiable and, therefore, can be used to justify the investment in simulation; we must sell the point solution. We publicize the simulation successes of our manufacturing colleagues. We also encourage them to speak of the value of their work, at both internal and external conferences.

- Increased Internal Validity Due to External Validity. We look for opportunities to spread our message at industry conferences, and make sure that managers see relevant articles in trade journals.

- Internal Publications. We attempt to publish, or encourage our colleagues to publish, in as many internal journals as possible, about successful work or just about the technology of manufacturing process simulation.

- Use of Animated Output Packages. The animated output of the current generation of tools is easily comprehensible to non-technical managers.

BREAKING THE COST JUSTIFICATION BARRIER. One of the initial barriers to entry for simulation is the tremendous cost in terms of software, training, and CPU time, of the tools. It is very difficult to convince management to invest in simulation tools for a first-time user. To overcome this problem, we have purchased several of the simulation packages and make them available to all DEC users over the corporation's engineering network (several thousand VAX computers tied together by telecommunication links). Typically, it takes only one or two successful projects before management accepts the fact that the tool is worth its price, and the willing purchase of their own copies.

TRAINING. We provide training on a variety of tools under certain conditions which we have found to be very helpful. First, we have not charged for our time. Second, when we train people we insist on small classes; this personalized approach reduces the training time required.

It is important for the user to have early successes in his simulation activity. If we give him just enough skills to get started and follow up with good support, he will learn much faster and gain confidence. We try to provide fast, personalized responses to user's problems. And, because the user has received only enough training to get started, we must follow up to continue his training as well as be sure the tools are not misused.

- A Look Toward the Future. Once new users have had the opportunity to become involved with simulation, we encourage them to take the more conventional courses offered at various universities, as well as the software vendors. If we are to establish a continuing growth curve in the use of simulation, we must make allowances for new employees with the required skills. Maintaining good relationships with academic institutions is the key to developing new educational programs.

WORKING WITH THE VENDOR. Our marketing plan involves working closely with our user community and the commercial vendors who create the simulation tools we employ. It is an attempt to bring the users and vendors closer together; to close the gap between the skill level a user brings to a simulation study and the skill level future generations of tools will demand of users.

- Providing Product Direction. The detailed logs of software and system problems that our user base experiences provide a valuable feedback loop to our vendors. Coupled with our well kept log of desired enhancements, the vendors receive valuable marketing product direction input.

  We always seek to be a beta site for new software. In this situation we are able to play an active role in the vendor's research and development.

- Providing Actual Design Specifications and Modifications. We prepare detailed specifications for modifications we deem necessary to insure the usefulness of the tool. Occasionally we will actually modify the software ourselves. We do not, however, use the modified versions immediately. Modifications are returned to the vendor for test, and then included in the next version of the package. It would be unrealistic to use software we modified ourselves and expect the vendor to support it.

- Providing an Extension of Vendors' Customer Support Facilities for our Users. The extensive internal user support mechanism that we provide greatly reduces the demands placed on our vendors' support facilities.

SUMMARY. In the past three years, the use of manufacturing simulation has virtually become standard operating procedure at Digital. The learning environment that we have created, the ease of internal communication, facilitated by DEC's networking capabilities, and recent developments in simulation tools have placed the simulation tools into the hands of the process experts; resulting in more cost effective, creative solutions with a high degree of acceptance.

CINDY MOREY - GENERAL MOTORS OF CANADA, LTD.

Once you have determined that simulation is a tool that your company should be using, your next step will be to gain management support. Simulation is not an easily justifiable tool since there are many costs involved in establishing and maintaining a simulation group.

There is the cost of computer hardware, software and CPU time. Simulation is very CPU intensive and depending on the size of your models you will likely run up a high data processing bill. There is the cost to staff the group with trained personnel. Many different skills are required by a simulation modeller and it is difficult to find them all in one person. Industrial engineers are well suited to become modellers, but mechanical or process engineers can easily be trained as well. Strong interpersonal, communication and analytical skills are a definite requirement. Since the modeller will be modelling manufacturing systems he should have experience in a manufacturing environment. Most simulation languages are easily learned by an engineer and it is preferable to teach an engineer to program than to teach a programmer to think like an engineer. Another prerequisite is a firm background in statistics and probability along with other operations research techniques. The chances of finding all of these skills in one person are slim and much time and money must be spent in training. You will run a high risk of failure if any of these skills are missing in your staff.

To offset these costs simulation does have many benefits. It reduces risk by highlighting areas of inefficiency or bottlenecks before a manufacturing system goes into production. It can be used to compare different design alternatives so that the best may be implemented. It can be used to study the interaction between manufacturing processes to gain insight on how the total manufacturing facility will operate.

However, these benefits are of a cost avoidance nature. Management will want to know what dollar savings will be achieved. This is next to impossible to calculate. It is much easier to list the intangible benefits of simulation than the tangible ones. However, if you are going to use simulation to model AGV or AMS systems, robotic cells or any type of new technology then the cost of performing a simulation will be relatively small in comparison to the cost of implementation of the manufacturing system. If, through your modelling efforts, you are able to identify and correct any system design errors or to improve the system throughput, your money will have been well spent. It is much cheaper to fix problems in a model than in brick and concrete.

The first step in convincing management to fund an internal simulation group is to carry out a pilot simulation project. This could be a small scale project done internally or an outside consulting firm could be hired. The project should be concerned with a problem of an existing system. This will allow data to be collected easily and the model can be validated against the existing system. Choose a problem of medium complexity. If the problem is too simple you will be questioned as to the need for simulation to solve the problem whereas if the problem is too complex, the project will take longer and you run the risk of management losing interest before results can be calculated. A simulation language should be chosen that supports animation. The animation will facilitate communication between the modeller, engineers, production staff and management. And in the end, the animation will greatly help in selling simulation to management. Being able to see the system operating dynamically will gain credibility for the model as well as convince management that the solution you are recommending will actually work. Once you have implemented the solution, analysis should be done to compare the performance of the real system against the predictions of the simulation model. An accurate prediction will increase the credibility even more.

This type of project should take about six to eight weeks to complete. Use this opportunity to increase awareness about simulation by getting as many people as you can exposed to the project. This can be in the form of status or progress reports, viewing sessions for the animation, newsletters, etc. The more people who are exposed to the project initially, the more projects you will have in the future. They will be aware of similar problems to the one modelled and if your first project is successful in improving the system's performance, then someone will likely come to you in the future with a similar problem. Also, if you have a success story modelling an existing system, your credibility will be established for modelling future systems where there is generally little known data and many assumptions that must be made.

Hopefully, this pilot project will be a success and management will be convinced of the usefulness of simulation as an engineering tool. It must be made clear from the beginning though that simulation is just a tool to aid in decision making and that it must be a person who makes the final decision.

PETER M. WALLER - INTEL CORPORATION

Simulation has been used at Intel for Semiconductor Manufacturing in die production for 2.5 years. We have evolved from one engineer working with an outside vendor to an internal group of seven engineers. The evolution of building our simulation group is a continuous loop of management approval, staffing and factory implementation. Projects currently entail production optimization, shop floor scheduling and factory automation. The following is a brief history of the evolution.

Management originally approved a simulation venture to model a new wafer fabrication plant before construction. Since no internal group existed, an outside vendor was brought in to work with the Intel automation group. The program took approximately one year to complete resulting in a single process model. Due to economic conditions and over capacity, the factory implementation was put on hold. Even though an application did not occur, simulation was introduced to Intel and several engineers were trained.

The subsequent application was to optimize the cost of manufacturing within a production factory. The corporate automation group chartered two trained engineers to work with a plant. Plant management had to be convinced to direct manpower to use simulation for real-time problem solving. This was achieved by proposing a model for only a portion of one department within the factory. The corporate group would also work under the direction of a factory expert team: engineering, manufacturing and maintenance. The final condition was that the model must be a working tool after the corporate group left.

The project implementation consisted of training a factory IE in modeling and coding, and meeting weekly with the expert team. The factory IE's role was to write the code under the direction of the corporate group. The expert team guided the project to address their problems by setting project priorities, reviewing model status and by guiding sensitivity analysis. The six month "cradle-to-grave" program resulted in significant cost savings and "factory converts".

Simulation now had a foothold. A corporate manufacturing systems group was formed to implement simulation within factories as an analytical tool to optimize manufacturing costs. This consisted of four engineers. The focus was to train factory IE's to model. The corporate group would assist with complex model building and multiple factory proliferation. The growth procedure repeated the above flow. Factory management approval was again required to model within a plant. The earlier success made this easier as the same implementation approach was followed. Teams were established and models were built for a total factory and individual departments. Models were also proliferated across factories.

Key problems which occurred in this stage were factory ownership and the building of generic models to ease multiple factory proliferation. All the same success steps were taken: management approval, training factory IE's, and the set up of expert teams; but factory commitment would intermittently vary depending on current problems causing scheduling slips. This resulted in the corporate group getting more involved with the building and coding of the model. By not having the factory IE build and code the model the final "hand-off" to the factory was delayed. One alternative to having the factory IE code was for the corporate group to build the model and the factory IE complete documentation.

Model proliferation to multiple factories was initially a problem as individual factory characteristics vary. A simulation users group consisting of an IE from each factory was established. The objective of the group was to build the individual factory models as generic as possible to meet other factory's requirements. Obviously models were not proliferated with no changes, but transfer time was significantly reduced.

The direction of simulation has recently changed again to factory automation. The scope of the job increased from die production to include assembly and test. Applications vary between work cell automation, total factory automation and shop floor scheduling. The emphasis of future factories was added to the optimization of existing plants. With the increased work load, the group grew to seven engineers.

In summary, simulation has significantly evolved at Intel. The key to our evolution has been repeatedly achieving management approval, acquiring the necessary staff within and outside of the factory and focusing on model implementation. Our actual applications are still growing, but we have successfully demonstrated the use of simulation to optimize our manufacturing costs.