Notes on the Use of Computer Simulation Modeling in Manufacturing Industry

Computer simulation modeling refers to a broad collection of methods and applications, which mimic on a computer using appropriate software, the behaviour of real world systems. Computer simulation modeling is applicable to almost any type of system of any degree of complexity, but is generally most useful in analysing the behaviour of dynamical systems, which are evolving over time through a succession of stochastically driven *critical events* in which complex interactions can occur between system components. Simulation not only enables the behavior of complex systems to be better understood. It also has a predictive and an evaluative capability, which in the context of systems design allows the dynamic alternative designs or specific features of designs to be compared *before the system is actually built.* Also, by simulating the behaviour of existing systems, it is possible to experiment with the effects of making various types of change to the system, either in terms of configuration or operating environment *in advance of actually making the change to the real system itself* (which would be prohibitively expensive, require very long time-scales, and possible be financially disastrous).

Computer simulation modeling has been applied to manufacturing industry since the late 1960's when IBM introduced its General Purpose Systems Simulator (GPSS) package. Simulation was found to be a very useful means of analysing the dynamics of materials flow through a manufacturing plant to for example:

- Identify current or potential bottlenecks and their impact on profitability.
- Examine effects of changing resource capacity (eg adding or subtracting operators or units of equipment, working additional shifts, purchasing extra machine etc).
- Analyse effects of different batch sizing policies on inventory levels, throughput and lead times.
- Examine effects of random equipment breakdowns and the potential impact of different maintenance strategies.
- Analyse the relative impact on material flow velocity of reducing process variability in alternative targeted areas.
- Check on the overall ability of the plant to respond to different assumed rates of demand increase, and identification of what resources will be the first to come under pressure

Limitations of the approach at that time were the fact that the simulation language (es) available were relatively low level necessitating usually a major programming task, and the results of the simulation were only available in the form of thick reams of printout consisting of many columns of figures all of which would require detailed content and statistical analysis before any conclusions could be drawn.

Since the late 1980's "application oriented" simulation software packages have become available which not only allow much more rapid construction of the model (through specifying options in a series of drop-down menus, rather than having to learn program statements) and in the presentation of results in the form of a visual, animated real-time

view of the simulated system, with built in statistical reports and summaries, the ability to stop the simulation at any time to review results and change key parameters etc.

The majority of these “application oriented” software packages have in fact been oriented to manufacturing industry, which is still the best customer of simulation applications. There are currently many such packages available varying in their sophistication and capabilities, and also in price which ranges from round about A$5000 to A$35000. As would be expected, higher levels of sophistication and customer support of the software are associated with higher prices.

Australian manufacturing companies have until recently made little use of simulation, and many are unaware of its potential capabilities. Simulation in the past has been hampered by the fact that even a relatively simple simulation project can end up with rapidly escalating costs if performed by inexperienced consultants, and the cost of purchasing simulation software to perform studies in-house is expensive, and often difficult to justify to skeptical finance managers who are looking for quantifiable short term benefits. Many of the benefits of simulation are hard to quantify directly in accounting terms. This is because a major component of simulation, in addition to providing short-term solutions to specific problems, is to assist the organisational learning process by helping appropriate personnel in manufacturing companies to gain insight into various critical interactions that may be more visible in an animated computer simulation than on the shop floor itself.

Currently, although certain large organisations have made the necessary investment in software and training in its use, to perform simulation studies in-house, the majority of successful studies are those performed by experienced external consultants. Although current simulation packages can be used to produce workable models after a short (typically three day) training course, a more critical aspect of simulation modeling is the ability to satisfactorily define and bound the problem under investigation, to ensure appropriate input data is used, and in the intelligent use of sensitivity analysis to assess those areas which justify more detailed investigation. Since most available simulation software can, in principle, model any type of manufacturing situation to any level of detail, it becomes critically important to be able to differentiate those aspects of a situation that need to be modeled in detail from those that don’t, and also when “typical” (subjectively estimated) data coupled with sensitivity analysis can be used, as opposed to a laborious sifting through and analysis of, actual data. Experience in these issues is the hallmark of an effective simulation consultant and can make the difference between an economically performed and highly cost effective simulation study, and a cost escalating study in which the original problem becomes lost in the complexity of the model.

In summary, simulation modeling is proving an invaluable tool for manufacturing industry, but only in the hands of the experienced.

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