SIMULATION'S EVOLVING ROLE IN MANAGEMENT

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ITRODUCTION

The paper argues that simulation techniques, while traditionally having been widely applied in Science and Engineering, have not yet attracted a corresponding degree of uptake in 'softer' management applications. Systems-thinking and its associated 'toolbox', simulation, have featured prominently in the systems literature for three decades or more and the question must therefore arise as to why the take-up of such a potentially powerful aid to management-planning and decision-making has traditionally proved so sporadic and sluggish amongst business practitioners? This question, along with a review of current trends illustrated by some basic examples, underscores the logic of this paper.

THE SYSTEMS SPECTRUM

Figure 1 presents a view of the potential scope for application of simulation, spanning the spectrum from the so called 'hard-systems', found in engineering and science, though to the softer systems involving strategic-planning, organisational learning and human resource management. Towards the left, many applications feature a pronounced control-engineering bias requiring a degree of familiarity with differential equation formulation and classical linearised, and state-space analysis of multivariable systems (Fowler, 1988). A well developed and mathematically underpinned theoretical base has emerged in these disciplines, over the decades. The central band includes problems of layout-design, capacity-planning, scheduling and computer-integrated-manufacture (Fowler & Lees, 1995). This is mainly the domain of discrete-event simulation and is, once again, substantially underpinned by established theory. To the right the picture becomes less clear, at least with respect to accepted theoretical underpinnings. The problem is that here we have soft, human centred disciplines combining with hard systems theory which owes much to the physical sciences. These are traditionally, 'unhappy bedfellows'.

A wide ranging UK review of the take-up of simulation in management, undertaken by The Simulation Study Group (1991) produced a very mixed response, generally indicating market failures in the areas of awareness, education and research. The report highlighted the complex combination of skills currently required to access simulation and called for further deskilling of the technology to provide greater access by new users. Training and Education deficiencies amongst managers, lack of familiarity with system modelling concepts, imprecision in defining information needs and fear of technology were identified as hindrances to its take-up. Computer packages were considered to be difficult to master for those without a specialist background and simulation was often regarded as an area for technically minded but relatively junior managers, as contrasted to senior decision makers.

Notably, the above study was specifically aimed at Manufacturing applications, found in the mid range of the spectrum defined in Figure 1. Similar studies, targeting the more generic aspects of management, do not appear to be available but given the relatively low level of input into University management courses, in the samples analysed, it seems reasonable to assume that exploitation of simulation is still relatively thinly dispersed in these areas. The question therefore arises as to what has happened, and is currently happening, which might redress some of these imbalances?

SIGNIFICANT TRENDS

It is argued in, this paper, that a number of trends are currently in train which will ultimately have a dramatic effect on the take up of simulation in the domain represented to the right of the 'systems-spectrum'. These include technical developments in information technology and changes in management theory and practice, including demographics.

Information Technology

Firstly there is evidence that perceptions of IT have changed substantially over its relatively short lifespan as the full managerial implications of the technology have become more apparent. From its origins as a backroom activity, implemented by technical specialists in the 1960's, IT is now seen as an essential core component of business and a highly strategic issue.

Secondly the emergence of the Personal Computer has unleashed an apparently insatiable appetite for end-user computing, thereby providing direct access to computer power even for those with minimal IT background. This trend has been matched by parallel developments in software, not least the emergence of user-friendly 'front-end' operating systems and GUI's. For management applications the generic products of word-processing, spreadsheets and databases have now been supplemented by many other specialist applications including Executive Information Systems. However, these management oriented 'decision assistance' applications are predominately spreadsheet based and while offering a capability for 'what if' and sensitivity analysis, they encapsulate, what is essentially, a static view of organisational life (Richmond, 1994). Complex dynamics and the presence of feedback are not readily accommodated and yet, these aspects of systems, can prove highly problematic for contemporary managers. Fortunately, new generation simulation products are now appearing and being marketed primarily at business managers (Wolstenholme & Stevenson, 1994). Exploiting the capability of modern hardware and object-oriented programming these products are accessible, user-friendly and in many cases very realistically priced. Powerful output graphics are available to interpret results and present them in a form which can slot directly into management reports. Most importantly results can be obtained and information gleaned from raw data, following a relatively brief expenditure of effort in training and familiarisation.

Management

It is now thirteen years since the advent of the PC and many younger managers, who have spent most of their working lives in the "IT era", are now progressing into positions of influence within the organisations of the 90's. Others, who have been using computers since they were at school, are also moving up the 'management ladder'. The implication of this is that the new generation of managers, many of whom will have technological backgrounds and/or MBAs, hopefully featuring MIS and simulation, will be more inclined than their predecessors to experiment with this technique in their planning and decision making processes.

There also exists a pronounced trend towards what is termed 'the lean organisation' which usually implies downsizing and delayering, often accompanied by the complete elimination of whole tiers of middle-management. This will often produce, as a side-effect, additional requirements for senior managers to use advanced information systems (Beheshti 1995).

Given the nature of the problems which such senior executives face, including strategy formulation, long time-scales and the processing of much unquantifable data, simulation presents a potential solution to emerging pressures in a way which is not addressed by alternative EIS. In particular, the current emphasis upon Business Process Reengineering (BPR) with its associated demands for an holistic and systemic approach and an emphasis on business processes which cut horizontally across the full range of vertical departmental functions, further reinforces the need for new tools. These must assist managers in their fundamental thinking about how the respective value-adding processes within the company integrate together. Simulation is potentially ideally poised to perform this role.

MANAGEMENT REQUIREMENTS AND APPLICATIONS

Arguably, the most sustainable competitive-advantage is the ability to learn faster than competitors. This requirement implies organisational-learning and understanding, not only of the complex relationships between the respective parts within the organisation, but also of the organisation's interactions with external factors such as customers, suppliers, the general state of the market, technological change etc. (Morecroft and Sterman 1992)

Such organisational and environmental understanding also proves indispensable when selecting and implementing appropriate business strategies, noting that implementation traditionally proves the most notoriously difficult stage in the 'design-school' sequence (Ansoff, 1991). The tendency to think 'open loop', thereby missing the constraints, interrelationships and feedback loops which inherently exist, can now be replaced by closed loop thinking and a full appreciation of 'organisational physics'. Finally systems thinking and simulation present an invaluable aid when contemplating either step change BPR initiatives or incremental TQM improvements.

Figure 2 presents a simplified generic model of a typical interactive business system showing a top-down view of the main subsystem models, the main process flows and some of the more important information feedback paths. Each block can be further decomposed to what ever level of detail is considered necessary by the particular management team which is undertaking the modelling exercise. Such a model may form a basis from which the organisational learning process can evolve, recognising that the thinking processes involved in the qualitative modelling phase is often as valuable as the actual experimentation phase. For example, the 'production block' in figure 2 may decompose into a number of sub-processes as shown in Figure 3, from which alternative operations-control alternatives, such as JIT and MRP, can be evaluated. For illustration Figure 4 depicts the type of result which can emerge in an inadequately designed system. Hence we observe the need for analytical design tools as typically formulated in the literature of control engineering, for example. Conversely, at the 'softer end of the model, as represented in the 'people' block, concepts such as motivation, morale, anger, frustration, self-confidence, self-esteem and pride must be included, these being areas requiring in-depth understanding based in the organisational sciences. Clearly the remit is very wide.

CONCLUSIONS

This paper has briefly attempted to reconcile the position of the manager, as a social scientist and holistic decision maker, with the role of the simulationist, who is characteristically reductionist and technically oriented. It is argued that although there are many similarities, there are also significant differences in modelling hard and soft systems. It may now be necessary to further explore these differences and to assess their implications for the take-up of simulation methodology. However, changes in the domain of management, compounded by technological developments in IT, have created a dynamic environment in which much wider exploitation of simulation now appears likely. It is therefore concluded that organisational learning and management decision support will provide a major growth area for the application of Simulation methodologies in the immediate future.

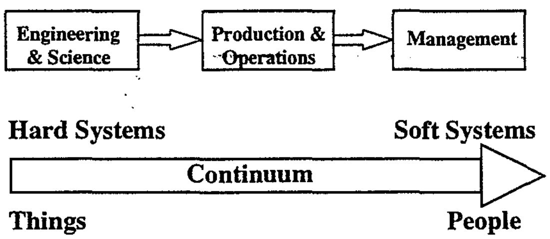

Figure 1 The Systems Spectrum

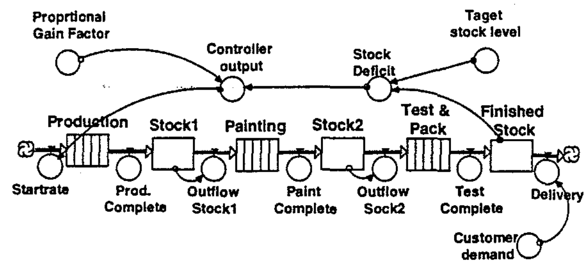

Figure 3 Traditional Production Control System

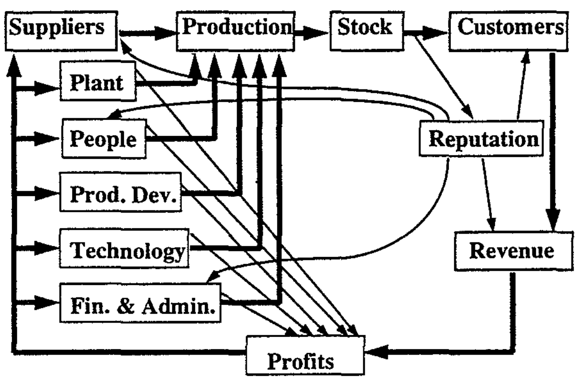

Figure 2 A simple Business model with feedbacks

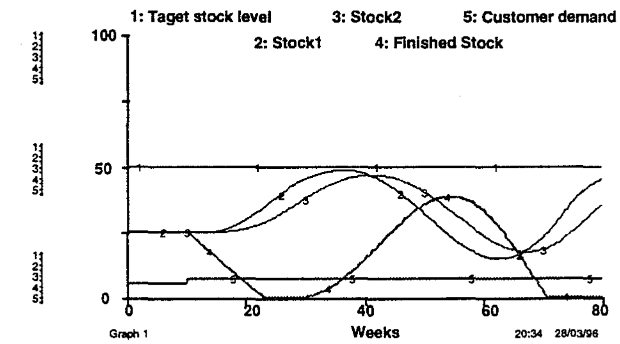

Figure 4 Response to 40% Step change in demand

REFERENCES

Ansoff, H.I. 1991. "The Design: School Reconsidering The Basic Premises of Strategic Management." *Strategic Management Journal* V.12. pp 449-456.

Beheshti, H. M. 1995 "Downsizing With Executive Information Systems" *Industrial Management Data Systems*, V.95, N5, pp18.

Fowler, A. 1988. "Microcomputer Based Simulation of Marine Propulsion Systems". Transactions of I.Mar.E, V.100, pp13-29.

Fowler, A. and Lees, D. 1995. "Process Simulation In Consumer Product Manufacturing and Packaging." *Proceedings of the UK Simulation Society Annual Conference, Berwick UK.* pp 155-160.

Morecroft, J.D.W. and Sterman, J.D. 1992. "Modelling for Learning". *Journal of Operational Research*, V.59, N1. Elsevier.

Richmond, B.1994. "Systems Thinking Systems Dynamics: Lets Just Get On With It". *Systems Dynamics Review*, V.10, N2-3, pp 135-157.

Senge, P. 1990. *The Fifth Discipline*, New York, Doubleday/Currency.

Simulation Study Group 1991. *Simulation in UK Manufacturing Industry.* University of Warwick Print Services.

Wolstenholme, E. & Stevenson, R. 1994. "Systems Thinking & Systems Modelling New Perspectives on Business Strategy and Process Design." *Management Services*, V.38, N9, pp22.