IMPACT OF GENERAL SYSTEMS ORIENTATION: PRESENT AND FUTURE

Bernard P. Zeigler
Department of Computer Science
Wayne State University
Detroit, MI 48202

ABSTRACT

The present impact of general systems orientation, i.e., theory and approach, on the simulation community is briefly outlined and assessed. Prospects for the future are contingent upon the evolution of educational and corporate settings conducive to "modelling in the large" methodologies.

1. SYSTEMS ORIENTATION AND SIMULATION

By general systems orientation, I intend to catch a large bag of approaches, motivated from diverse directions, all of which speak of such things as a system, its environment, its state, its component systems, their interaction, etc. While some of the early proponents of these concepts were perhaps overly optimistic about their power to rescue mankind from its predicament, there can be little doubt that the systems view of the world has taken root in the disciplines. Its concepts are employed and elaborated upon usually with different names and without attribution to the founding fathers. The simulation field has, like the rest, been influenced in this subliminal way, but it would take a historian of science to trace this evolution. Instead, I want to assess the impact of systems theory and concepts, as consciously advocated by its adherents. I believe that this systems orientation has helped to clarify troublesome concepts and to suggest new ones which open exciting possibilities for future computerization. But the uptake of these concepts, and hence the computer tools which support them, depends on the emergence of a more long range attitude to the fruits of simulation modelling.

1.1 Clarification of Concepts

Simulation, as a methodology in the intersection of numberless disciples, is notoriously uncertain about its fundamental concepts. Pritsker (1979) compiled the various definitions of the term "simulation" that have been offered; Nance (1981) did likewise for definitions of discrete event concepts--event, activity, process. I contend that, more than just a semantic difficulty, the problem goes deeper to a lack of universally accepted and understood theoretical basis. The remedy should be a formal, rigorous theory (expressed in set theoretic language) embodying general systems theoretic concepts. Among the tasks of such a theory are the integration of both continuous and discrete modelling formalisms within a unified framework and the elucidation of the basic entities in the simulation enterprise and their inter-relations. Attempts in this direction (Zeigler 1976, 1979; Kindler 1981) have met with some success but have yet to see full ramification in the consciousness of the simulation community. A recognition of the importance of the interface between systems and simulation will be manifest in the contents of forthcoming "Encyclopedia on Systems and Controls" (Pergamon Press) which will devote one out of five of its volumes to modelling and simulation.

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1.2 Suggesting New Concepts

General systems' concerns with the relation between structure and behavior, system-environment-observer boundaries, hierarchical decomposition and reconstitution suggest the need for broadened simulation perspectives and the development of computerized tools to make such concepts operational.

1.3 Basis for Advanced Methodologies

The broadened perspective just referred to suggest that current simulation practice is oriented to obtaining short run solutions to isolatable, hence well definable, problems. As a consequence, simulation programs are regarded as once-only disposable with little flexibility for later reuse. Methodologies which place simulation activities in a broadened class of other model-oriented activities (Zeigler 1980, Zeigler et. al. 1979, Oren & Zeigler 1979) are concerned with the reliable development of long run capabilities, i.e., with "modelling in the large" as well as "modelling in the small".

1.4 Directions for Future Computerization

"In the large" modelling methodologies demand structuring, discipline and abstraction that constitute an overhead of labor from the point of view of the immediate problem solution. Computerization is thus essential if they are to be feasible and attractive alternatives to "in the small" practice. Systematic enumeration of the possibilities for computer assistance in the modelling process can be based on a system theoretic framework (Ören 1979, 1981, 1982), as can proposals for particular software (Ören & Collie 1980, Overton & White (1981), Subrahmanian 1981, Zeigler et al. 1981) and hardware (Dekker et al. 1980) systems to support "in the large" methodologies.

2. FACTORS IN THE UPTAKE OF SYSTEMS ORIENTATION

Of critical importance to the realization of system theory oriented computerization is the acceptance by the simulation community of its concepts. Simulation as a, perhaps <u>the</u>, problem solving tool ("The last resort when all else fails" as it used to be said) carries with it a pragmatic attitude which is not conducive to absorbing the abstractions of methodology. The simulationist is most often not a professional in the discipline per se but comes from an applications area with the desire to do the necessary modelling and simulation as quickly and cheaply as possible so that he may get on with the 'real' problem (i.e., the problem which motivated his turning to simulation). With such a ruthless attitude toward time budgeting he may well regard any but the most concrete, here-and-now considerations as irrelevant at best, and counterproductive at worst. Of course, the arguments for methodological approaches concern the quality and reusability of the end result but it will be difficult to convince someone operating under pressure to produce that the long run is worth considering.

So the demand for theory and methodology based computer support, and consequently the progress in its realization, is not likely to emerge until there is a basic change in attitude in the simulation user community.

But this attitude can change and indeed, the fact of this panel session is evidence that it is changing for the better. What circumstances will contribute to greater acceptance?

a) <u>Education</u>: The next generation of simulation practitioners is being educated now. Students in all disciplines should be exposed to general system theory concepts. Indeed, I believe that a fundamental course in computer-oriented modelling should be a required offereing early in the undergraduate curriculum. Such a course would present the basic formalisms commonly employed -- automata, differential equation, discrete event, etc. -- as shorthand means of specifying themore universal concept of "system". It should thus foster an appreciation of the alternative approaches to the representation of reality, a critical understanding of the arbitrariness of modelling and hence a concern for model evaluation and validation. Having been exposed to the issues and the possibilities, future computer users will want tools which help deal with them.

b) <u>Environment</u>: An organizational structure which regards its simulation activities as something more than a series of disconnected forays and wants to build up a reliable set of capabilities will encourage the development of systems and methodologically based computerization. Such an organization will regard models as knowledge and will be concerned that this knowledge is transmittable, reusable, testable, and correctable. It will seek a balance between the economics of throw-away simulations and that of development of long term model supported capabilities. Consequently, it will reward its individuals both for their short term problem solving performance but also for their contribution to the organization's knowledge base. In such an enviornment, having systems concepts and tools at one's fingertips will be a definite advantage.

3. TIME FRAMES

The time frames in which one can expect to see the uptake of systems concepts therefore depend on the above educational and environmental factors. These in turn depend very much on the vagaries of the socio-economic climate. So perhaps only relativities can be speculated upon: I would expect that larger, solidly based companies would be first to adopt the "models as knowledge" approach to their simulation capabilities. Secondly, there is a more-or-less clear evolutionary sequence: 1) special purpose simulators with flexibilities in model/experimental frame specification, hierarchical model construction and storage/retrieval; 2) general purpose systems with these capabilities and with tools for constructing special purpose ones; 3) integrated modelling-design systems with capabilities for systems theory based design as well as modelling methodologies in the technical system domain; 4) ditto for the non-technical managerial domain.

There are indications in the literature of the increasing recognition of the role dynamic models in the more comprehensive design/decision framework. Will the simulation community be ready with the integrative -system oriented-- concepts when the time comes?

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