June 1982

REFLECTING DECISION-MAKING IN MODELS OF DYNAMIC SYSTEMS

G. Arthur Mihram, Ph. D.
Post Office Box Nº 1188
Princeton, N.J. 08540

(ABSTRACT)

System dynamics has been virtually defined with a requirement for authoring a model in the language, DYNAMO. The present paper extends the previously established [THEORY AND DECISION 7: 67-94 (1976)] result that DYNAMO essentially requires that the author of a model of a dynamic system write a set of difference equations.

Thus, for the most part, 'system dynamics' has restricted itself to the language of mathematics: viz., to time-dependent difference equations. This approach is essentially a continuous-change representation of the dynamics of the system to be modelled, quite in consonance with Forrester's [PRINCIPLES OF SYSTEMS, 1968] and Pugh's [DYNAMO II USER'S MANUAL] well-considered concepts.

System dynamics therefore has essentially represented dynamics in terms of the discrete formulation of time-dependent differential equations, thus providing essentially the same modelling artform as that employed by applied mathematicians using IBM's Continuous System Modelling Program [CSMP]. Forrester and Pugh have indeed pointed out that the discrete mathematical formulation (difference equations) represents elementary feedback loops and, hence, provides a mimicry of decision-making. Though their subsequent publications have noted that one can indeed incorporate occasionally irregular decisions, DYNAMO's "world view" still imposes on an author the requirement that he, for the most part, view a system's dynamics in terms of decisions which are with regularity repetitiously performed as the computerised model's clockworks is advanced one unit of time after another.

The present paper endeavours to criticise responsibly this methodology, pointing out that there are living systems which are not likely to be amenable to representation by this more limited view of system dynamics. The paper therefore extends the results of the award-winning essay, "Computerised Modelling: Mathematics is a Third-person Language, Simulation Second-person" [SIMULATION OF LARGE SYSTEMS, Universitat Bielefeld, F.R. Germany, 1980: pp. 137-148].

Indeed, James G. Miller's revelation [LIVING SYSTEMS, 1978] notes that every living system, whether as simple as the cell or as complex as the human society, possesses nineteen critical functions ('subsystems'); yet, the central one of these nineteen functions is conducted by the system's "decider".

The 'decider' subsystem of any living system collects information from all the other functional sub-systems and, when and if necessary, transmits a message that a "corrective", an adaptation, be made in the other pertinent sub-systems. Thus, the dynamics of living systems can not likely be represented with scientific credibility by the rather strictly mathematical approach of either differential or difference equations.

The paper therefore separates the dynamic systems representable by mathematical models [e.g., CSMP or the typical DYNAMO programme] from those more credibly represented by algorithmic models (e.g., GASP IV). In so doing, the paper will conclude with pertinent comments regarding the distinction between truth and proof in both mathematics and computer programming.

*

* *