WHY JAMES G. MILLER'S "DECIDER" LETS SIMULATION HARDEN THE "SOFT" BIOLOGICAL SCIENCES

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ABSTRACT

James C. Miller's compendium, LIVING SYSTEMS, just released by McGraw-Hill (1977), notes that every living system, from the cell through the society, undertakes change by means of its intrinsic 'decider'. The paper shows that the application of this result, by constructing simulation models (one algorithm for each 'decider' or deciding process), will permit us simulationists to provide what biologists have long sought: a modelling methodology deemed as 'hard', as scientifically credible, as mathematics has been for physics and chemistry.

Biologists have typically provided, as their explanations for the naturally occurring phenomena which they have observed, a model of the <u>descriptive</u> category. Indeed, Konrad Lorenz (NATURWISSENSCHAFTEN, 1973) takes considerable issue with what he terms contemporary biologists' "fashionable fallacy" of dispensing with natural-language descriptions of biological systems in favour of writing mathematical models of the phenomena confronting them.

Mellanby (Nature, 1976) has rather belittled the contemporary concern of "modelling," despite the fact that, like M. Jourdain (Moliere's character, who spoke prose for 40 years without really knowing it), scientists have been writing models (descriptions) since at least the time of da Vinci.

However, both Lorenz and Mellanby share the same concern: that biologists currently are over-emphasizing the "fitting" of mathematical curves to recorded data rather than the reflective evaluation of one's observations in order first to arrive at an understanding of some biological phenomenon and then to describe one's conclusion (i.e., to author one's descriptive or mathematical model).

Both Lorenz and Mellanby may well be decrying the intensive use of computerised models, but what each appears to have overlooked is the fact that not all computerised models need be strictly mathematical. Indeed, the distinguishing characteristic between computerised models which are of the more general (simular) variety permits the contemporary biologist to regain what both Lorenz and Mellanby seem to fear has been lost: the intense mental reflection on observations before constructing the model.

The proper simulation, or simular variety of model, consists of a set of event routines, each of which is an authored algorithm. The distinguishing characteristic of the algorithm is that it is a second-person "formula" or instructuin, much like the cook's recipe, for making a decision. The computerised algorithm becomes, then, a "paragraph" in a model, the paragraph being a set of instructions to the computer (a robot). The biologist, reflecting upon his observations of some natural phenomenon (or some system of natural phenomena) is required to "describe" in a simular model his understanding of the observed phenomenon (-a) in terms of a "recipe" which the robot must follow if he (the robot) were to himself act as the "director" of the natural system being modelled; i.e., the robot (the computer) is provided an executive routine (its "mind") with which to keep track of all the pertinent information ("entities" and their "attributes", or "state variables") within and about the system, and through which to command a particular "state variable" to alter its value if, when, and only when, the conditions among those ever-dynamic variables would require a change in the natural system being modelled.

Thus to author a model of the truly simular variety for a biological phenomenon requires that a considerable greater mental reflexion shall have taken place by the biologist than would be the case for the biologically-minded entrepreneur who seeks merely to find some hastily-conceived differential equation which "adequately" fits some data observed and recorded for the purpose. The truly similar model of a biological system requires that its author has painstakingly reflected on the decision-making qualities which reflect the many observed changes taking place in the system at hand.

General systems theorists (cf., e.g., James C. Miller, PROCEEDINGS OF THE 1975 ANNUAL NORTH AMERICAN JOINT MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE AND THE SOCIETY FOR GENERAL SYSTEMS RESEACH) have noted that every level of biological systems, whether cell, organ, organism, group, organization, or society, possesses a "decider", its "executive subsystem which receives information inputs from all other subsystems and transmits to them information outputs that control the entire system." Thus, no matter at what "level" one is modelling biological systems, simular models, with their emphasis on the algorithm, are ideally suited.

The analogies between individual animals and social animals also serve to illustrate the importance of simular, as opposed to strictly mathematical, models. For example, the Mind is an individual's "Neural Librarian" while the Brain is his personal "Library" of experiences; whereas, seen by the biologist of social systems (e.g., the sociologist), Man's archival respositories (libraries, museums) are merely his "Brain" and their controller (conscientious editors, publishers, and librarians) is Man's "mind," storing for generations his collective observations for survival.

The paper therfore underscores the distinctive characteristics of simulation, characteristics which will permit biologists to model, with scientific credibility, biological systems. In this context, the pertinence of Thom's "catastrophe theory," particulary as accounted by Zeeman (SCIENTIFIC AMERICAN, 1976) and in other popular accounts (e.g., NEWSWEEK, 1976), is questioned.

Every biological system requires its own "decider," or deciding sub-system. The algorithm is a recipe for decision making. Thus, the paper reveals the value of computerized simulation to the modelling of biological systems.