

NOTES ON SYSTEM DYNAMICS

I. Claims made for the methodology.

1. Generality of application. Provides both a vocabulary and a set of symbols for representing systems of all kinds. Similarly, the basic principles of systems and ways of analyzing them apply to practically any type of system.
2. Comprehensiveness. While highly useful to specialists, it also excels in transcending subject boundaries and facilitating overall views of large, complex wholes.
3. Designed to deal with dynamic situations, rather than static ones.
4. Readily deals with non-linear change. Normally when we consider change, we think of it as occurring at a constant rate rather than as accelerating or decelerating.
5. Equipped to handle many variables, including those which are simultaneously interacting among themselves.
6. Provides a method for examining hidden, often inaccurate, assumptions. Also permits testing of assumptions.
7. Provides a basis for selecting key information from among a wealth of available but unorganized data. Also provides basis for determining what information may be needed that is not yet available.
8. Promotes more effective discussion of and insight into complex issues.

II. Claims made about the nature of systems.

Proponents of system dynamics assert that nearly all systems have basic characteristics in common. Here are several principles of systems, paraphrased from Jay Forrester's book, *Urban Dynamics*, and also from his article, "Counterintuitive Behavior of Social Systems" (Technology Review, Jan. 1971).

1. System behavior is non-linear. Change in specific components of systems is rarely straight-line change, but exponential change.

2. System behavior is counter-intuitive. Due to the large number of variables, their non-linear interaction, and other aspects of the nature of systems, the actual behavior of systems often runs counter to our expectations.
3. Systems are remarkably insensitive to changes in many of the system parameters. However, systems are highly sensitive to changes in key parameters, and to changes in structure.
4. There is usually a conflict between the short-term and long-term consequences of a policy change. A policy which produces improvement in the short run, within five to ten years, is usually one which degrades the system in the long run, beyond ten years. Likewise, those policies and programs which produce long-run improvement may initially depress system behavior.
5. To the extent that a subsystem maximizes its own advantage, operation of the overall system is degraded.
6. Efforts to improve performance of systems (particularly social systems) often produce worsened performance. "In fact, a social system tends to draw our attention to the very point at which an attempt to intervene will fail."
7. Though large systems may be composed of many elements, each element normally functions in one of six simple, generic subsystems. It is these subsystems, linked together, which comprise a large system.

### III. Specific attractive aspects of the system dynamics approach.

1. Provides a set of simple, easily-grasped symbols for graphically representing a complex situation. This can be quite valuable, even without actually "running" the model on a computer.
2. Provides a "laboratory" for experimentation that, for reasons of cost, time, practical or ethical considerations, cannot be performed "in the field".
3. Provides a tool for forecasting. And for relating study of history in an interactive way with study of the future.
4. Provides an outstanding planning tool.

5. Provides a tool for dealing with complexity. That is, situations with many variables interacting with each other even though widely separated in time and space.
6. Offers a framework for interdisciplinary study and research.
7. An excellent tool for learning algebra and gaining a basis for calculus.
8. Stimulates independent research and thinking by students, both individually and in groups. Students usually grasp and apply this approach more quickly than their teachers; this naturally recasts the educational enterprise as a collegial endeavor.

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Internationale Zeitschrift  
für Semiotik und Ästhetik  
13. Jahrgang, Heft 3/4, 1988

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