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Spotlight On Systems Dynamics

There are, essentially, two general approaches to computer-based statistical modeling that are used by business managers. (In essence, there are two mathematical approaches to creating the underlying "engines" that execute the models.) One approach is referred to as Systems Dynamics, and the other is termed Discrete Event Simulation. Either can be effective in analyzing business problems, though, as a generalization, Systems Dynamics is usually taught in MBA classes and is used by consultants for higher-level analysis of options, while Discrete Event Simulation is typically packaged with business process modeling tools and used to determine how actual processes perform, or to project how they might perform under various future scenarios.

We have covered both approaches to statistical modeling on BPTrends. This month we'll turn our Spotlight on Systems Dynamics, and next month we'll Spotlight Discrete Event Simulation.

Systems Dynamics is an approach to simulation originally developed by Jay Forrester at MIT in the mid-Sixties. Forrester initially focused his approach on Industrial Systems, but was gradually drawn into the social arena and did important studies on Urban Dynamics and on World Dynamics. Forrester's concern with business process modeling is still championed at MIT and is well represented by the work of John D. Sterman, whose textbook, *Business Dynamics: Systems Thinking and Modeling for a Complex World*, is probably the best technical introduction to the subject.

Figure 1 illustrates a systems dynamics model taken from the introductory article on systems dynamics, written by Max Hughes, a professor at Drexel and a business consultant, and published on BPTrends in April of 2003. Dr. Hughes' paper: [Case Study: Process Modeling Using Systems Dynamics: A Combined Case Study and Tutorial](#), provides a gentle and practical introduction to the Systems Dynamics approach to modeling.

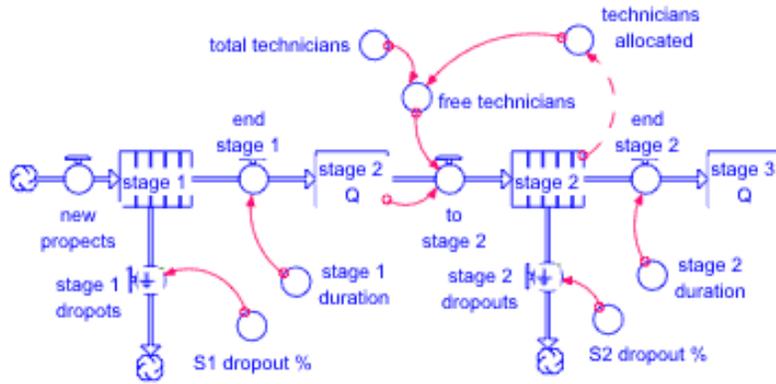


Figure 1. An example of a Systems Dynamics model from the Hughes Case Study.

Those familiar with the Discrete Event Simulation models know that the models look like workflow diagrams. Systems Dynamics diagrams, on the other hand, look more like network diagrams with many circles and loops. This reflects, in part, the fact that Systems Dynamics modelers are usually concerned with more general properties of processes and approach modeling more abstractly, while Discrete Event practitioners usually begin by defining a specific process and then using simulation to refine their understanding of the process.

This isn't to say that Systems Dynamics can't be used for specific and practical problems. In a technical brief published on BPTrends in January of 2003, [Systems Dynamics: Too Little Appreciation of Little](#), Hughes showed one of the common principles of systems design, Little's Law, could be used with, and illustrated by, a Systems Dynamics simulation.

For many managers, their first introduction to Systems Dynamics probably occurred when they read *The Fifth Discipline: The Art & Practice of The Learning Organization* by Peter M. Senge. Senge, who was the Director of the Center for Organizational Learning at MIT's Sloan School of Management when he wrote the book. *The Fifth Discipline* went on to become a major best seller in the early Nineties. Senge took the basic ideas of Systems Dynamics, with its emphasis on feedback and interrelated variables, and simplified it to make it a tool for management thinking. As he explained it: "...systems thinking is the fifth discipline. It is the discipline that integrates the disciplines, fusing them into a coherent body of theory and practice."

In effect, Senge would say that, ultimately, we understand our organizations as systems, and having good tools to use allows us to learn and refine our models in order to better understand and manage them.

It would be easy to suggest that, today, we might rephrase Senge and say that "process thinking" is the fifth discipline, but

that wouldn't be exactly in line with Senge's thinking. He emphasized that managers need to focus on seeing the forest and the major relationships that link things and make them whole. That focus, even today, is more on organizations and how very large scale processes work together to achieve an organization's goals - not on processes as they are typically conceived by line managers or by IT practitioners. Senge's emphasis on the "whole," largely sums up the difference between Systems Dynamics and Discrete Event Simulation. If you are concerned with strategy and want to create a model and simulate how the organization or a very large scale process interacts with its environment, you are likely to find yourself working with a Systems Dynamics model. If, on the other hand, you are down in the trenches trying to get a specific process to perform better, you are more likely to be using a Discrete Event Simulation approach.

Obviously, as organizations try to shift and become more process-centric, they are going to find uses for both types of simulation.

A short list of key books on Systems Dynamics includes:

- Jay W. Forester. *Industrial Dynamics*. Cambridge, MIT Press, 1961
- Jay W. Forester. *Principles of Systems*. Cambridge, Wright-Allen Press, 1968.
- Jay W. Forester. *Urban Dynamics*. Waltham, MA, Pegasus Communications, 1969.
- Jay W. Forester. *World Dynamics*. Waltham, MA, Pegasus Communications, 1973
- Peter M. Senge. *The Fifth Discipline: The Art & Practice of The Learning Organization*. Currency Doubleday, 1990.
- John D. Sterman. *Business Dynamics: Systems Thinking and Modeling for a Complex World*. McGraw-Hill, 2000.

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