This article on **System Dynamics** is a **stub**. You can help the Foresight Wiki by expanding it with new sections on the usage of this method in foresight exercises.

System Dynamics (SD) was developed by Jay Forrester of the Massachusetts Institute of Technology in the 1950s. It is a modelling technique for framing, understanding and managing the dynamic behaviour of complex systems, which may be found in business, industrial and social systems. Based on the notions of Systems Thinking, including causality, holism, hierarchy and continuity, SD considers the interrelations and interdependencies between system elements by using feedback loops. Stocks and flows in a system illustrate how system elements are connected by feedback loops. Computer software is used to simulate the model of the situations under investigation. SD is a widely used by public and private sectors for the design and analysis of policies in a wide variety of areas such as corporate planning, public management, energy and environmental systems and biological and medical modelling.

Contents

The FOR-LEARN Guide to System Dynamics

This is a summary of the article on the System Dynamics method from the FOR-LEARN guide. To read the full article go here.

Overall description

FOR-LEARN guide highlights that System Dynamics is a tool to investigate and model complex dynamic problems in terms of stocks (the accumulation of things), flows (the motion of things) and feedback loops at any level of aggregation. The method was further popularised with 'Limits to Growth', a summary of the results of a computer modelling exercise concerned with the future development of the world economy. Using relationships among the major variables, which included population, pollution, resources, capital and land, it purported to show that within the next 50 to 100 years the world system, as we now understand it, would collapse. The book became a best-seller, and formed a strong link in people's minds between systems ideas, computer modelling and predictions of future catastrophe.

Using the method

System Dynamics is now one of the most commonly used forms of computer simulation for dealing with multifaceted problems. The objective of this method is to find the conditions under which a system under study

will evolve and in what direction. The tools used are models that represent symbolically the reality of the system. It aims at considering the interrelationships between the components of an organisation or environment rather than looking at each component in isolation.
It is usually developed using a specific computer language (though it is in principle possible to use spreadsheets and similar methods to perform the tasks involved.) A system dynamics application starts with the identification of a problem. The modellers should then draw in all major patterns of influence that together create the 'system' that produces the problem. A successful model is able to simulate these patterns and produce system behaviour. Different values for variables and different policy structures may then be introduced to simulate how the system would respond to different circumstances or initiatives. This method searches for the causes of system behaviour that lie within the system, with events 'outside' serving as triggers rather than causes.

Step-by-step

System Dynamics looks for dynamic patterns, and describes them in terms of structural relationships between their multiple positive and negative feedback loops and the levels and rates of the primary variables. The FOR-LEARN guide suggests five steps for the design of a system dynamics model:

- Step 1: Setting the time frame
- Step 2: List the factors that contribute to the problem
- Step 3: Sketch the structural relationships between the factors with particular attention to characterise them as levels and rates that feed or drain them. Levels and rates need to alternate in the model; no level can control another without an intervening level
- Step 4: Attribute quantitative values to these factors and assumptions behind them
- Step 5: Run computer simulations to test the validity of the model. The model will begin from the initial quantified values for the variables and step through them at discrete time intervals. The basic computer model employs a set of first order, non-linear differential equations to reflect changes over time, with the chosen time interval small enough so that system behaviour appears continuous.

Pros and cons

The FOR-Learn guide System Dynamics models are used to understand and anticipate changes over time in puzzlingly complex systems. It can be used with what are thought to be 'data poor' problems. The information base for the conceptualisation and formulation of System Dynamics models is much broader than the numerical database employed in operations research and statistical modelling. This method can be useful to gain insight and understanding in a messy situation by sketching increasingly sophisticated causal loop diagrams.
However, a System Dynamics model is only capable of running one version of a situation at a time, although it may capture a great deal of variety in the changing values of its variables. Different stakeholders or groups with different cultural or political agenda might bring different assumptions and thus see a quite different picture. A system dynamics diagram can become very complex when actual situations with lots of variables are modelled.

Variations

System Dynamics can be used with most of other models to enhance understanding of system behaviour or to simulate the future. Some of the other methods which can be integrated with System Dynamics are give below.

Sea also

Environmental Scanning & Monitoring
Structural Analysis
Agent Modelling
SWOT Analysis
Trend Intra & Extrapolation
Modelling & Simulation
Gaming
Creativity Methods
Expert Panels
Delphi survey
Backcasting
S&T Roadmapping
Critical & Key Technology Study
Scenario Building
Morphological Analysis & Relevance Trees
Cross-Impact Analysis
Multi-Criteria Analysis