Complexity Science

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Module 1.1

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History of Decision Making Systems

In her book, Strategic Thinking and the New Science, 1998, T. Irene Sanders provides a world view of how and why mechanistic or linear thinking became the norm. The development of society over the past 2000 + years gave root to the belief that to understand the parts meant we could understand the whole. “The interweaving of scientific and religious views created a world of cause-effect thinking, belief systems, and institutions that were fixed and inflexible” (Sanders 1998, p.50). This way of thinking describes linear thinking and problem solving as we’ve all known it.

Chaos Theory

The advance of technology has helped perform the mathematics necessary to show the study of Chaos Theory, where through mathematics and a view of the bigger picture, the hidden order within what appears to be disorder can be shown. Chaos theory’s hidden order was first shown by Lorenz’s study of weather, and his experiment with convection that revealed the “Lorenz Attractor” (Sanders, 1998, p.59). Lorenz theorized that there were variables happening within systems that appeared to be in chaos or completely without predictable order, and this lead him to discover “attractors.” “An attractor is the end state or final behavior toward which a nonlinear dynamical system moves” (Sanders, 1998, p.66). These end states are either predictable or unpredictable; this predictability is for the end attractor state only and not to predict what happens to get to the end state. This is essence of a nonlinear dynamical system, and how even though it may seem predictable by knowing it’s attractor state, input into the nonlinear dynamical system my alter the attractor, or end state. According to Sanders (1998) "there are chaotic systems that never settle into a predictable or steady state, and those are said to have strange attractors" (p. 66). The term strange attractor "describes the behavior of the force or forces that hold the system variables in place." (Sanders, 1998, p.67) These strange attractors also establish the boundaries of the system; an example used is a hurricane or tornado.

The Butterfly Effect is used to describe, within Chaos Theory: "the image of a butterfly flapping its wings in Asia and causing a hurricane in the Atlantic" (Sanders, 1998, p.57). The implications for disaster or unintended consequences are great, and Sanders describes the following description of the butterfly effect:

> "how small systems interact with large systems. A small change in the initial conditions of one system multiply upward, expanding into larger and larger systems, changing conditions all along the way, eventually causing unexpected consequences at a broader level sometime in the future" (Sanders, 1998, p.57).

Complexity Science

Complexity Science is the study of Chaos and Complexity theories, through the understanding of nonlinear dynamical systems, and complex adaptive systems. Nonlinear dynamical systems are characterized by their variables being unpredictable; where Sanders (1998) describes "variables can't be taken apart and added back together again like a child's building blocks; A+B does not equal C" (p.57). The need for complexity thinking became apparent when our 20th and 21st century problem solving and strategic planning models have failed, due to variables, to provide predictable outcomes. According to Sanders, most of our lives are immersed within nonlinear dynamical systems.

Chaos and Complexity

Since Chaos Theory is dependent on the initial conditions and possible consequences through Butterfly Effect; it's important to understand that Complexity theory, as described by Sanders (1998), "describes how order and structure arise through the process of adaptation set in motion by new information" (p.69). Complex Adaptive Systems, which are nonlinear and receiving new information and adapting with a new shape emerge as a result of the adaptations, and are the product of the need for a new structure to form within a system.

Examples Mechanistic

Examples of mechanistic linear decision making could be: 1) a budget process where capital funds are reserved for an administration building and new construction is planned and accomplished by cause (tax mill) and effect (planning). We do this with my fire department budget for capital improvements, but it's much harder to predict funding needs for salaries and overtime, since it's dependent on variables. 2) Another example of mechanistic is when leadership from the top down gives a directive to accomplish a task and expects it will be done. Little credit is given to how important the communication variable may be.

Examples Complexity Thinking

Examples of Complexity Thinking are prime for fire departments: 1) The predictable attractor state is for the response of equipment to arrive, Assess the situation and establish command, address rescue, evacuation, exposures, ventilation, fire attack, and support functions. (To a novice or untrained spectator the response process would appear chaotic, but there is order within the chaos.) If new information arises to create an incident within an incident, this is where an adaptation of the original system occurs. A higher priority may necessitate deviating manpower and equipment to another incident or system within this incident. This process is ever changing and dependent upon many forms of new or updated information. Most times these changes are a function of command, but as with ants and their leaving pheromones as an indicator of form emergence, there are "accepted command practices" that allow the fire scene system to adapt and emerge into another from.

References

Sanders, T. Irene (1998). *Strategic Thinking and the New Science,* (22-70)