

Complex System Behaviours

BBAS 413 Complexity Management & BBAS 423 Leading Social Change with Systems Thinking

The following are behavioural properties that are commonly found in complex systems, and which make those systems difficult to understand, predict, and control.

Property:	Definition:	Example:
Emergence	Whole-of-system level behaviours that are qualitatively different from the behaviours of the parts. The interaction of the elements produces a system-level structure or behaviour, and that system-level property affects the behaviour of its parts in a way that reproduces the overarching structure or behaviour.	A flock of birds that exhibits different flight dynamics than each individual bird that composes it
Self-Organization	The decentralized interactions of elements generate collective properties without central control or planning.	A vortex forms spontaneously in a draining bathtub
Sensitivity to Initial Conditions (Chaos):	Very small changes to a system can produce drastically different outcomes later on. Such systems are highly contingent and unpredictable.	The butterfly effect
Path Dependence	The past trajectory of a system constrains its future possibilities. Directions that were once possible become inaccessible as the system develops.	The QWERTY keyboard is locked-in even though alternative layouts may perform better
Non-Linear Behaviour (Thresholds)	When incremental changes in conditions at a certain point produce drastic qualitative change in the state of the system, which may be difficult to reverse.	Gradual decreases in summer sunlight caused the Western Sahara to flip from lush wetland to desert about 6000 years ago