What makes a system?

- The parts or components
- The relationship between the parts
- The purpose of the system (subsystems may have several purposes conflicting or not)

“Nothing is completely itself without everything else”

(T. Berry)
“Today, system thinking is needed more than ever because we are becoming overwhelmed by complexity. Perhaps for the first time in history, humankind has the capacity to create far more information than anyone can absorb, to foster far greater interdependency than anyone can manage, and to accelerate change far faster than anyone’s ability to keep pace”

(Peter Senge)
Linear Causality

A
Cause

B
Effect

C

Circular Causality

Feedback: shows how actions can reinforce (positive feedback) or counteract (balance through negative feedback) each other

Variables are organized in a circle or loop of cause-effect relationship called a “feedback process”
**Flow and Stock**

- **Stock**: Anything that accumulate and can be measured at one point in time (water in bathtub or behind a dam, population, wood in the forest, etc.)
- **Flow**: Anything that changes over time (number of births, inflation rate, etc.). Inflows and outflows
- Stock and flow obey laws of conservation and accumulation
“I am filling a glass of water”

From *The 5th Discipline* by Peter Senge (1990)
The hand on the faucet is controlling the rate of flow of water into the glass. The level of water in the glass is controlling the hand.

The intent to fill a glass of water creates a system that causes water to flow in when the level is low, then shuts the flow off when the glass is full. The system causes the behavior.
Positive or Reinforcing Feedback Loops (R)

A reinforcing loop is one in which the interaction are such that each action adds to the other. Any situation where action produces a result that promotes more of the same action is representative of a reinforcing loop. These loops amplify or add to change. *Vicious vs. virtuous.*
Negative or Balancing Feedback Loops (B)

A balancing loop is one in which actions attempts to bring two things to agreement. Any situation where one attempts to solve a problem or achieve a goal or objective is representative of a balancing loop. These loops negate change and create stability. They often display goal seeking behavior.
Feedback Processes

**Reinforcing (R) or Amplifying**

- Cause dramatic growth or collapse
- Amplifies change
- Snowballing effect
- Make something greater or less
- Accelerating growth or decline
- “Vicious cycles”, “self fulfilling prophecies”, “Virtuous cycles”, “Bandwagon effect”, “rats are jumping ship”

**Balancing (B) or Stabilizing**

- Operates when there is a goal oriented behavior (implicit or explicit)
- Keep things under control
- Limit dramatic growth
- Ensure that systems fulfills its purpose
- Seeks equilibrium and stability
- Self correction to keep goal or target
Reinforcing Feedback
Balancing Feedback

Diagram showing a feedback loop involving body temperature and clothing adjustment.
Delay = interruption between actions and their consequences
Systems Archetypes
(archetypos = first of its kind)

- Limits to growth
- Fixes that backfire
- Shifting the burden
- Eroding goals
- Escalation
- Success to the successful
- Tragedy of the commons
- Growth and under-investment
- Balancing process with delay
Limits to Growth Archetype
“We never grow without limits”
Fixes that backfire
Shifting the Burden Archetype

SYMPTOM-CORRECTING PROCESS

Quick fixes

Problem symptom (performance that you can measure or observe)

Side effects (unintended consequences for the fix)

Corrective actions or fundamental solutions

Source of problem or root cause

PROMBLEMCORRECTING PROCESS

SYMPTOM-CORRECTING PROCESS

HEROICS AND TEMPORARY CRISIS MODE RELAXATION OF RATES AND FORMALITIES

ADDITION LOOP

Rewards for heroic behavior

Dependence on heroic behavior for sense of accomplishment

Effectiveness of project management system, roadblocks such as rules and formalities

ADDITION LOOP

Delays on product launch (wandering crisis proportions)

Improvement of project management system, roadblocks such as rules and formalities

PROBLEM-CORRECTING PROCESS

PROBLEM-CORRECTING PROCESS
Tragedy of the Commons