Feedbacks and Systems Diagrams

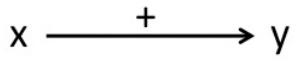
BBAS 413 Complexity Management & BBAS 423 Leading Social Change with Systems Thinking

"*Once we see the relationship between structure and behaviour, we can begin to understand how systems work, what makes them produce poor results, and how to shift them into better behaviour patterns.*"[1]

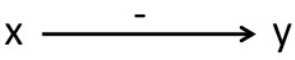
Causal Loop Diagrams:

Causal Loop Diagrams trace the cause and effect relationships between different factors using arrows to show the direction of causality. When a cause has an effect or series of effects that influence that cause, they make a feedback loop. Feedback loops make up the structure of the system, generating the patterns and events that we observe and may wish to change.

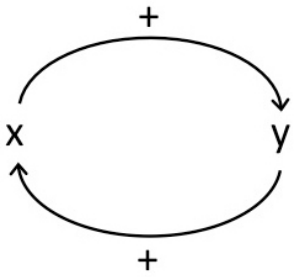
A positive relation (+) indicates that two factors increase or decrease together: as x increases, y increases; as x decreases, y decreases.



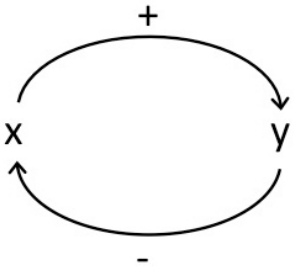
A negative (inverse) relation (-) indicates that two factors change in opposite directions: as x increases, y decreases; as x decreases, y increases.



In **positive, or reinforcing, feedbacks**, a change (increase or decrease) in the cause produces an effect (or effects) that augment the change in the cause, which then amplifies the effect(s), which further augments the change in the cause, which amplifies the effect(s), and so on. If the cause increases, the positive feedback produces runaway growth (for example, the rich get richer). If the cause decreases, the positive feedback produces a spiral to nothing (for example, the poor get poorer).



In **negative, or balancing, feedbacks**, a change (increase or decrease) in the cause produces an effect (or effects) that counteracts the change in the cause, and restores the cause to its previous value. Negative feedbacks cancel out change and restore the system to equilibrium. A thermostat maintains a desired room temperature by activating the furnace and air conditioner to counteract rises and falls in room temperature, for example.



To figure out where a multifactor causal loop is a **positive or negative feedback**, multiply the positive and negative signs one by one over the path of the loop. If the product is positive, it is a positive feedback loop; if the product is negative, it is a negative feedback loop.

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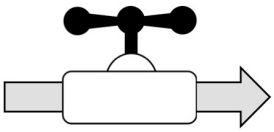
[1] Meadows, D.H. (2008). *Thinking in systems: A primer*. Chelsea Green Publishing: p. 1.

Stock and Flow Diagrams:

Stock and flow diagrams trace the accumulation and depletion of stocks. The advantage of thinking in terms of stocks and flows is that they are quantifiable. When we know the *amount* of a stock and the *rate* of a flow, we can calculate and graph system behaviour in a behaviour over time diagram.

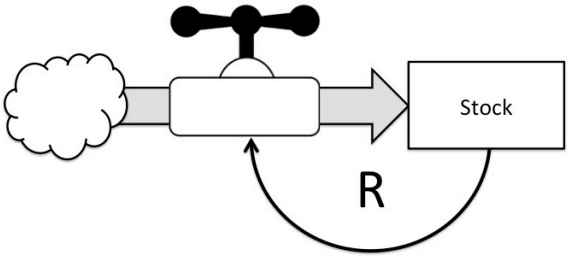
A **stock** is and accumulation (or store) of matter, energy, or information within a system.

A **flow** is a transfer of matter, energy, or information into or out of a stock.

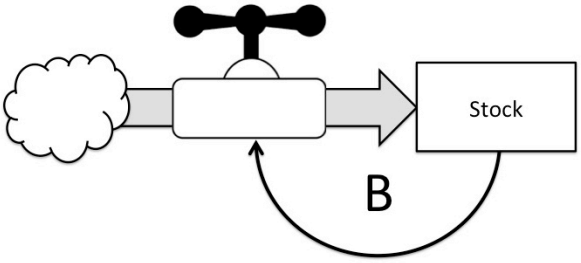


The **environment**, represented as a cloud, is the source of a flow into the system, or the destination of a flow leaving the system.

In a **reinforcing feedback loop**, marked R, the stock and flow change in the same direction. If the stock increases, then the flow into the stock increases. If the stock decreases, then the flow into the stock also decreases.



In a **balancing feedback loop**, marked B, the stock and flow change in opposite directions. If the stock increases, then the flow into the stock decreases until the stock returns to its normal level. If the stock decreases, then the flow into the stock increases until the stock returns to its normal level. Balancing feedbacks are goal seeking and stability seeking because they reverse changes to a desired stock level.



This summary of stock and flow diagrams is based on: Meadows, D.H. (2008). *Thinking in systems: A primer*. Chelsea Green Publishing.