Thinking In Systems _ Pt 1 _ System Structure & Behavior

One: The Basics

More Than the Sum of Its Parts

System: interconnected set of elements that is coherently organized in a way that achieves something. Must consist of ① elements ② interconnections ③ function or purpose

"A system is more than the sum of its parts. It may exhibit adaptive, dynamic, goal-seeking, self-preserving & sometimes evolutionary behavior."

→ there is an integrity/wholeness to systems & willtry to maintain that integrity. Even if systems contain or consist of, nonliving things
↳ they are self-repairing over a certain range of disruption

Look Beyond the Players to the Rules of the Game

* the elements of a system are typically the easiest to notice because they are typically tangible & visible (but they don't have to be)

? How to know if you're looking at a system?
a) Can you identify parts?
b) Do the parts affect each other?
c) Do the parts together produce an effect that is different from the effect of each part on its own?
d) Does the effect the behavior over time, persist in a variety of circumstances?

* Before getting lost in elements, start looking for interconnections, the relationships that hold the elements together.

"Many of the interconnections in systems operate through the flow of information. Information holds systems together & plays a great role in determining how they operate."

* A system's function & purpose is expressed through the operation of the system, the best way to work out a system's purpose is to watch & see how it behaves after awhile.

"Purposes are deduced from behavior, not from rhetoric or stated goals"

* An important function of any system is to ensure its on perpetuation.

* one of frustrating parts of systems is that the purposes of subunits may result in a behavior no one wants
* there are nested purposes in a system & sometimes they conflict. keeping sub-purposes & overall system purposes in harmony is essential for a successful system
* Can understand the relative importance of a system's elements, interconnections & purposes by imaging them changed 1/1
  ↳ you can change elements w/ impact but specific elements can be important

"A system generally goes on being itself, changing only slowly if at all, even with complete substitutions of its elements — as long as its interconnections & purposes remain intact."

"The least obvious parts of the system, its function or purpose, is often the most crucial determinant of the system's behavior."

↳ if interconnections change the system could be unrecognizable
↳ changes in function / purpose can be drastic even if every element & interconnection stays the same

* all 3 aspects are essential & have their place in a system

Stock is the elements of the system you can see, feel, count or measure & it's the foundation of any system

System stock is a store, qty, accumulation of material or info built up over time

"A stock is the memory of the history of changing flows w/in the system."

Flows are actions that change stocks over time. Filling / draining, birth / death, purchases / sales

* all diagrams are simplified versions of the real world

dynamics are the behavior of systems over time
* can use graphs to see dynamics of a system
dynamic equilibrium when inflow matches outflow, the level doesn't change even though there is flow in the system & levels don't change

"A stock can be ↑ by ↓ its outflow rate as well as by ↑ its inflow rate"
* You can change flows quickly but not necessarily the stock
"a stock takes time to change bc flows take time to flow"
↳ "Therefore stocks act as delays or buffers * or shock absorbers in systems"
* Changes in stocks set the pace of the dynamics of systems
* This stability & momentum in stock can cause problems but can also provide reliability / stability

"The time lags imposed by stocks allow room to maneuver, to experiment, and to revise policies that aren't working."

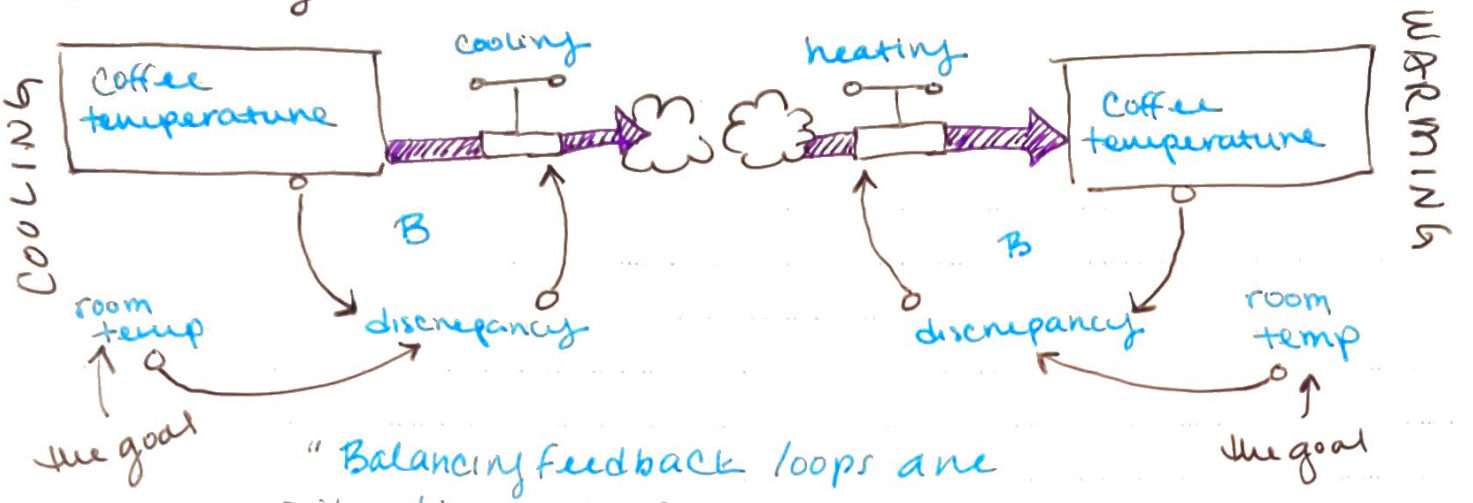
"Stocks allow inflows & outflows to be decoupled & to be independent & temporarily out of balance w/ each other."
↳ "[allows] life to proceed w/ some certainty, continuity, & predictability, even though flows vary in the short term."

"System thinkers see the world as a collection of "feedback processes""
feedback loop is formed when changes in a stock affect the flows into or out of that same stock.

"A feedback loop is a closed chain of causal connections from a stock, through a set of decisions or rules or physical laws or actions that are dependent on the level of the stock & back again through a flow to change the stock."
* there may be stabilizing feedback loops that keep the stock w/in acceptable boundaries.
* loops can work in two directions & can correct over- & undersupply
balancing feedback loop are goal syncing / stability syncing

Goal-Seeking

~~Balancing~~ Feedback Loop

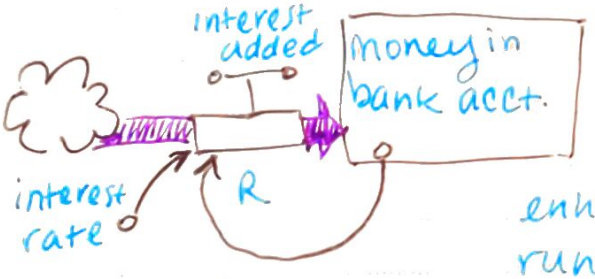


"Balancing feedback loops are equilibrating or goal-seeking structures in systems & are both sources of stability & sources of resistance to change."

*Feedbacks can fail or not be strong enough to affect stock

Reinforcing Feedback Loop (R) ↑input to stock → ↑stock → there is ↓input to stock → ↓stock → there is enhances whatever dir. is imposed on it

→ found whenever a system element has the ability to reproduce itself or grow as a const fraction of itself.



* exponential growth 

"Reinforcing feedback loops are self-enhancing, leading to exp. growth or to runaway collapses over time."

Time to double = ~70/$growthRate

"doubling size" ↑ as a percentage

ex. 100$ in bank @ 7% interest → 70 ÷ 7 = 10, 10 years to double

"If A causes B, is it possible that B also causes A?"