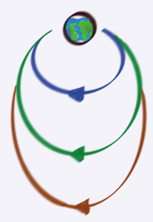
STORIES

Disproportional? - Tacoma Narrows Bridge

Small, repetitive, influences can have huge effects. In 1938 a continuous wind brought the tacoma narrows bridge into an undulation you wouldn't believe from a Sci-Fi movie, until it went beyond breaking point and the bridge collapsed. Although not technically a case of 'resonance', it shows

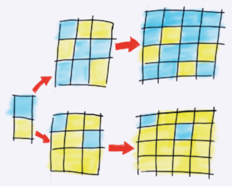
the impact of small, coupled stimulation. After the collapse, a lot was learned about how to improve bridge design. B6 (+loads of youtube videos showing the collapse). B6

Stocks and Flows - Circular Economy



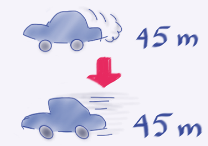
Finite amounts of resources, and how they get depleted, play a large role in sustainable design. How can we connect the flows of such materials in cycles of reuse, refurbishment, recycling, so that we don't run out of them.

Stagnation - Internet Filter Bubbles



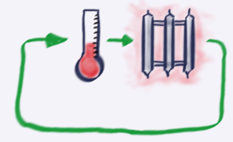
When you search through an online service such as Google, it can track what you asked and which answers you looked at. On your next search, the service is then tuned to what it expects you will be interested in. One effect of this is that what you find on a search will be different from what I find. Also, the service may 'shield' us from discovering something different: trap us in our individual information bubble. V1

The System Kicks Back - Traffic Improvement



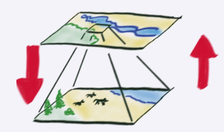
A new highway may reduce the time commuters need to get to work. This is a reason that is often given in its justification. But after the highway is there for a while, the commuting time is again the 45 minutes on average that it was before. People went to live at a greater distance from work (or vice versa). So the effect of the highway then is more traffic, not shorter travel.

Stability - the Thermostat



A thermostat is a simple feedback system which measures the temperature of a vessel, and activates a heater when the temperature falls below a certain level. Human and animal bodies contain many of such homeostatic systems to maintain temperature, hormones, levels of oxygen and nutrients in the blood, balance of standing.

Causal Chains across Levels - Wolves move rivers



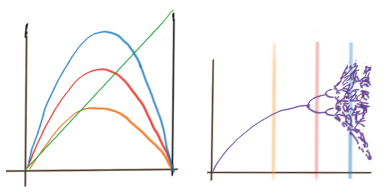
We easily recognize that the large scale influences the small scale. If the land dries up, there is less food for the animals. But it can also work the other way. The reintroduction of predator wolves led, through a chain of effects, to changes in the landscape at a larger scale. V2

Disproportional? - The Butterfly Effect

A prediction depends on your model and your data. With weather predictions it was noted that in order to predict the details of a storm in Europe more , you'd have to invest surprisingly much in your data - to the detail of measuring even whether a butterfly in the Amazon flaps its wings at a certain moment or not.

EXAMPLES TO PLAY WITH AND EXPERIENCE

Surprising Returns - the Logistic Map



A bank account with fixed interest will grow exponentially; a petering our resource decays exponentially. When you know the amount at time t, this graph gives the amount in the next year. And a timeline looks a bit like this.

In nature, animal populations fluctuate, but not just exponentially. They show stability, fluctuations, and surprising cyclical patterns. The Logistic Map is the simplest mathematical model and it shows surprising complexity. The shape of the returns function is an inverted-U, with 0 (dying out) when the population is too small to succeed, or too large to find enough food. The height of the U is a tuning parameter A, which goes from A=0 to A=4. The value at which it is tuned gives rise to these strange patterns.

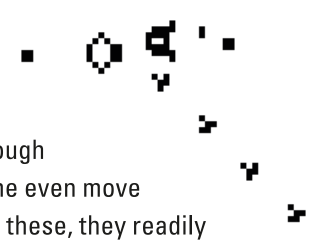
For small values of A, the result is simple decay: no matter how many animals we start with, they will die out. As we tune up A between 0 and 2.8, the population will always converge to a certain size. How large depends on A. Then, at A=2.8, the solution becomes an oscillation alternating a higher and lower value. At first, the difference is small, but as A increases, they go further apart. One year up, one year down. Etcetera.

This continues until at 2.8 the cycle takes on 4 values, and repeats after 4 steps. And then it widens. At A = 3.2 it becomes 8 values, later 16 etc, until close to 4 the sequence seems to go haywire: small values and large values alternate in random order (noise).

This structure has been studied in detail, and contains suprising regularities. For instance, around A = 3.6 there is a small stable point again. It's a dynamic process. V4

Emerging Levels - Conway's Game of Life

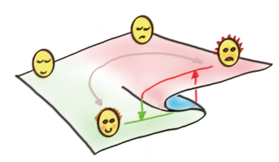
Another famous simple yet surprisingly rich model of population growth simulates spatial patterns of growth and decay. It starts with an n*n grid of cells, each in state alive or dead, and calculates iterations. In each step, if a cell has too few or too many neighbours it will die (of cold or hunger, respectively), otherwise it survives. An empty spot can spawn a living cell if it touches upon exactly three neighbouring cells. This calculation is repeated time and again.



The visual grid shows patterns of moving dots which appear to be cell groups. Most fall apart, some stay at rest. Others go through a repetitive cycle of motion. Some even move about the grid. When people see these, they readily agree on what are 'the animals', usually characterizing them as 'a block' or 'a swimming thing' on the basis of the motion patterns.

But the rules of the simulation didn't specify blocks or swimming things or larger structures: it was just some simple rules defined at the level of a grid cell, which led to these complex emergent patterns complexity. V5 V6 V7

States and Transitions - Zeeman's Catastrophe Machine and Nonlinear Dynamics



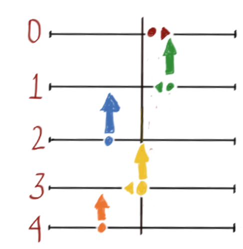
We know the basic states of water (solid, liquid, gas) and their transitions (freezing, boiling, etc). And we know a tuning parameter, temperature, which can predict exactly in what state the water is. But the transitions are not always so simple. Consider humans with three states of moving: walk, jog, and run, each state allowing a speed range (it's similar for horses that walk, trot, or gallop). We can change from walk to jog, but don't always do that at the same speed. When you speed up from walking you may start to jog at 3 km/hour, and when you slow down, you change at 2 km/hour. If you see a group of people coming by at 2.5 km you can see both joggers and walkers. If it's 1km/h you're pretty sure, and for 3 km/h you also are. The thing is that in that overlap area we can change from one state to the other, but that in itself takes effort. So if we're only going into the overlap speeds briefly we stay in the same walking state, even if that other way of moving would be more efficient or pleasurable. So if you only know of a person he's moving at 2.5 km/hour, you can't be sure if he's walking or jogging, but if you knew the history (he just came down from 3 km/h or up from 1 km/h) you'd know it's jogging or walking. That's hysteresis: you need to know the history to be able to interpret the current state.

Zeeman's Catastrophe Theory paper applies such models to a variety of phenomena, from economies, to human and animal emotions, to behavior change in anorexia/bulimia. And also shows how introduction of a second dimension (for emotion, it's arousal next to attraction, for anorexia it's) can be a way to predict or avoid the 'sudden crashes' of transitions. P4

Delays and Overshoot - Higher Order Control

All of us have witnessed what happens when an amplifier feeds back sound to its microphone, either at music concerts, teleconferences, or phone conversations. It results in a sharp, high-pitched squeak which -if you're lucky- is shut down by a protective mechanic or mechanism. These are overshoots, such as when you have problems setting the shower thermostat in a hotel, when that has delays and tends two swing from scolding hot to freezing cold.

Also in other situations, delays may make it difficult to operate an influence. An easy example: the webpage in the browser on your phone: you thought you tapped a button, but saw no response, so you tap it again. But the browser had responded, and loads a new page just as you make your second tap.



As a result you press a button on the new page that you didn't intend to press at all, and end up in an advertiser's dialogue that you need to find your way out of.

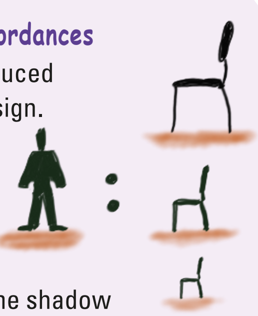
The speed of influences matters, as in delays and orders of influence. For instance, in a car you can control acceleration by pushing the gas pedal; that leads to increased speed which makes you move ahead. But the speed takes time to build up, a delay. When we control rates of change, applying the right amount at the right time is a challenge because of the delays. L4

Complexity - the Cynefin model

Snowden & Boone distinguish four different types of **complexity**, and argue that for each one we must use different (design) tactics to deal with them. **Simple** systems we understand well and know how to solve. **Complicated** ones require more effort, more detail, more expertise, but can still be predicted and handled. **Complex** systems change as we intervene, have feedbacks, and require us to reframe and adjust regularly. Finaly **chaotic** systems do not allow for much prediction, and instead force us to observe and act, keep on steering and engaged continuously. In design, we encounter all four of these, often in different parts of the same project. P3 Pc1

SOME DESIGN EXAMPLES TO START WITH

Relations put Central - Gibson's Affordances

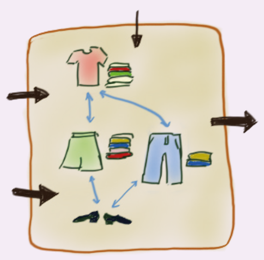


The psychologist James Gibson introduced two important systems notion into design. He coined the term affordances to indicate the action opportunities that a product or situation can have for a person, such as 'I can sit on this box, hide in it, or use it to gain some shadow on a sunny day'. Affordances are relations that depend on the properties of the product and the user. A child may stand on or sit in a box that would not hold or carry a grown adult.

Another innovation was his book 'the senses considered as perceptual systems' where he challenged the existing theories which saw perception as an interpretation by the brain of light patterns on the retina, or sound signals on the eardrum. These theories all had difficulties with explaining spatial behavior, because a lot of information seemed to be missing. Gibson instead described how our eyes are part of an organized structure with muscles and reflexes, and that perceptual behavior in natural circumstances involves active information seeking behavior ('the orienting reflex'). At the level of the active animal or person a different description is needed than that of the stimulus at the level of the cell.

The Wardrobe as a System - Maldini's Services

As part of her PhD thesis, Irene Maldini studied how people deal with their clothes. The existing theories, and services, treat people's collection of clothes, their wardrobe, as a numbers of pants, skirts, socks, etc.

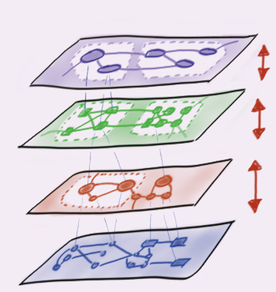


In her study, Irene explored if designers and consumers can think of their wardrobe as elements with many relations, which can form the basis of services, e.g., a repair or replacement service, or suggestions which things you like to wear together. S2

Multilevel interaction - Ecological Interfaces

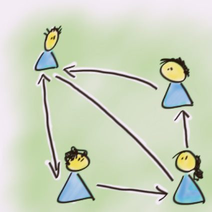
Systems can (or have) to be modeled at multiple levels of abstraction. In the field of Cognitive Systems Engineering, interfaces have been developed that provide an operator (e.g., an aircraft pilot, or the operator of a chemical plant) with interfaces that allow the operator to switch between the different levels of an abstraction hierarchy, depending on how to guide it in different states.

When the plane (or plant) is running smoothly, the pilot (or operator) can navigate on a high level (efficiently running the business), when the circumstances require, he can switch to an overview of energy and coolant flows, or below that the flows of specific materials (water, fuel), and even below that the valve that controls pipe number 17b. P1



Interacting Groups - Postma's Socionas

Carolien Postma's IPD graduation assignment was to design a museum experience for 12-14 year olds. At this age, youngsters appeared to have two interests: their own image and interacting with a small group of friends.



Carolien focused not on the individual youngsters, or on '12-14 year olds as a generic group', but on the interactions in these small groups ('cliques'), such as teasing, joking, fighting, getting together, and made these interactions the basis of the museum experience: e.g., visitors were shown items, and prodded to engage with exhibits through questions as 'for which one of your group would this be a fitting product'. S3