System Thinking Introduction

A lesser traveled path

Credits

- I have borrowed almost all of the slides in this presentation from one source or another. I've modified most of them for use in my class, so I hesitate to attribute the current slide to the original source. Nevertheless, certain people and organizations deserve thanks and acknowledgement.
- They are:
  - Hal Hamilton and Phil Rice from the Sustainability Institute, VT
  - Karlo North, farmer and systems modeler, NY
  - Carol Anderson, Organizational Consultant, Ann Arbor, MI
  - Dick Richardson, teacher extraordinaire, Austin, TX
  - Paul Krafel, author of "Seeing Nature", Cottonwood, CA

Thanks friends.

Systems

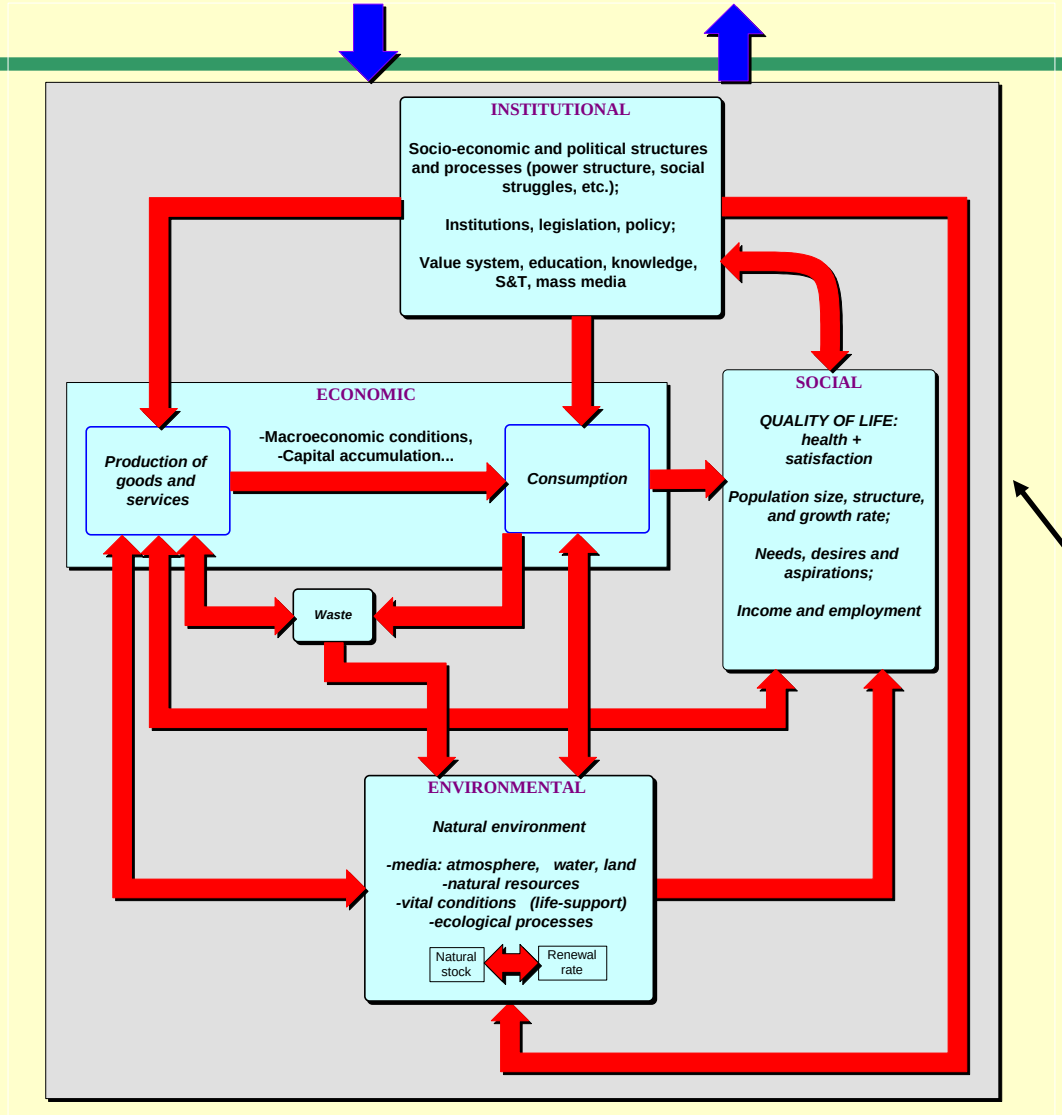
- **A system is a collection of related parts that interact in an organized way for a purpose.**

- **Key words:**
  - **Related parts**
  - **Organized**
  - **Purpose**

Systems…

- **Materials, energy and information that enter the system from outside are *inputs*.**
- **Materials, energy, and information that leave are *outputs.***
- **All systems have *boundaries.***

Inputs Outputs



Boundary

A system can be:

- **made up of many sub-systems**
  - **A human body for example, is a system made up many smaller sub-systems like the heart sub-system, liver sub-system, kidney sub-system etc.**

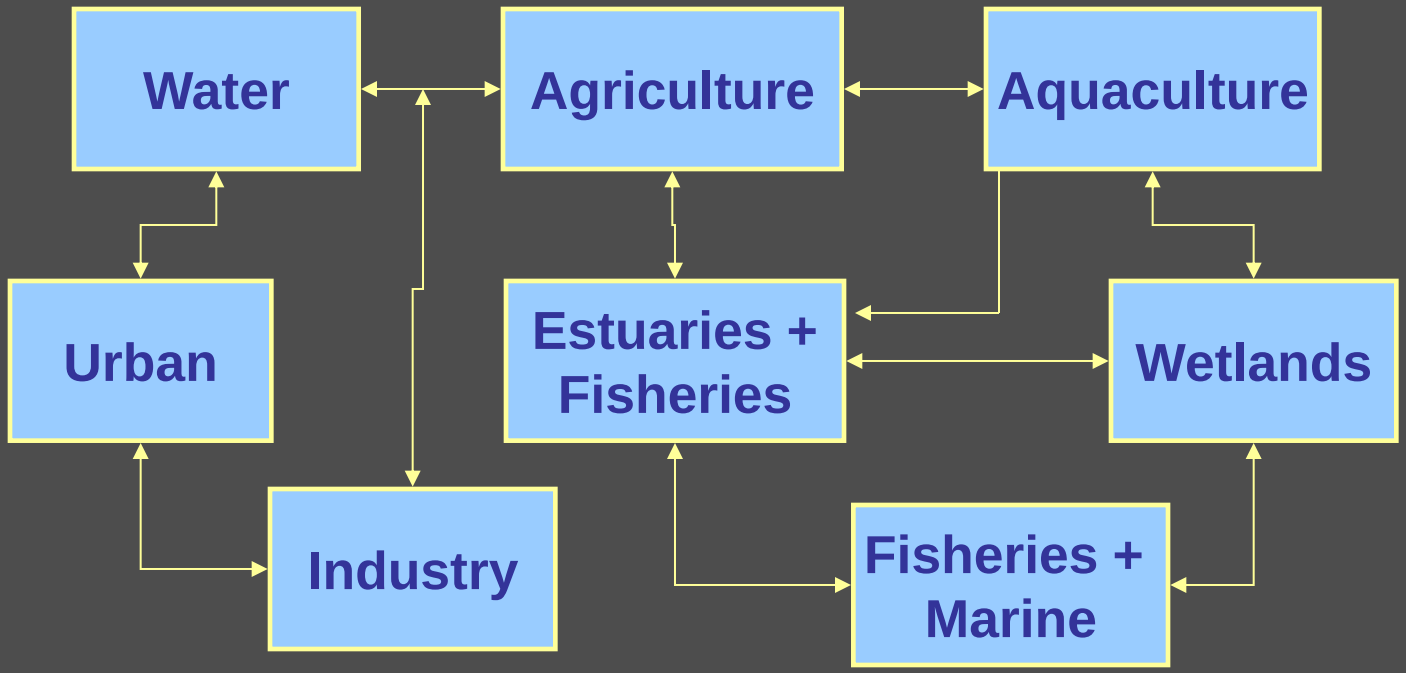
A system can also…

- **be part of a larger system.**
  - **A human may be part of a family, community, team etc.**

The earth is a system

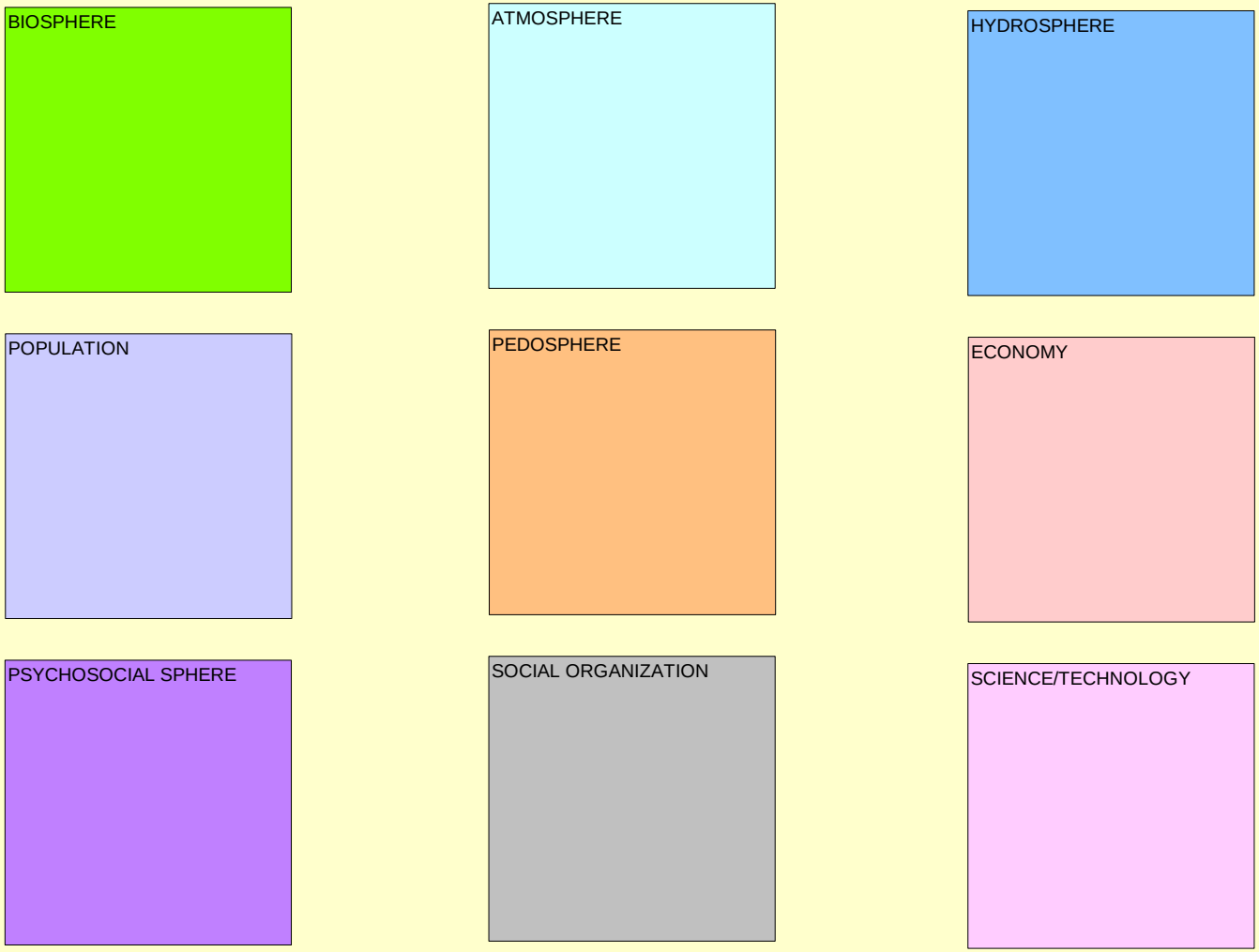
The earth system is made up of sub-systems

Sub-system Interactions

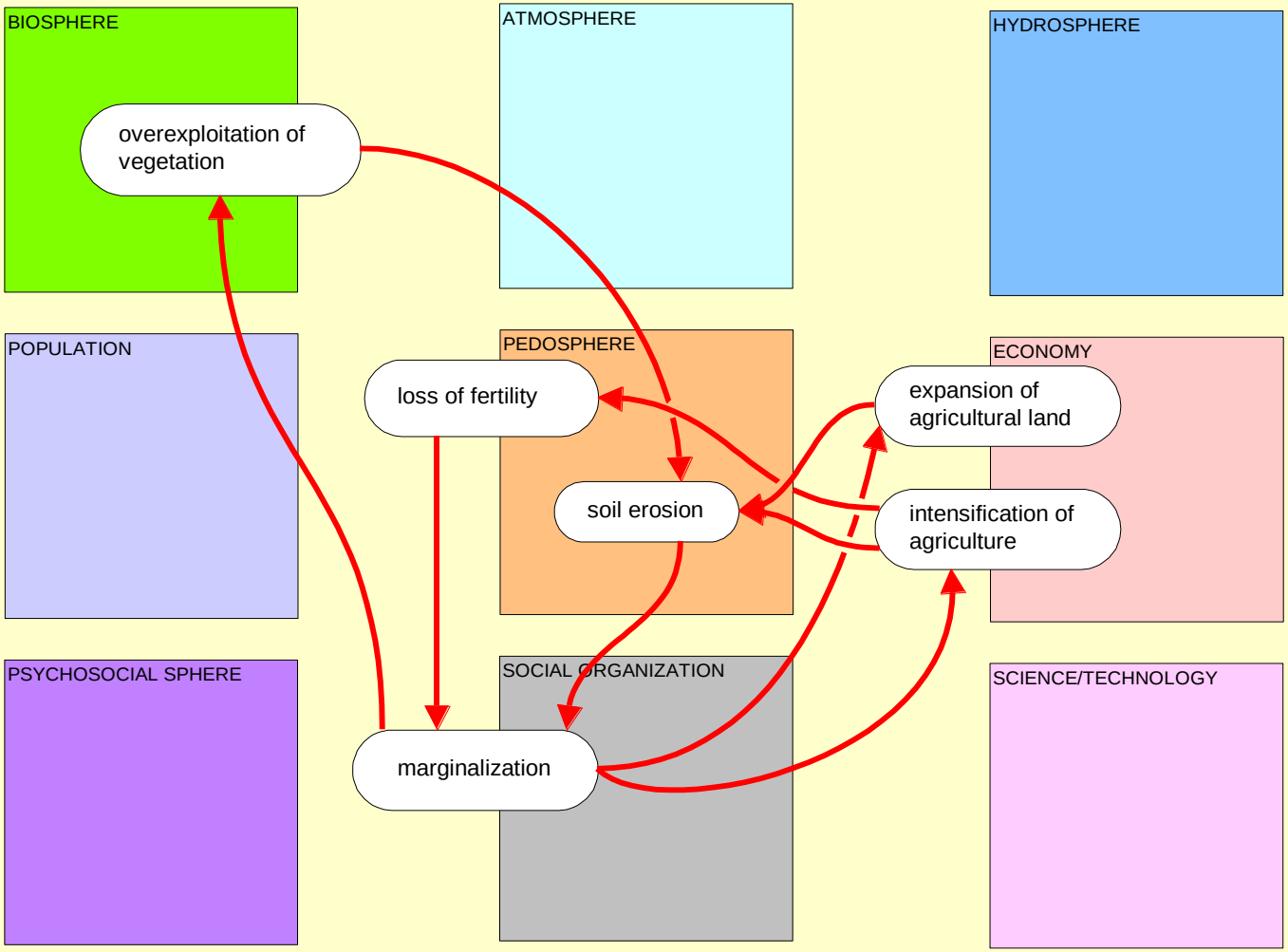


The desert is a system (and a sub-system)

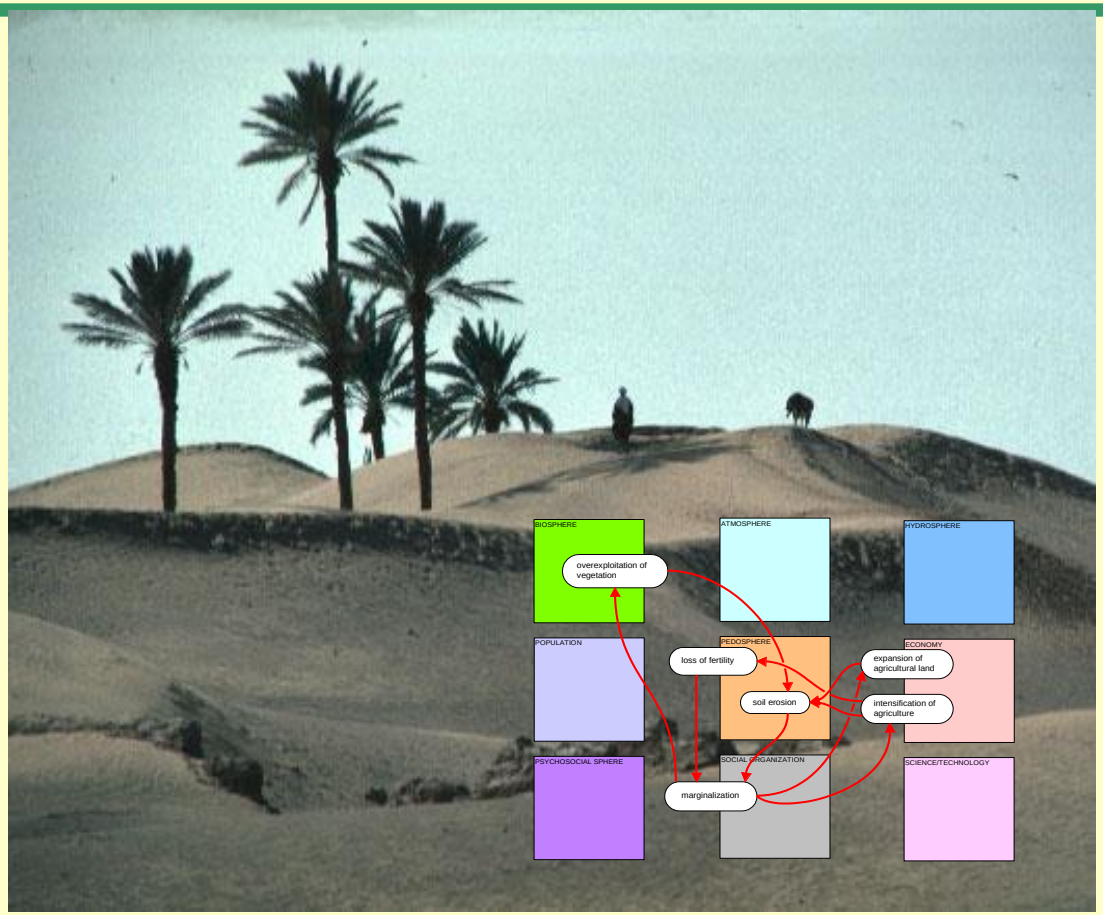
The desert subsystem has its own subsystems



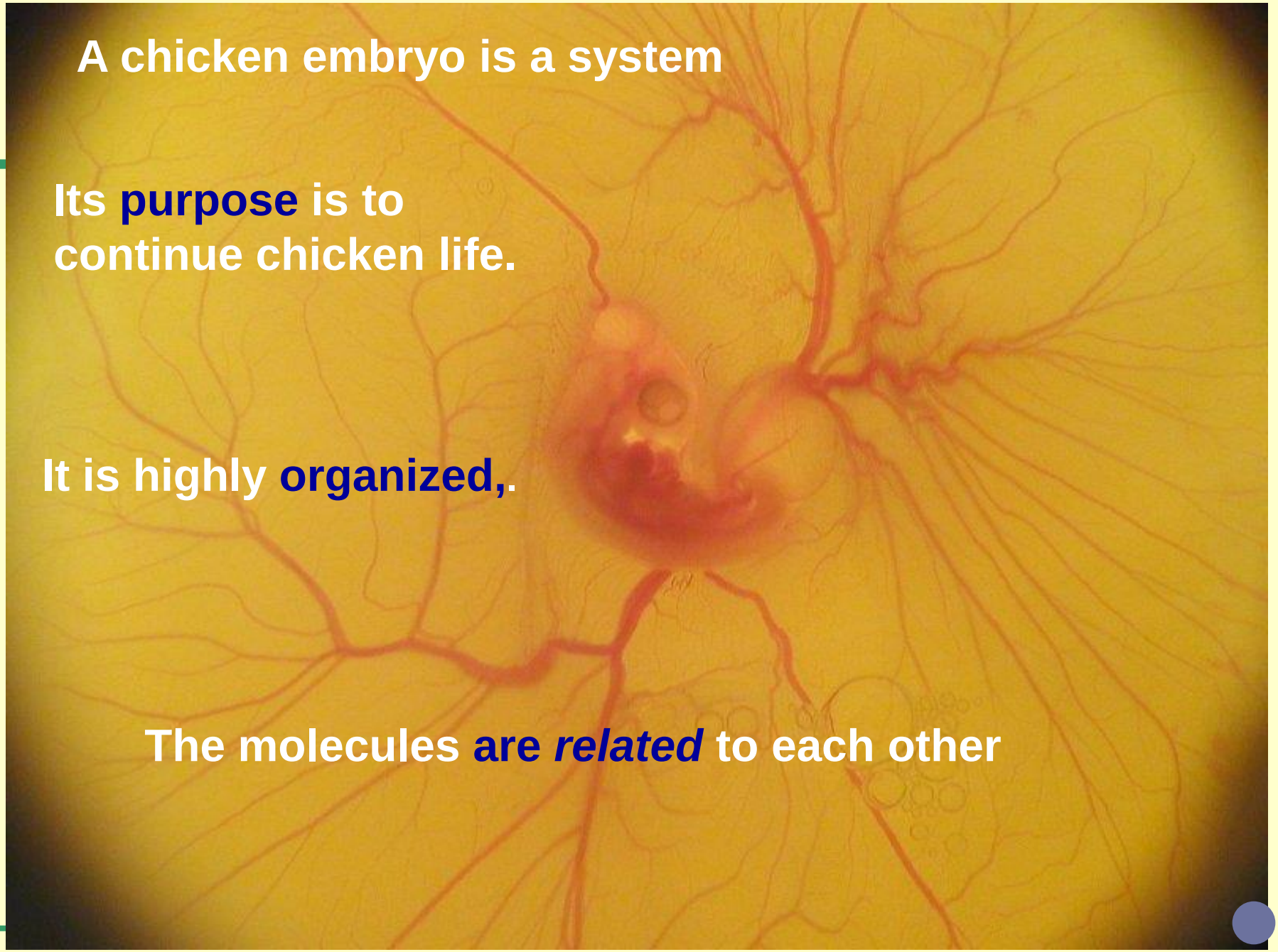
Modeling desert subsystems



Comparing the world with the model



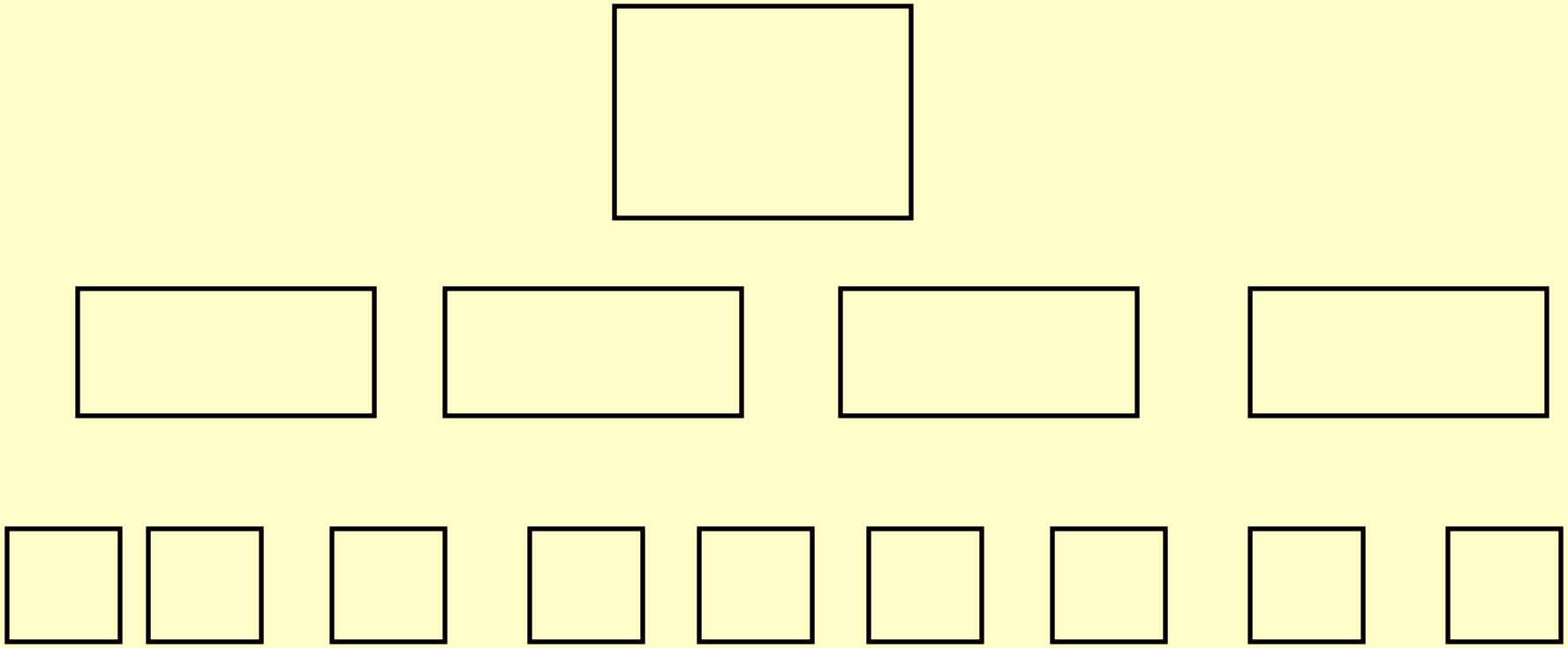
"The map is not the territory"


A chicken embryo is a system
Its purpose is to continue chicken life.
It is highly organized,.
The molecules are related to each other

A University is a System

University systems are actually complex

Our standard mental model of a university system is hierarchical

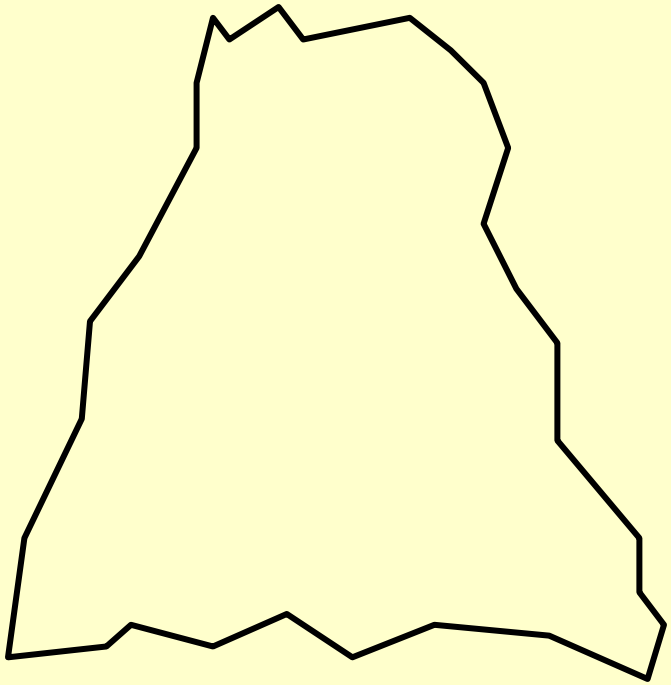


An expression of this mental model

A tool to begin unraveling complexity

The “pyramid” or “iceberg” model of systemic relationships is a simple tool to begin to unravel complexity.

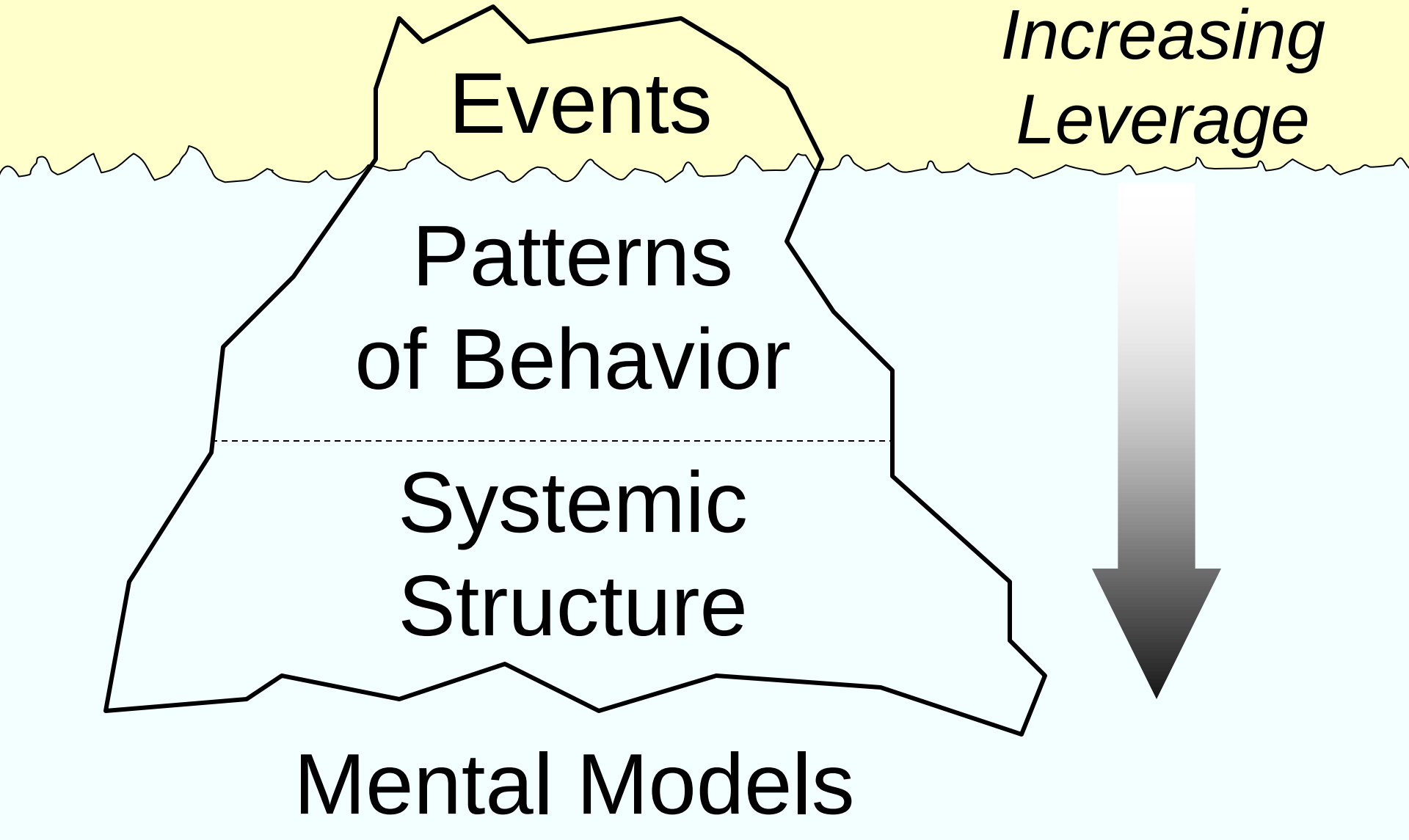
Lets look at it…..



Some Definitions

- **Events.** The things we see happening (and sometimes wonder why).
- **Patterns of Behavior.** Consistent and regular actions or events.
- **Systemic Structure**. Physical portions, relationships and the flows of information between parts of the system.
- **Mindset or Mental Models**. The shared belief systems, ideas, assumptions and goals of a community. Usually unstated but universally understood.

The Iceberg

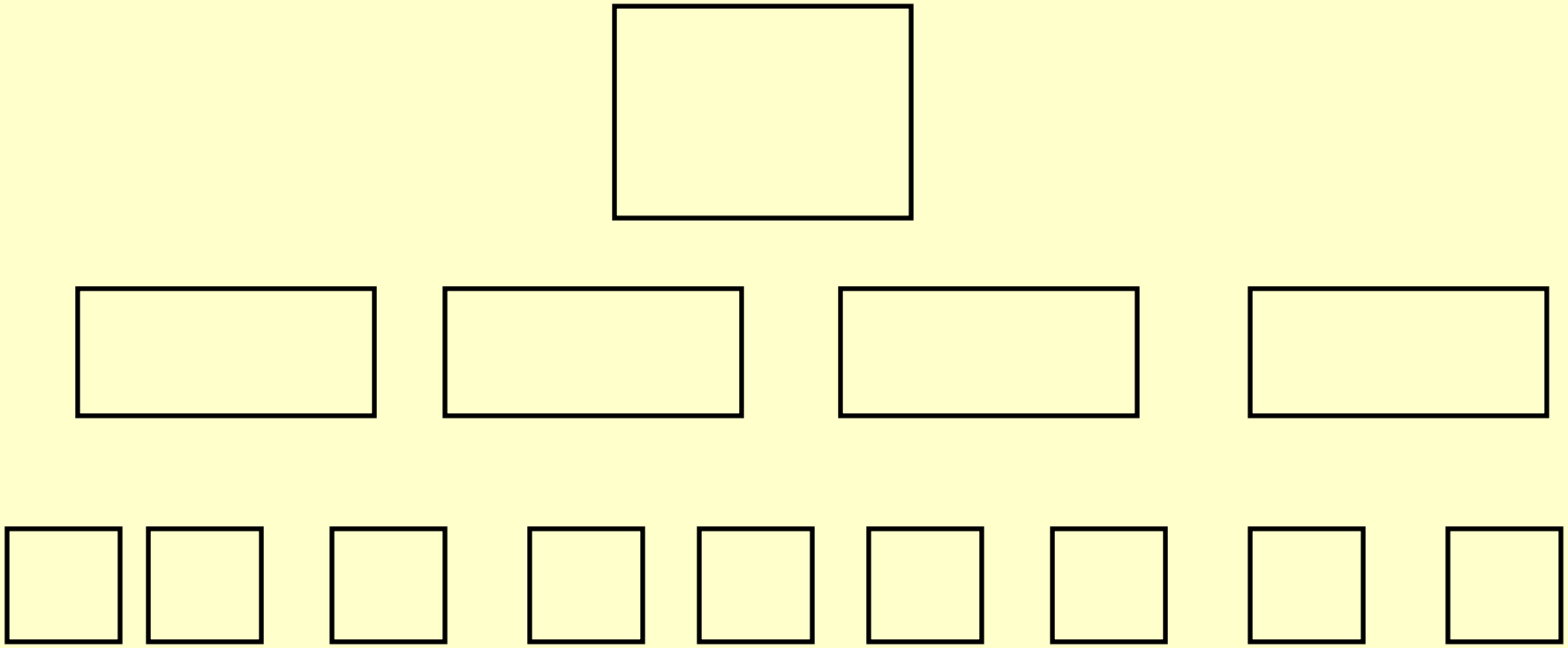

Events
Increasing Leverage
Patterns of Behavior
Systemic Structure
Mental Models

"***The problems that we have created cannot be solved at the level of thinking that created them.***"

-Albert Einstein

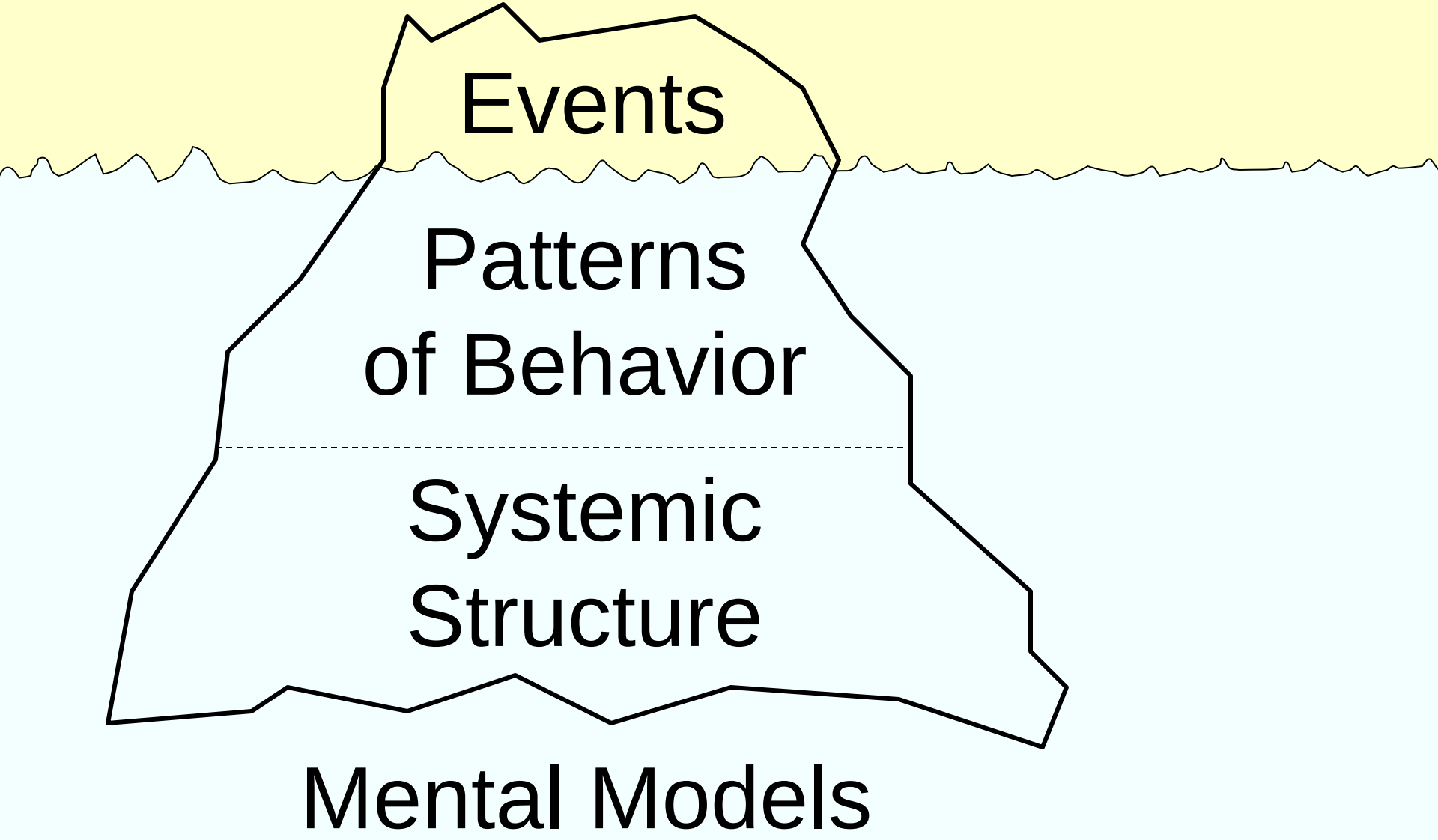
A pattern of behavior

A systemic structure



The mental model

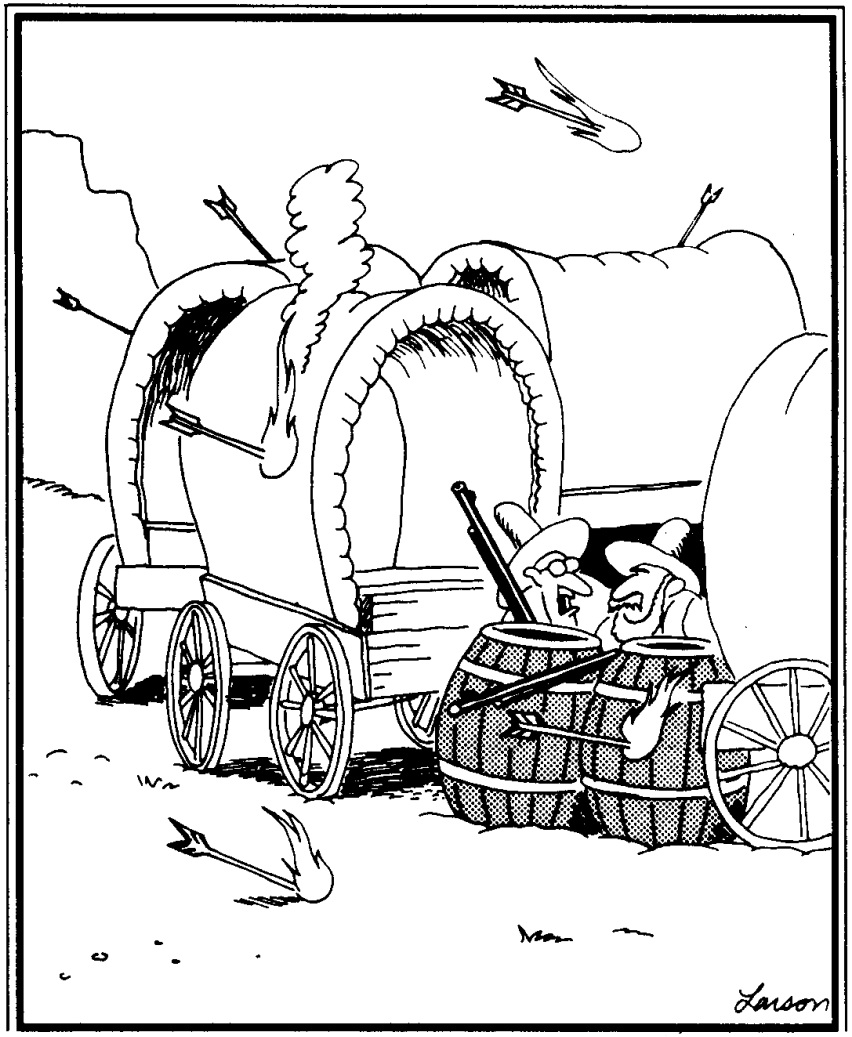
Systems thinking looks below events and patterns of behavior



Systems Tools:

- Move focus away from events and behavior (which are symptoms) and toward system structure and the underlying mindset

Sometimes we get stuck in our mental models following rules that don't really exist

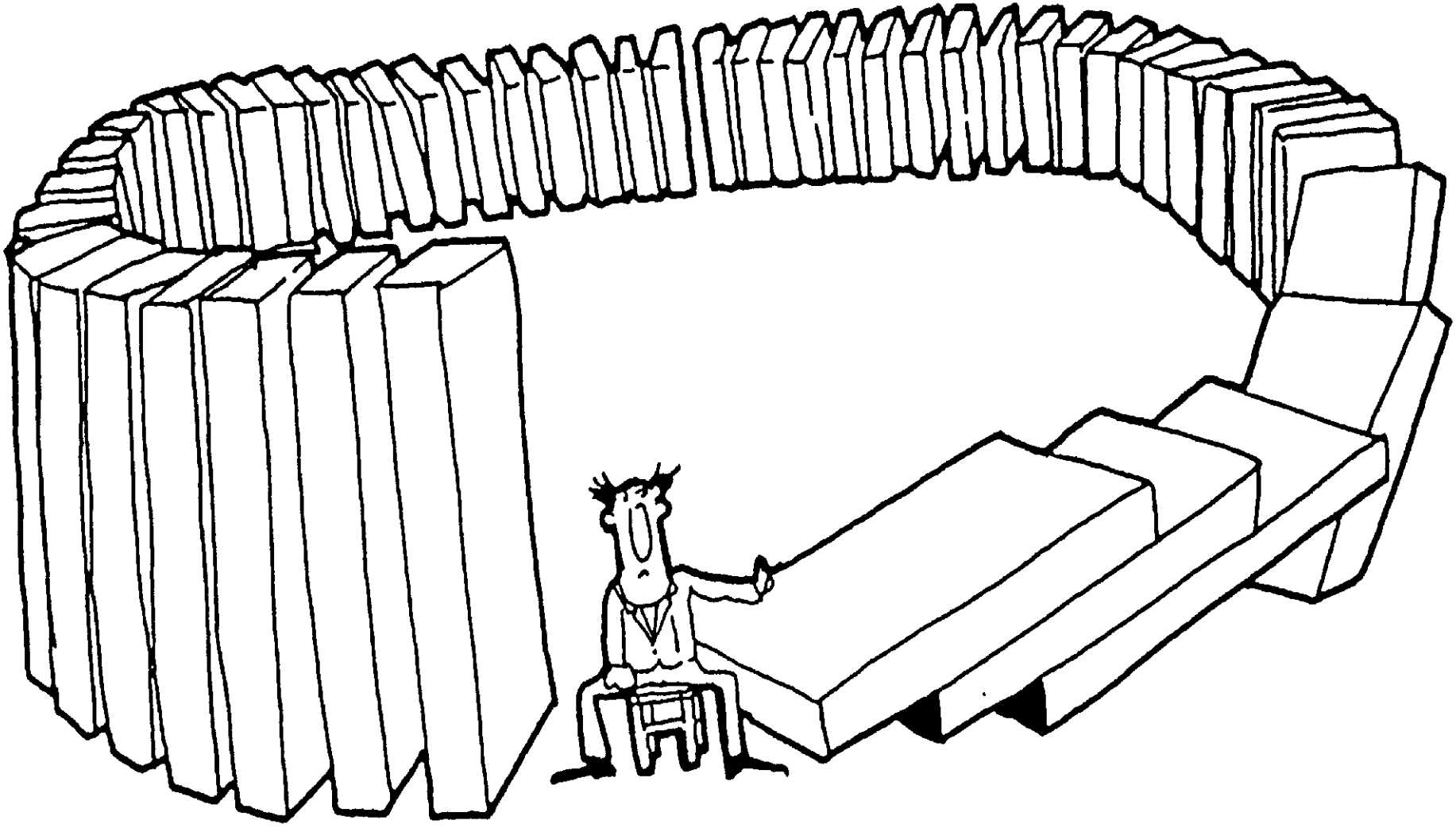


"Hey! They're lighting their arrows!...Can they *do* that?"

Systems Tools:

- Help us to see “cause and effect” over long periods of time and far away in space

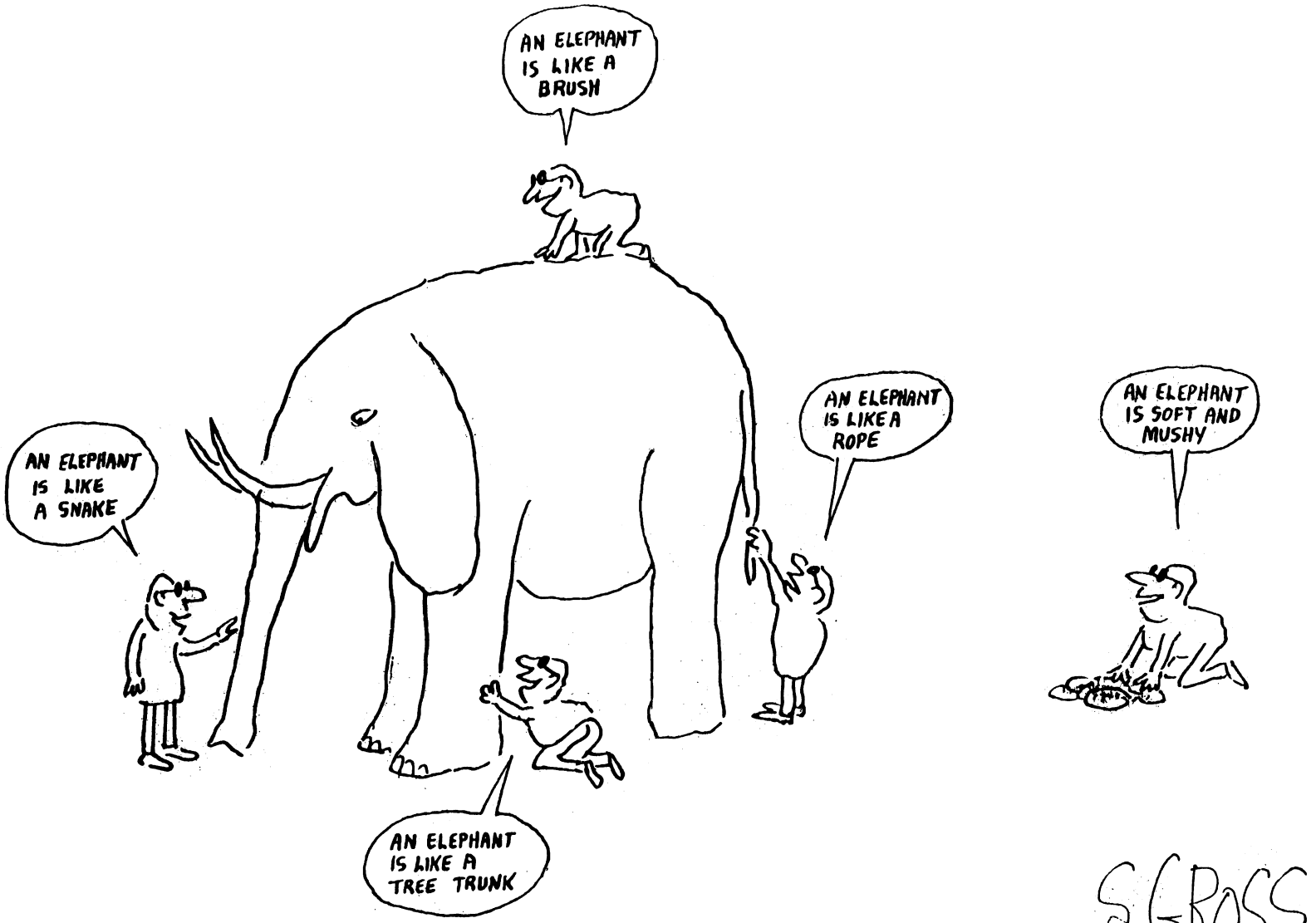
In complex systems, cause and effect are distant in time and space



Systems Tools:

- Help us to see the “whole”

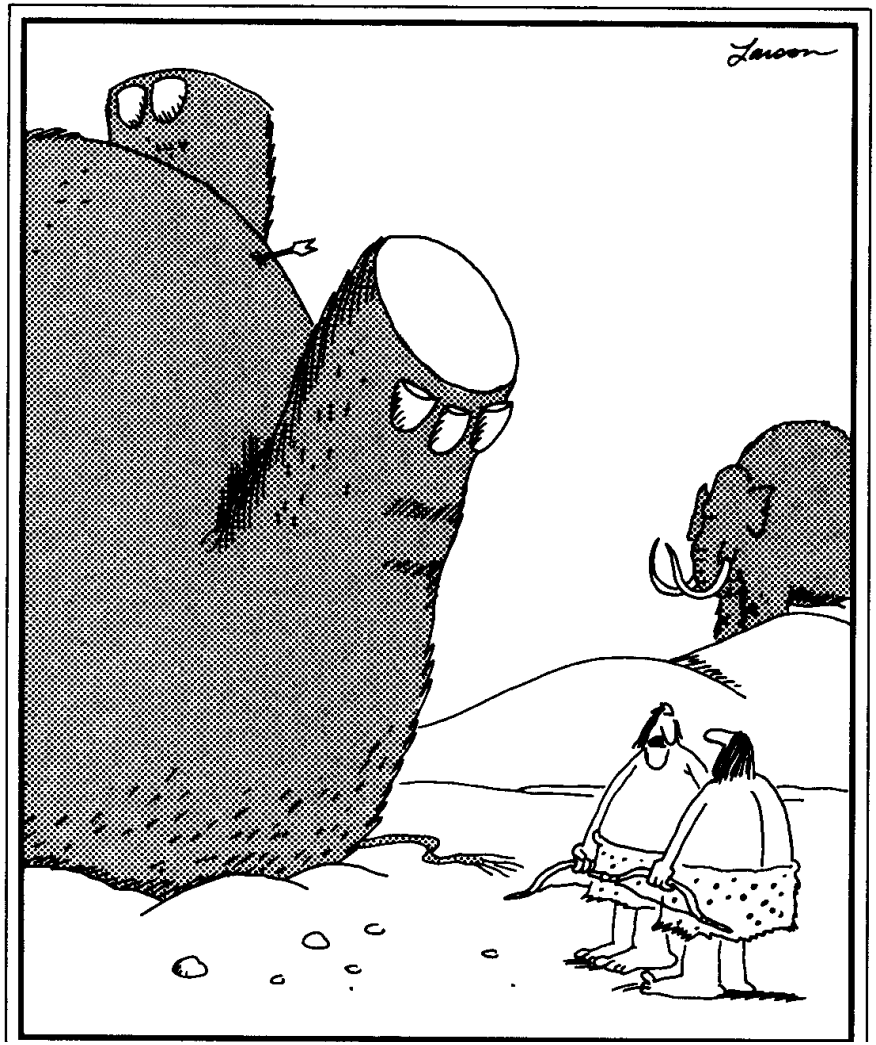
We sometimes fixate on our part of the system, and miss the whole



Systems Tools:

- Help us to find the leverage points for systemic change.

A leverage point – where small action yields large results



"Maybe we should write that spot down."

Changing Systems – We Have A Long History of NOT Finding Leverage Points

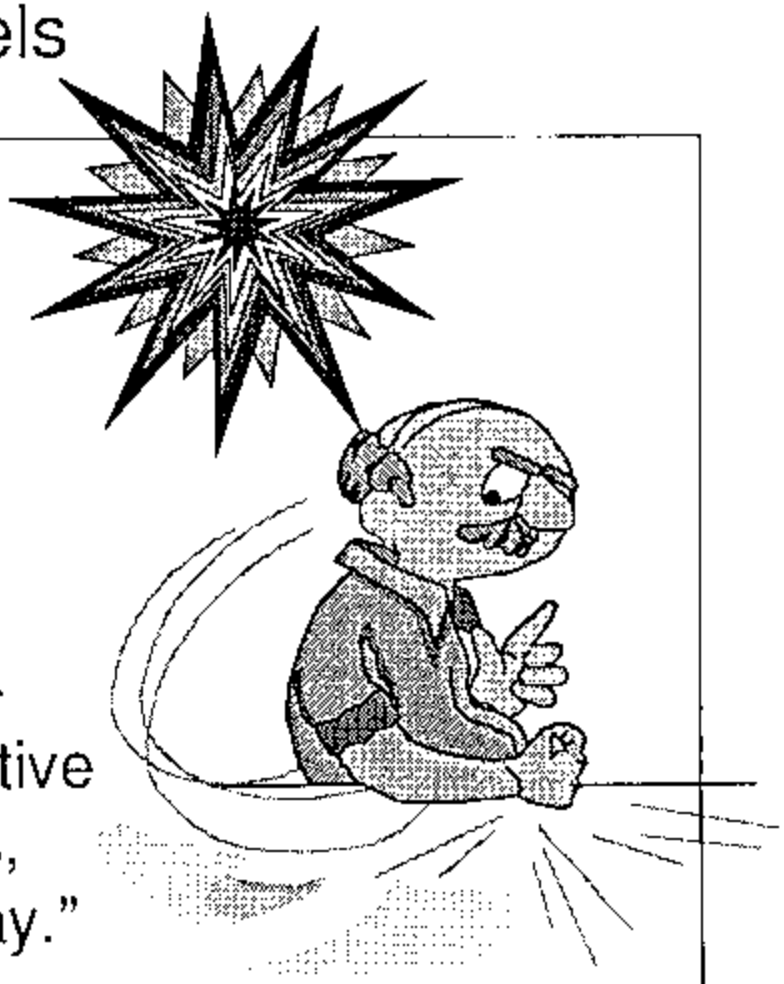
- Paving dirt roads in mountain areas leads to **decrease** in safety
- Low tar and low nicotine cigarettes actually **increase** intake of carcinogens, CO, etc.
- US policy of fire suppression has **increased** the size and strength forest fires in many areas
- Road building programs designed to reduce congestion have **increased** traffic, delays, and pollution.

Systems Tools:

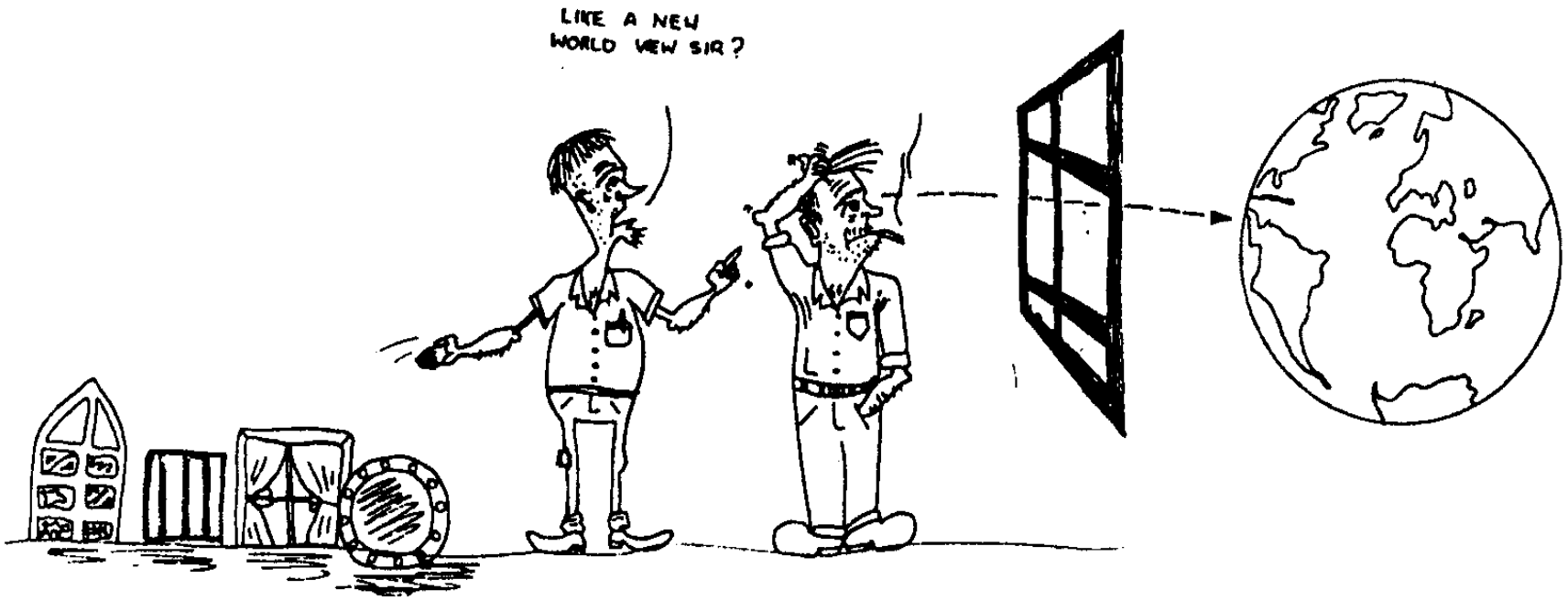
- Help us to see how our old mental models get in the way of new ideas.

Mental Models

"Mental models are the images, assumptions, and stories which we carry in our minds of ourselves, other people, institutions, and every aspect of the world. Like a pane of glass framing and subtly distorting our vision, mental models determine what we see...they are congnitive mental maps; and all of these maps, by definition, are flawed in some way."

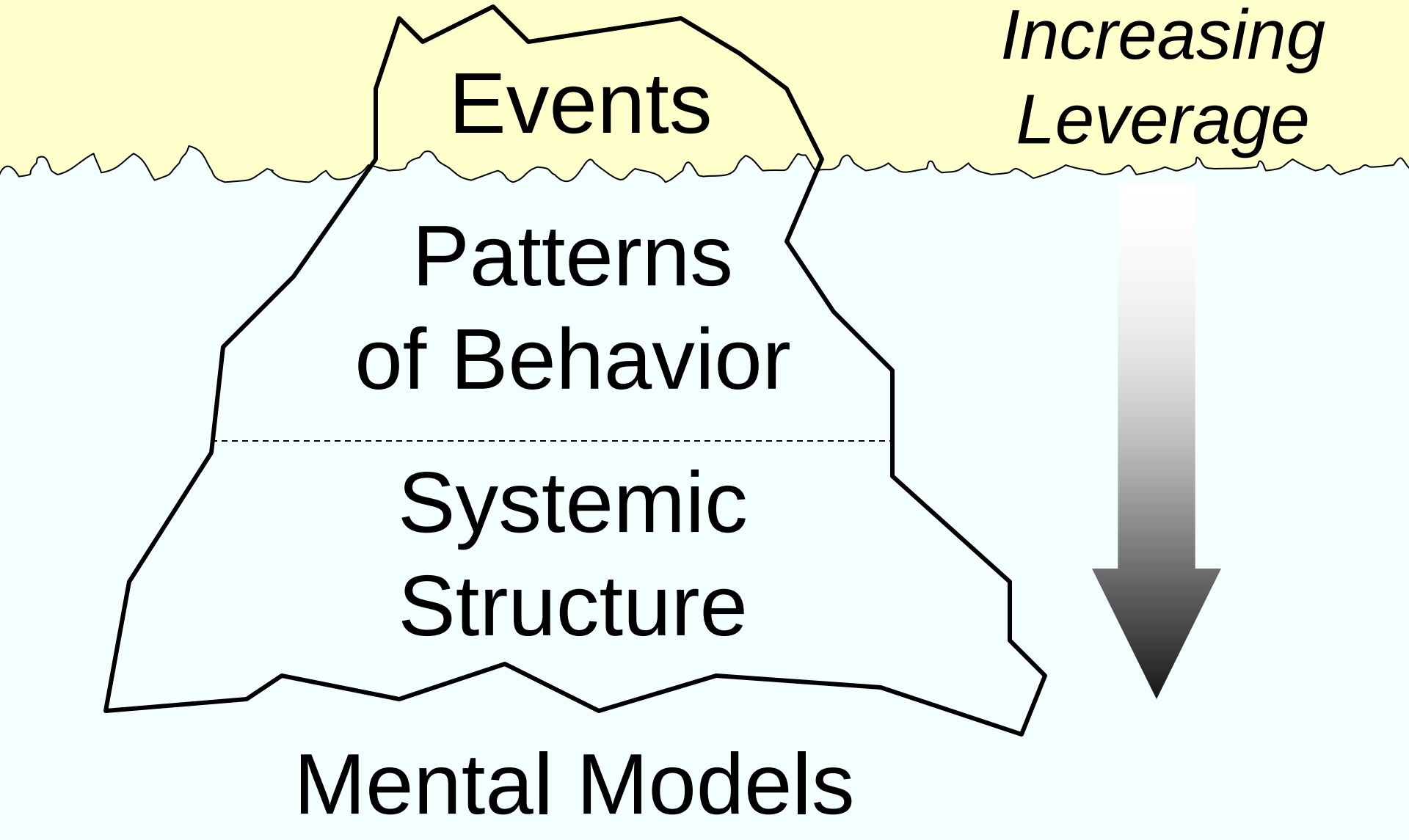


Systems Thinking is a new “window on the world”



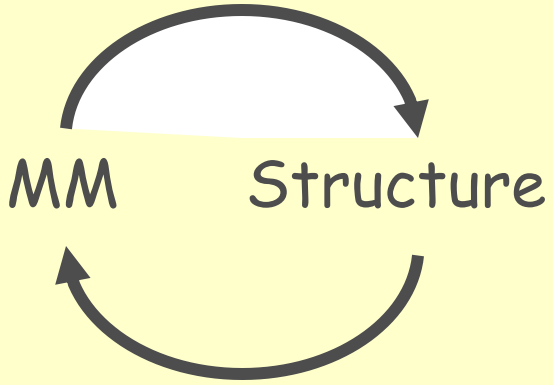
We all have a different ‘window’ on the world!

The Iceberg


Events
Increasing Leverage
Patterns of Behavior
Systemic Structure
Mental Models

Why Transforming Mental Models Helps Change Structure

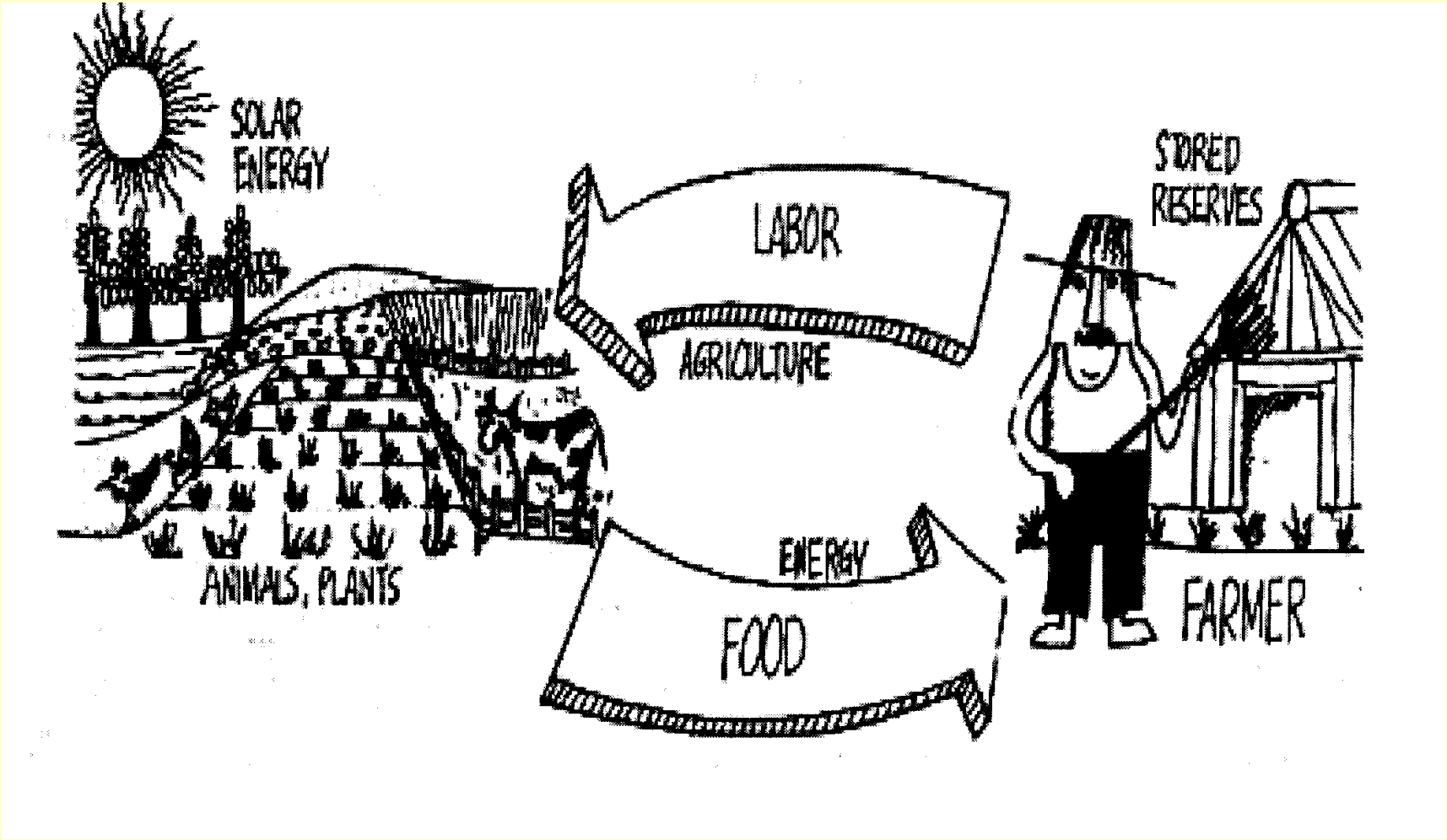
- Our current mindset prevents us from seeing and using existing opportunities for structural changes that could help solve a problem
- Changing our mindset allows us to choose or create new possibilities for action
- Incremental changes in one tend to lead to incremental changes in the other



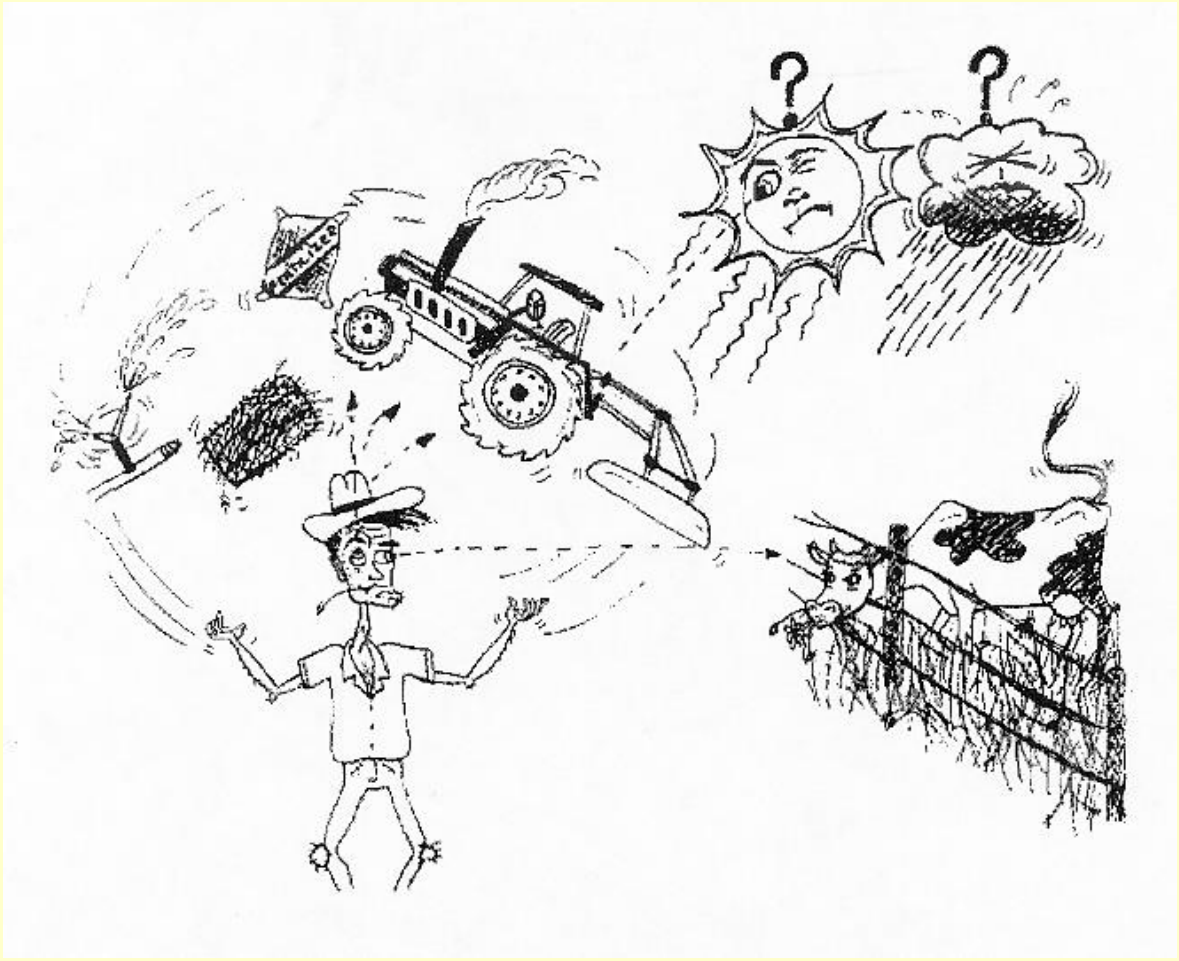
Bottom Line on Shifting Mental Models

- Bring attention to ways the old mindset leaves problems unsolved
  - **Point out the anomalies (what's not working)**
  - **Try to do this without judgment (hey, look at that!)**
- Communicate the new mindset clearly
  - **Without an alternative, we can't even see the problem**
- Solve problems by acting out of new mindset
  - **Try something new – reward failure**

Farming systems are simple



Farming systems are a mess….



Is there any evidence?

- Environmental
- Economic
- Social

Is it economically viable?

1935 – 6.8 million farms

- Today – 1.3 million farms

&

McDonalds increased from 1000 restaurants in 1968 to 28,000 today, with 5 new ones each day

&

Suicide rate among American farmers and ranchers is 3X national average

Is it environmentally sound?

Dead Zone in the Gulf of Mexico from nitrogen fertilizer

- Chemical fertilizer use has increased 10X since 1950

Is it socially just?

- Farm workers
- Meatpacking plant workers
- Fast food workers
- One billion under-nourished

- *Is it sustainable if one child is hungry?*

A mess = system in disorder

Messy situations…

- Are unbounded
- Have long, uncertain timescales
- Can’t be disentangled from their context
- Often have ill-defined problems
- Have broad and uncertain implications

- ….. are messy!

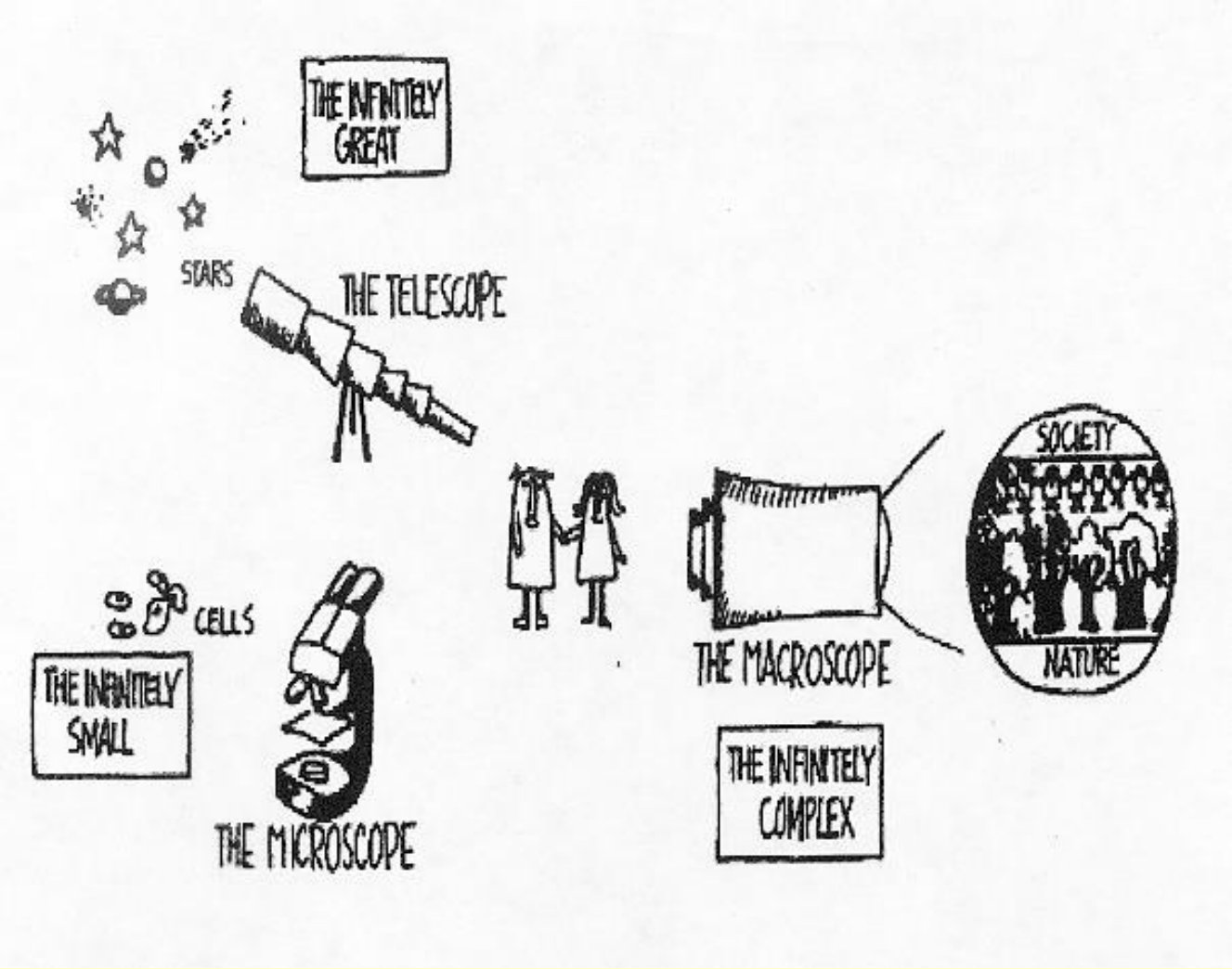
Agricultural Science….

- Has created many tools that are useful for understanding levels of complexity from the organism “down”
  - Organism - cow
  - Organ - stomach
  - Cell – stomach wall cell
  - Molecule – molecular biology

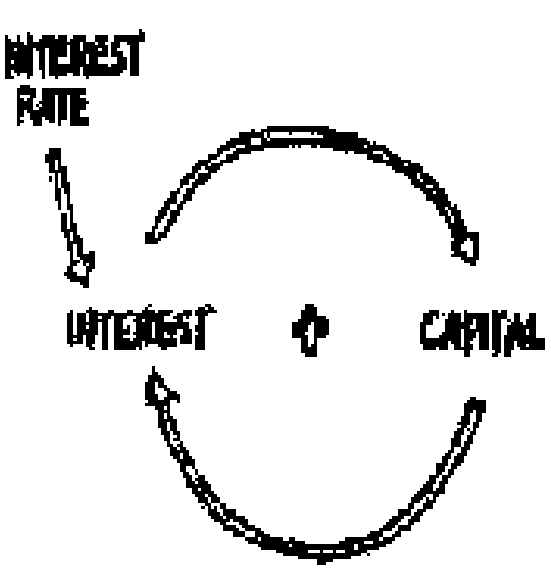
Agricultural Science…

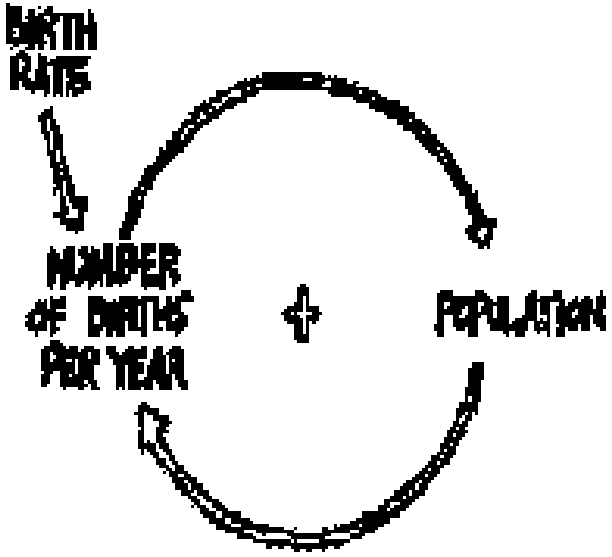
- Has created few tools that are useful for understanding levels of complexity from the organism “up”
  - Agro-ecosystem – cow in its environment
    - Community – cow & grass
      - Population - herd
        - Organism - cow

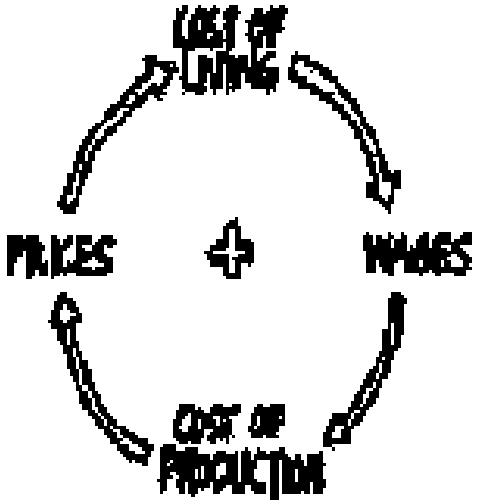
We need new tools!



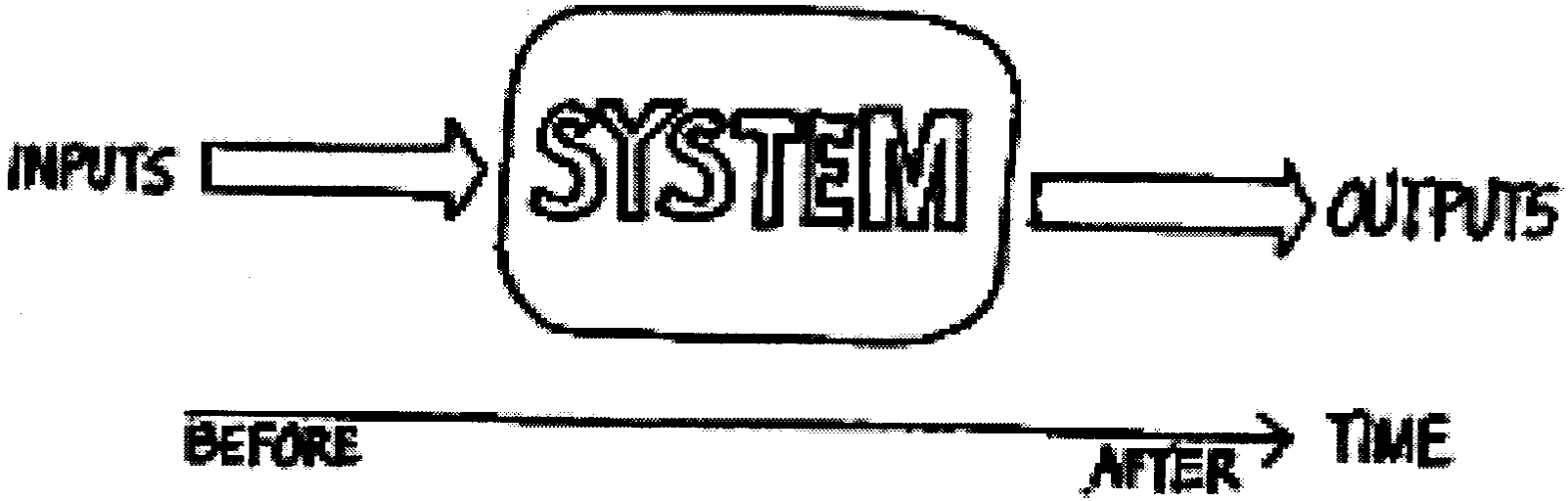
Like feedback loop diagrams…



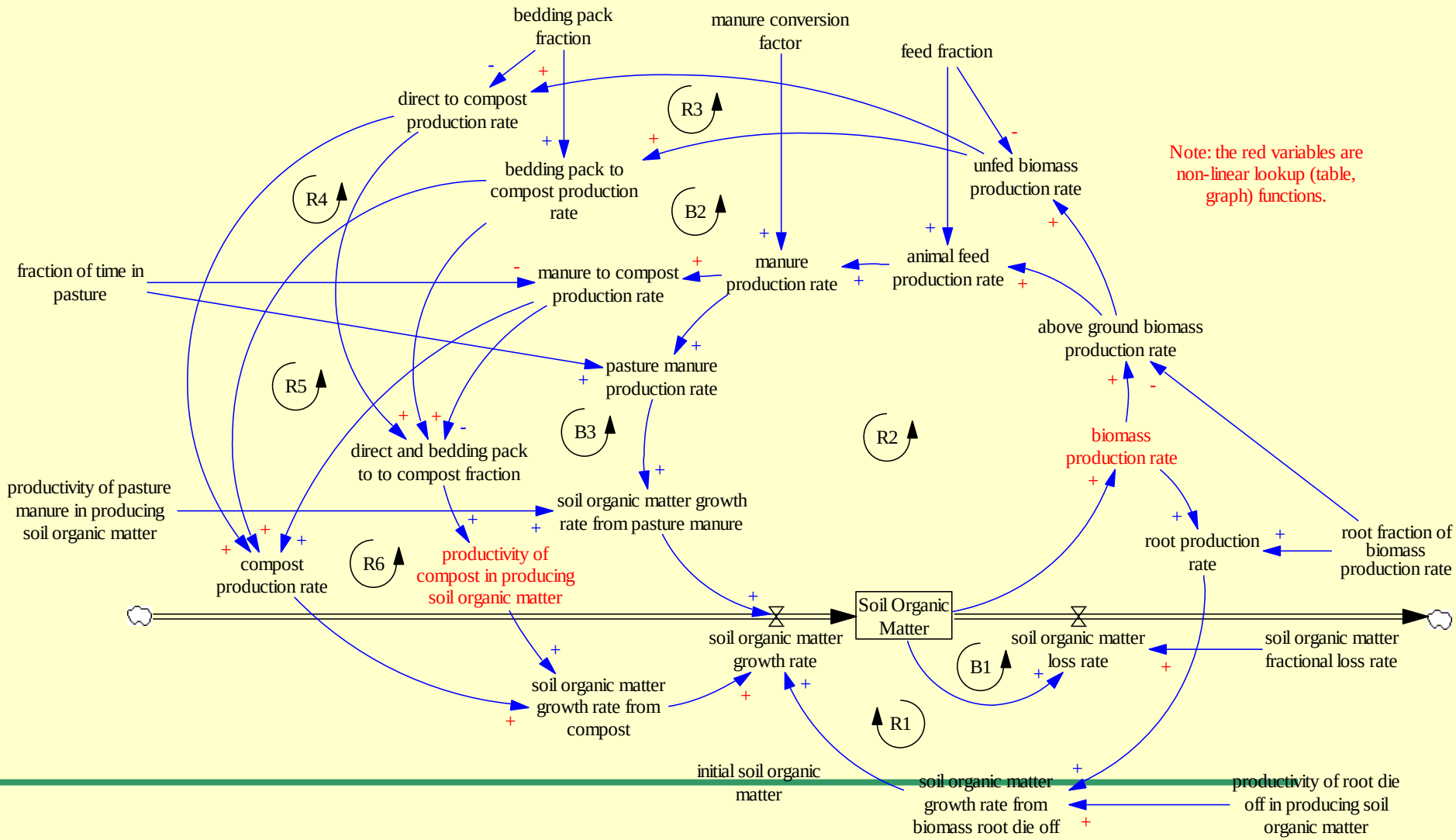




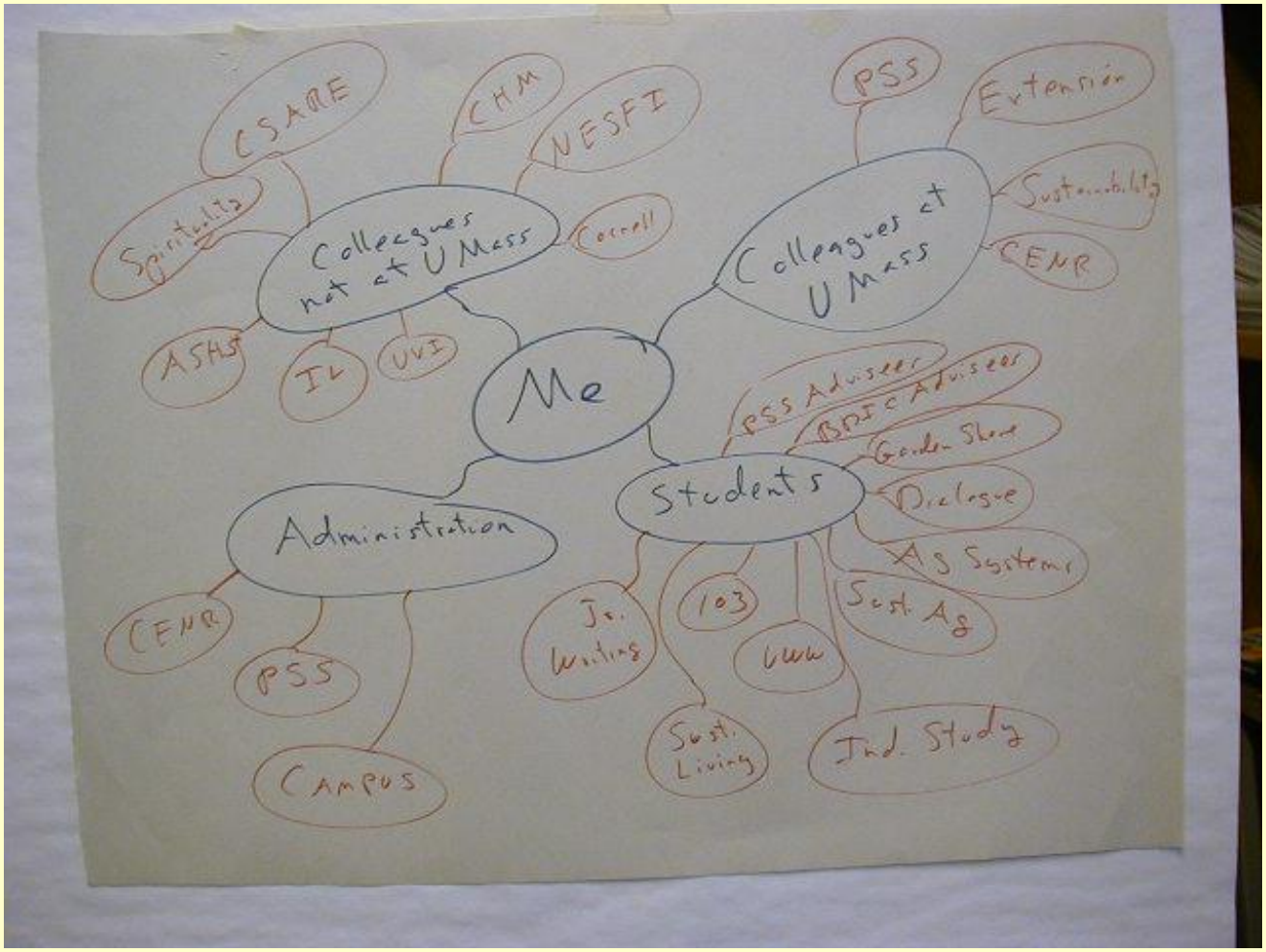
And stock and flow diagrams….



And Dynamic Systems Models

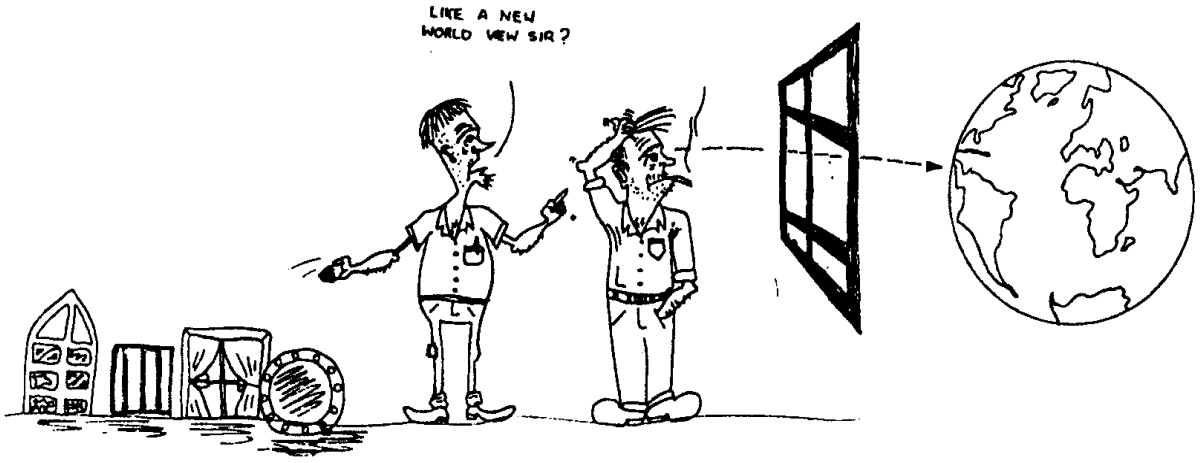


And mind maps…..



We need new “lenses”

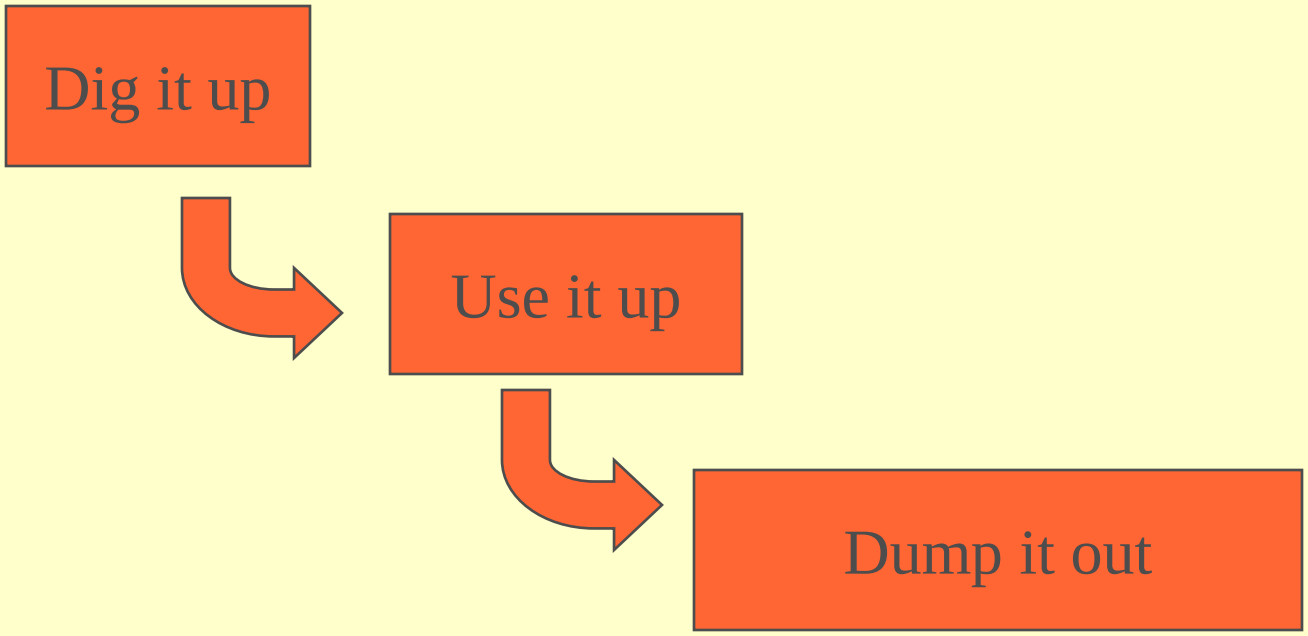
Systems Thinking is a new “window on the world”



We all have a different ‘window’ on the world!

Industrial Agriculture is Linear

- One way ticket!



But there are limits …

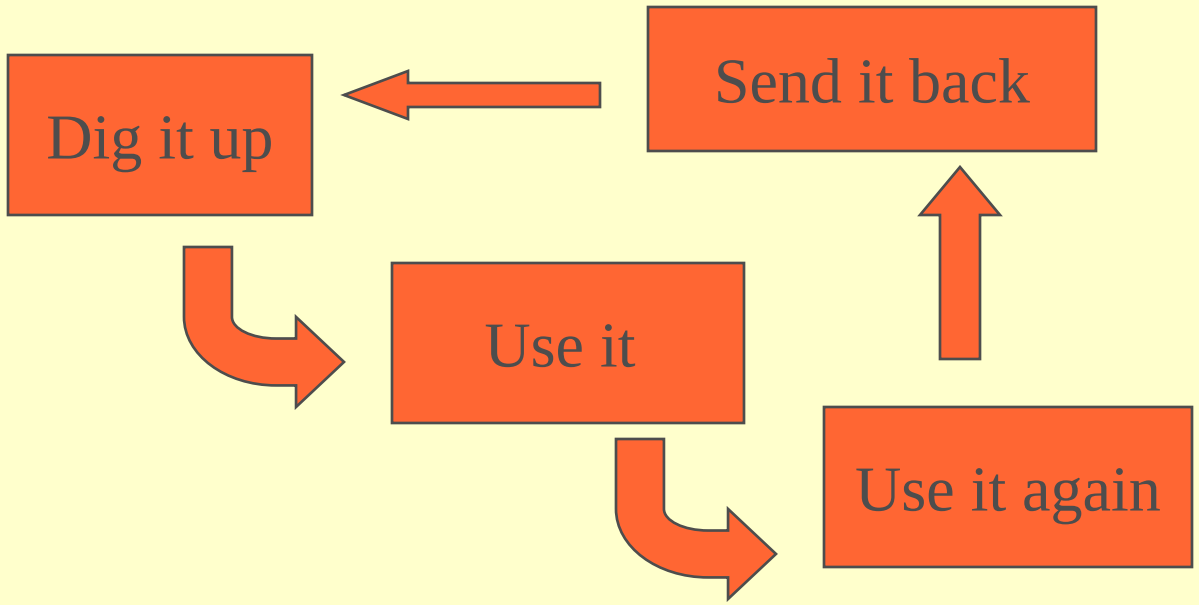
- Both the source and the sink!

Source is limited

Sink is limited

The answer is to think in cycles!

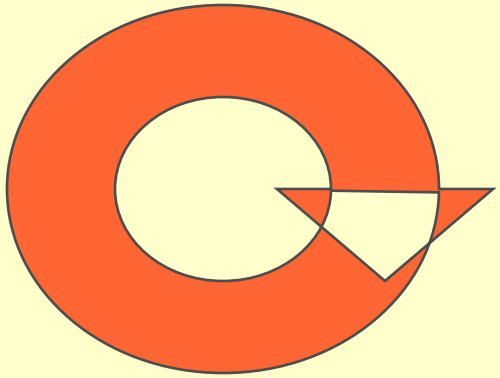
- A return ticket!



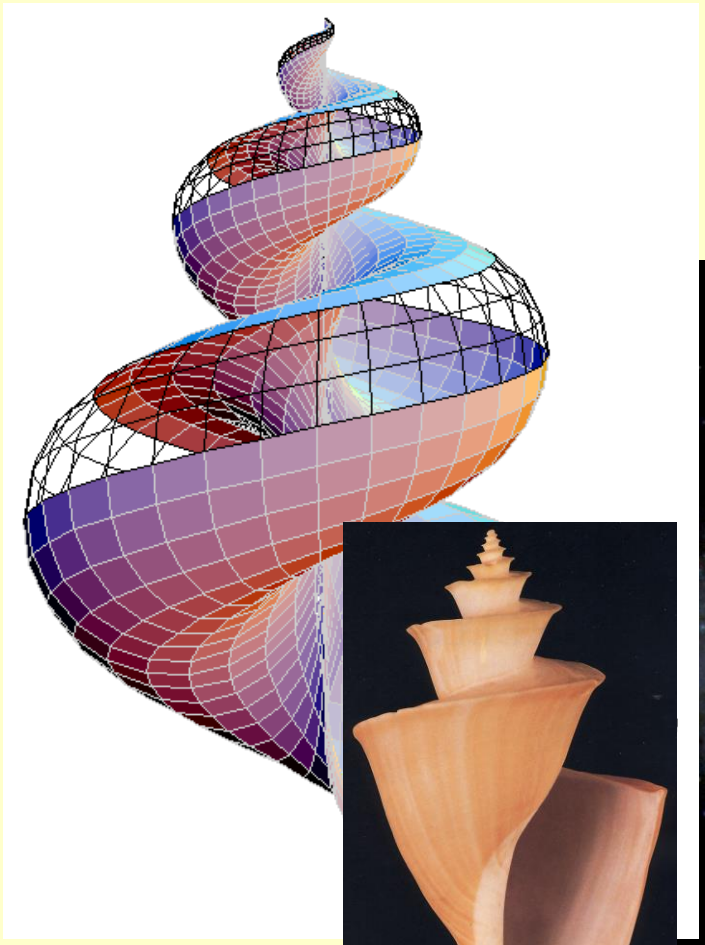
Two paradigms

- Industrial Agriculture = linear

- Sustainable Agriculture = cyclic



Spirals of change



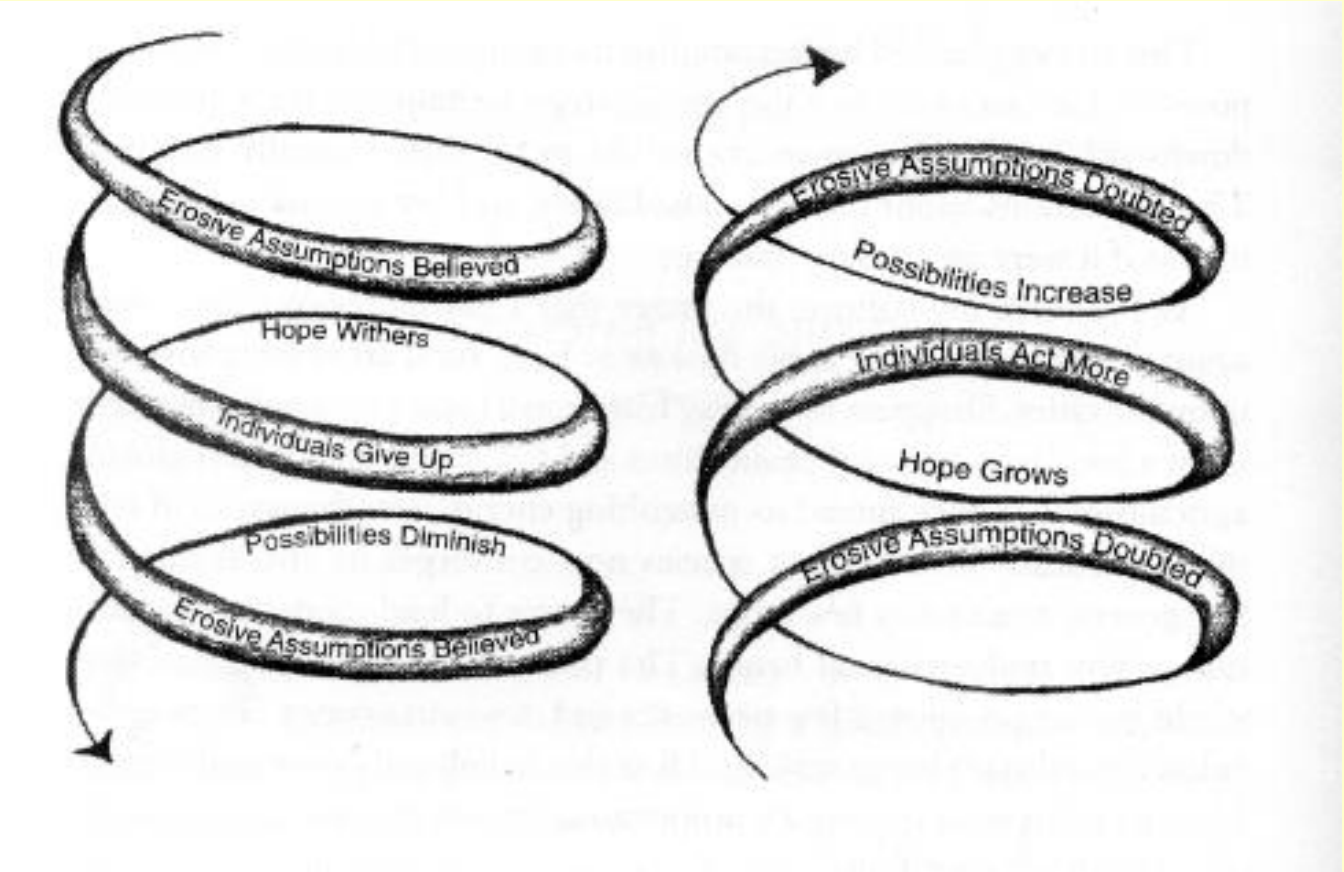
Feedback loops are powerful

- We know about “vicious” cycles
  - *Hate breeds hurt - hurt breeds hate…hate breeds hurt….*
  - Addictions – *I feel bad so I “take something” – I feel better for a while, but then…..*

Feedback loops are powerful

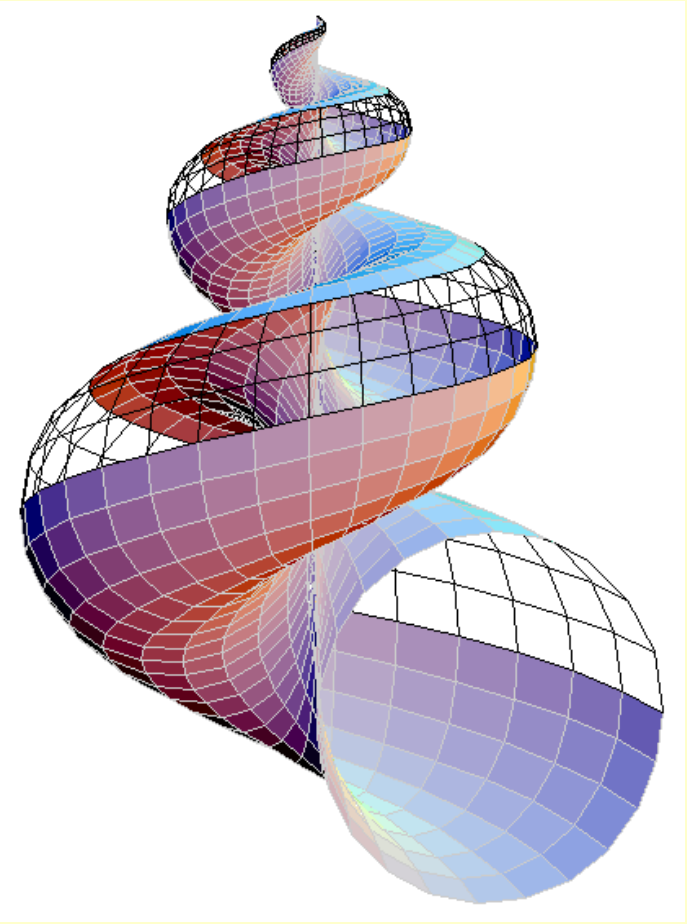
- Did you know there were “virtuous” cycles as well?
  - *Add worms to your compost*
  - *Smile*
  - *Hold the door open for someone*
  - *Make salt (April 6, 1930)*

Spirals of Change



From; ***Seeing Nature*** by Paul Krafel, the text for PLNTSOIL 597S, **Ag Systems Thinking**

Downward spirals



- ***Erosive assumptions believed***
- ***(One person can't make a difference)***
- ***Hope withers***
- ***Individuals give up hope***
- ***Possibilities diminish***
- ***Erosive assumptions believed***

Upward spirals

- ***Erosive assumptions doubted***
  (Is it true that one person can't make a difference?)
- ***Hope grows***
- ***Individuals act more***
- ***Possibilities increase***
- ***Erosive assumptions doubted***

Doubting assumptions like…

- *One person can't really make a difference*
- *The world was made for humans to use*
- *Humans are not a part of nature*
- *I am an individual, separate from you*

Thinking in cycles & spirals

The circle of life

Albert Einstein wrote….

- *"The world we have made as a result of the level of thinking we have done thus far creates problems we cannot solve at the same level of thinking at which we created them."*