Faculty of Design

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A systems literacy manifesto

Dubberly, Hugh

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A Systems Literacy Manifesto

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www.dubberly.com/presentations/system_literacy.pdf

"…there is a good deal of turmoil about the manner in which our society is run

….the citizen has begun to suspect that the people who make major decisions that affect our lives don't know what they are doing.

…because they have no adequate basis to judge the effects of their decisions."

— C. West Churchman, 1968

“Government is not the solution to our problems; government is the problem.”

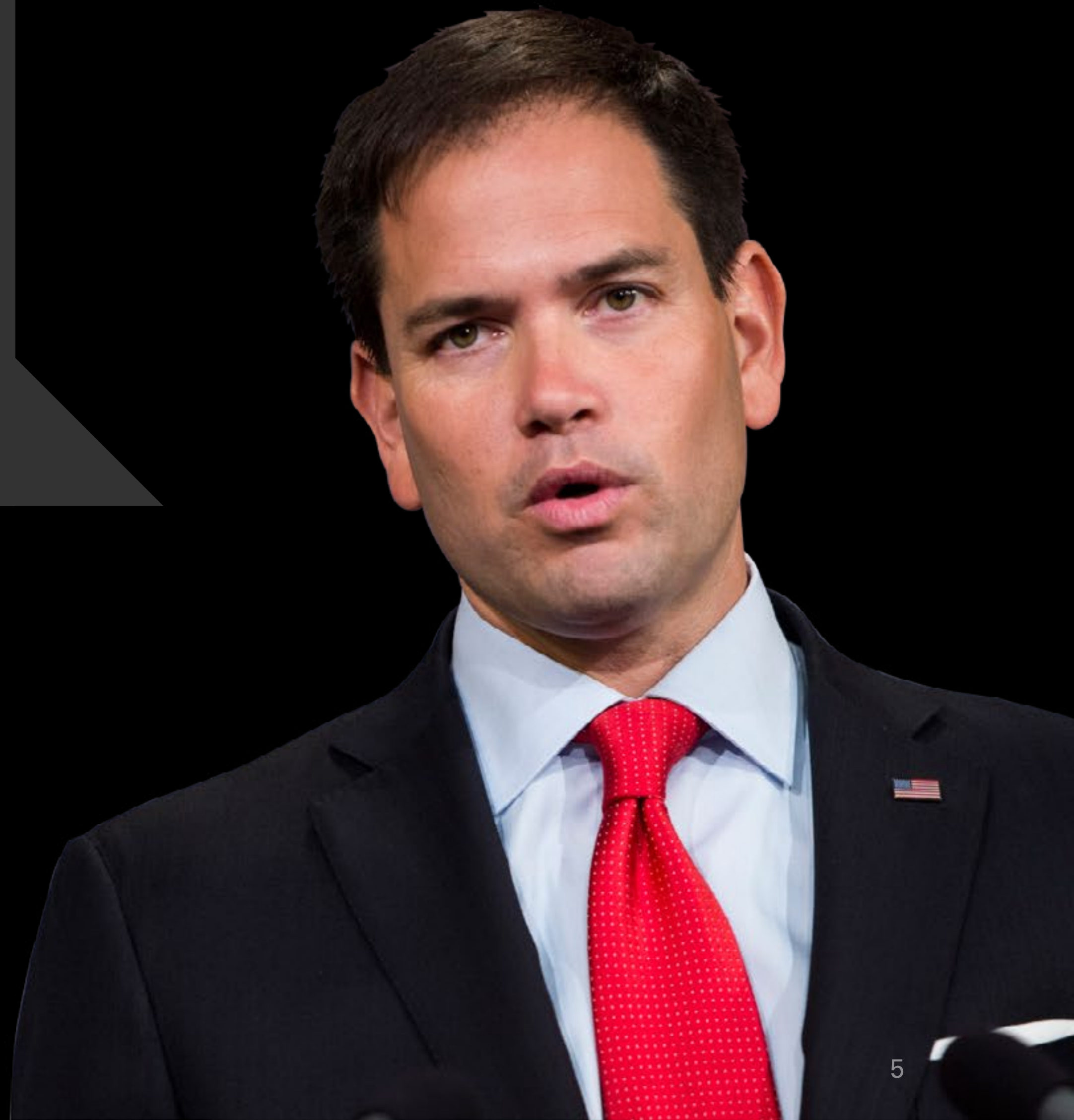
— Ronald Reagan, 1981

“Those of us who have looked
to the self-interest of lending institutions
to protect shareholders’ equity,
myself included,
are in a state of shocked disbelief.”

— Alan Greenspan, 2008

“I do not believe that human activity
is causing these dramatic changes
to our climate
the way these scientists are portraying it…”

— Marco Rubio, 2014
(U.S. Senator and candidate for President)



Decision makers “not knowing what they are doing,” lacking “adequate basis to judge effects,” is not stupidity.

It is a type of illiteracy.

It is a symptom that **something is missing** in public discourse, in organizations and businesses, and in our schools.

A Systems Literacy Manifesto

**We need systems literacy—
in decision makers and in the general public.**

A body of knowledge has grown about systems;
yet schools largely ignore it.

It can be codified and extended.
**And it should be taught
in design and management schools in particular,**
but also in general college education
and in kindergarten through high school,
just as we teach language and math at all levels.

Why do we need systems literacy?

Almost all the challenges that really matter involve systems, e.g.,

- Energy and global warming
- Water, food, and population
- Health and social justice

And in the day-to-day world of business, new products that create high value almost all involve systems, too.

Alibaba.com

facebook

amazon

Google

SAMSUNG

For the public, for managers, and for designers, part of the difficulty is that these systems are

- **complex**
  made of many parts, richly connected

- **evolving**
  growing + interacting with the world

- **probabilistic**
  easily disturbed + partly self-regulating
  (not chaotic, but not entirely predictable)

The difficulty is compounded because these systems may not appear as “wholes”.

Unlike an engine or a tornado or a human being, they may be hard to see all at once.

**Systems are often dispersed in space,
their "system-ness" experienced only over time,
rendering them almost invisible.**

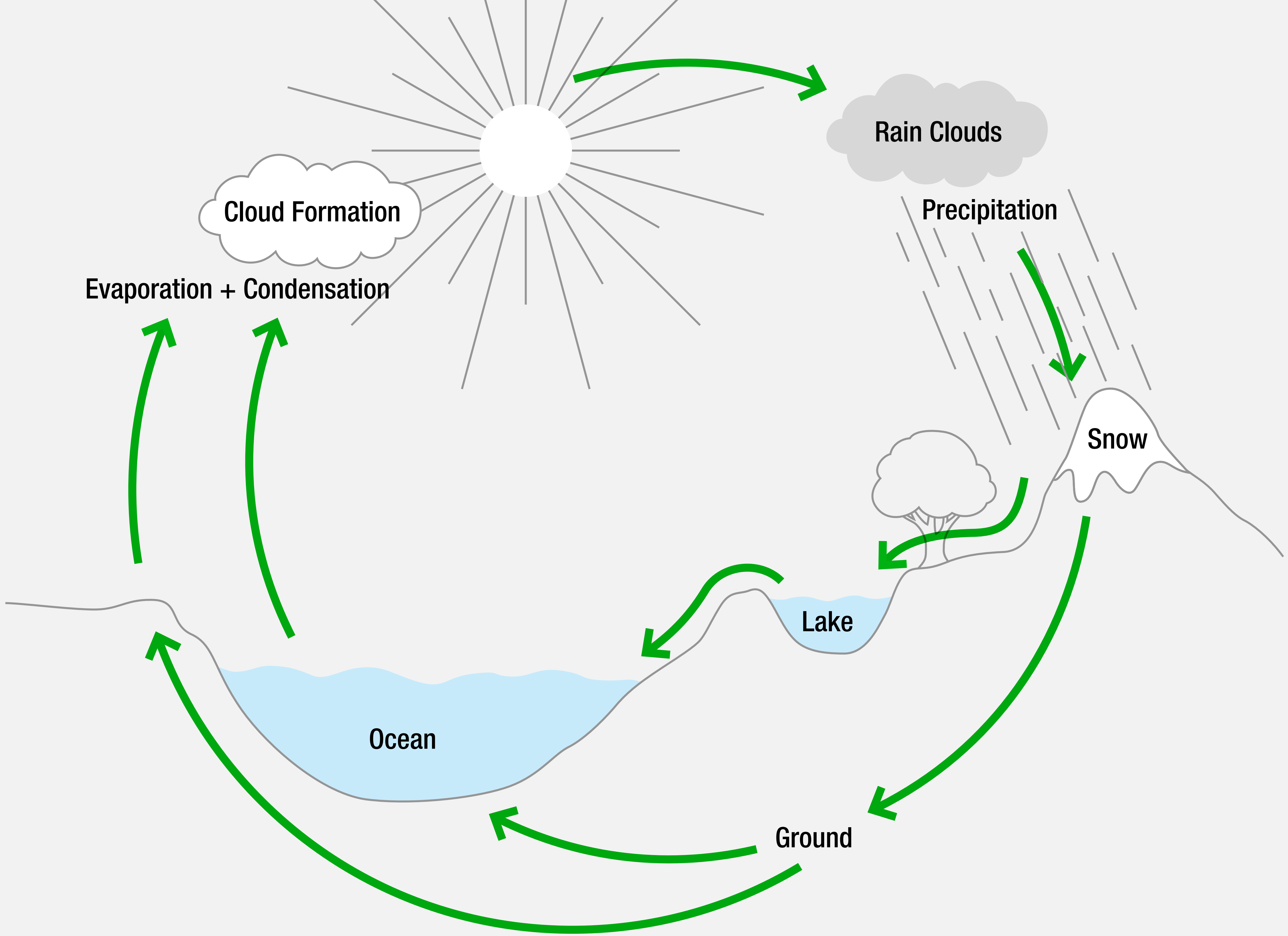
Or we may live within these systems
seeing only a few individual parts,
making the whole easy-to-overlook.

We might call these **"hidden"** systems—
or gossamer or ethereal or translucent systems.

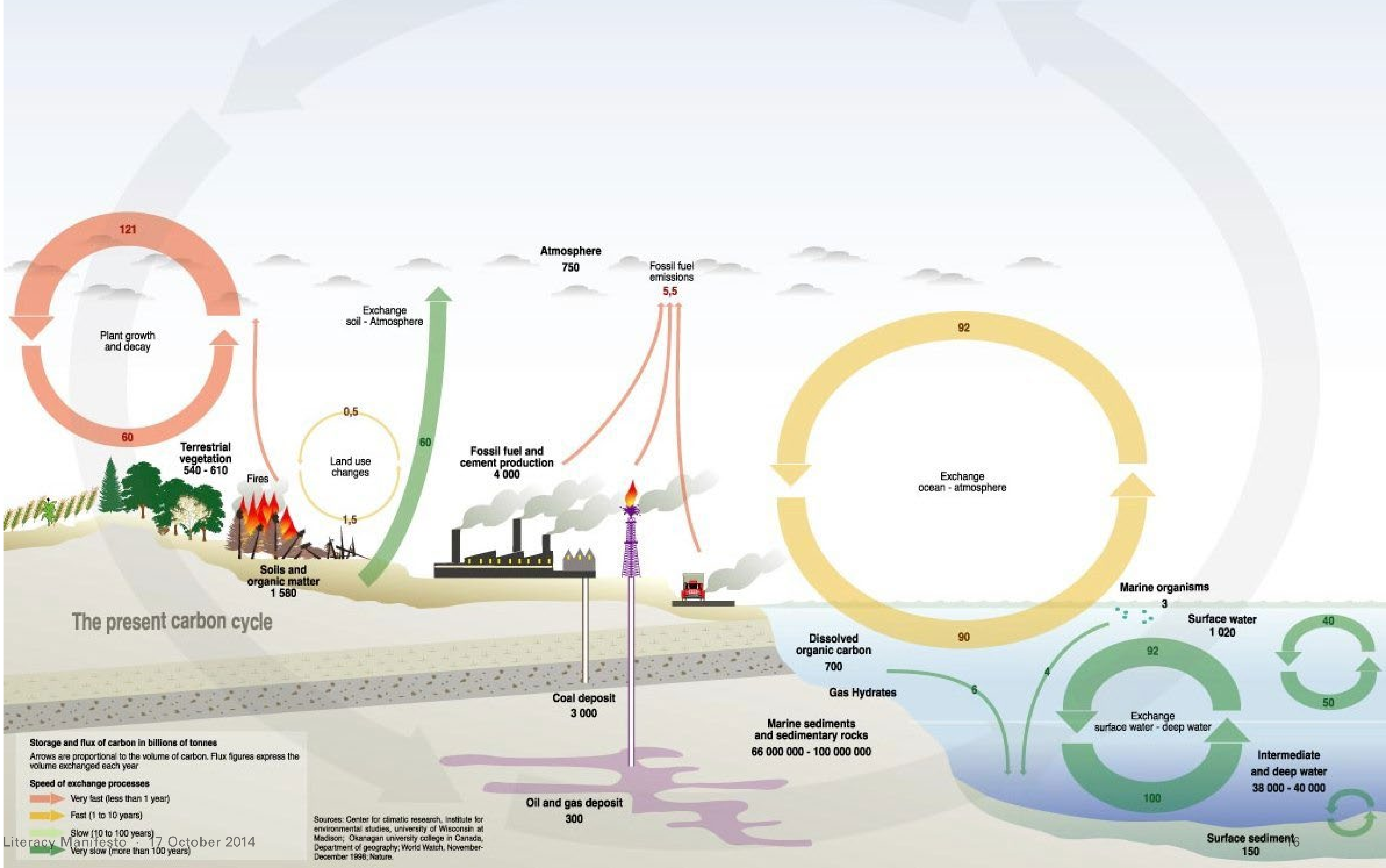
For example,

- **natural** system
  the water cycle, weather, and ecologies
- **information** system
  operating systems, DNS, cloud-based services
- **social** system
  languages, laws, and organizations
- **hybrid** system
  local health-care systems and education systems

Water travels contionuously through a cycle.

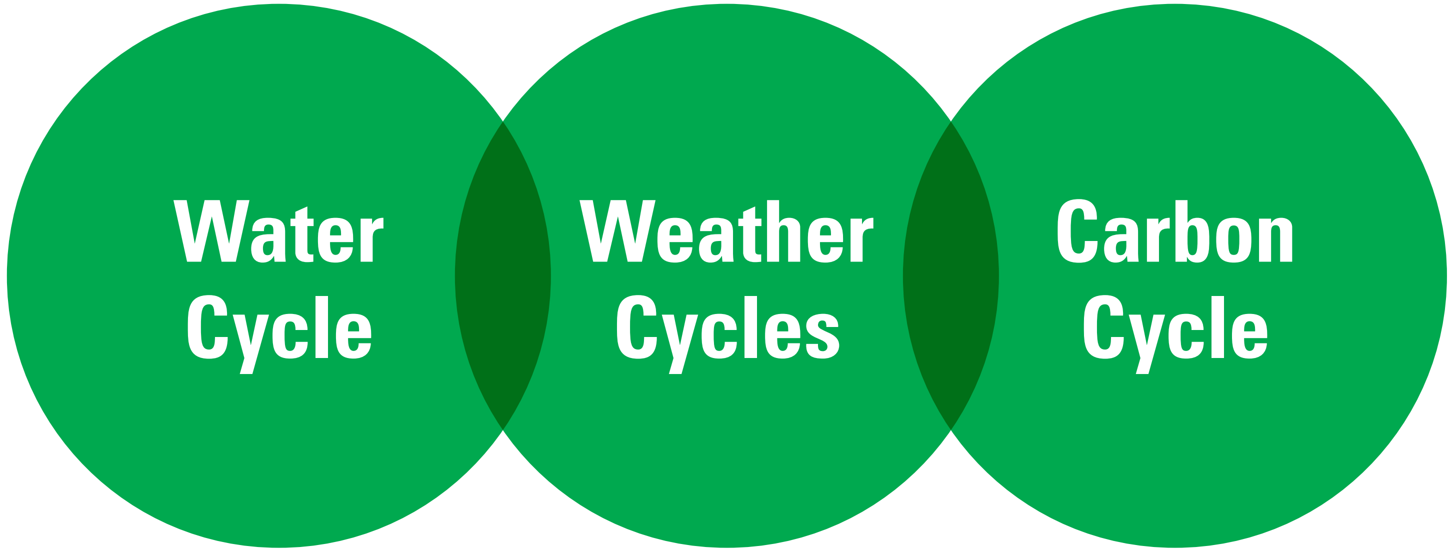


Carbon also travels through a cycle.



**Sometimes large quantities can be tied up—sequestered—
so that they are not traveling through the cycle.**

**Changing stock levels—sequestering or releasing water or carbon—
affects the climate as ice or carbon dioxide
interacts with the planet's weather system.**



In sum:

We face the difficulties of untangling messes (taming wicked problems)
and fostering innovation (economic and social),
which require understanding systems—

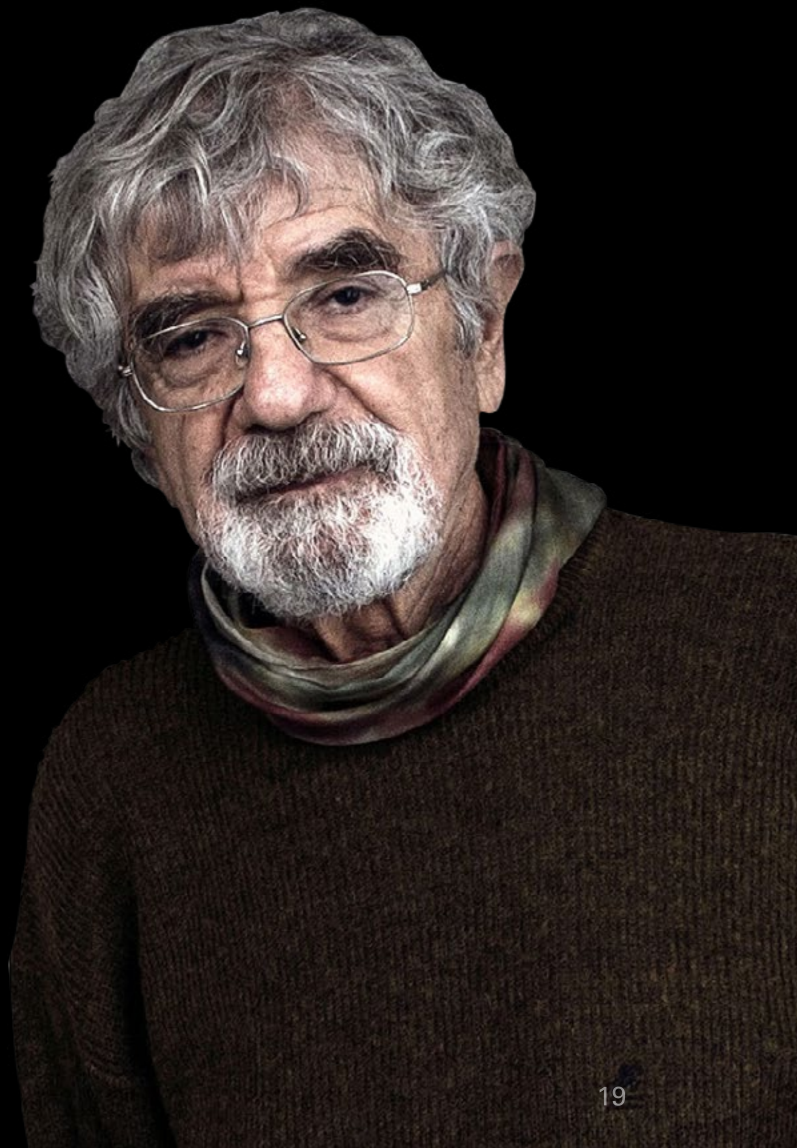
which are complex, evolving, and probabilistic—
and “hidden” or “translucent”.

What is more: **systems are “observed”.**

"Anything said
is said ***by an observer.***"

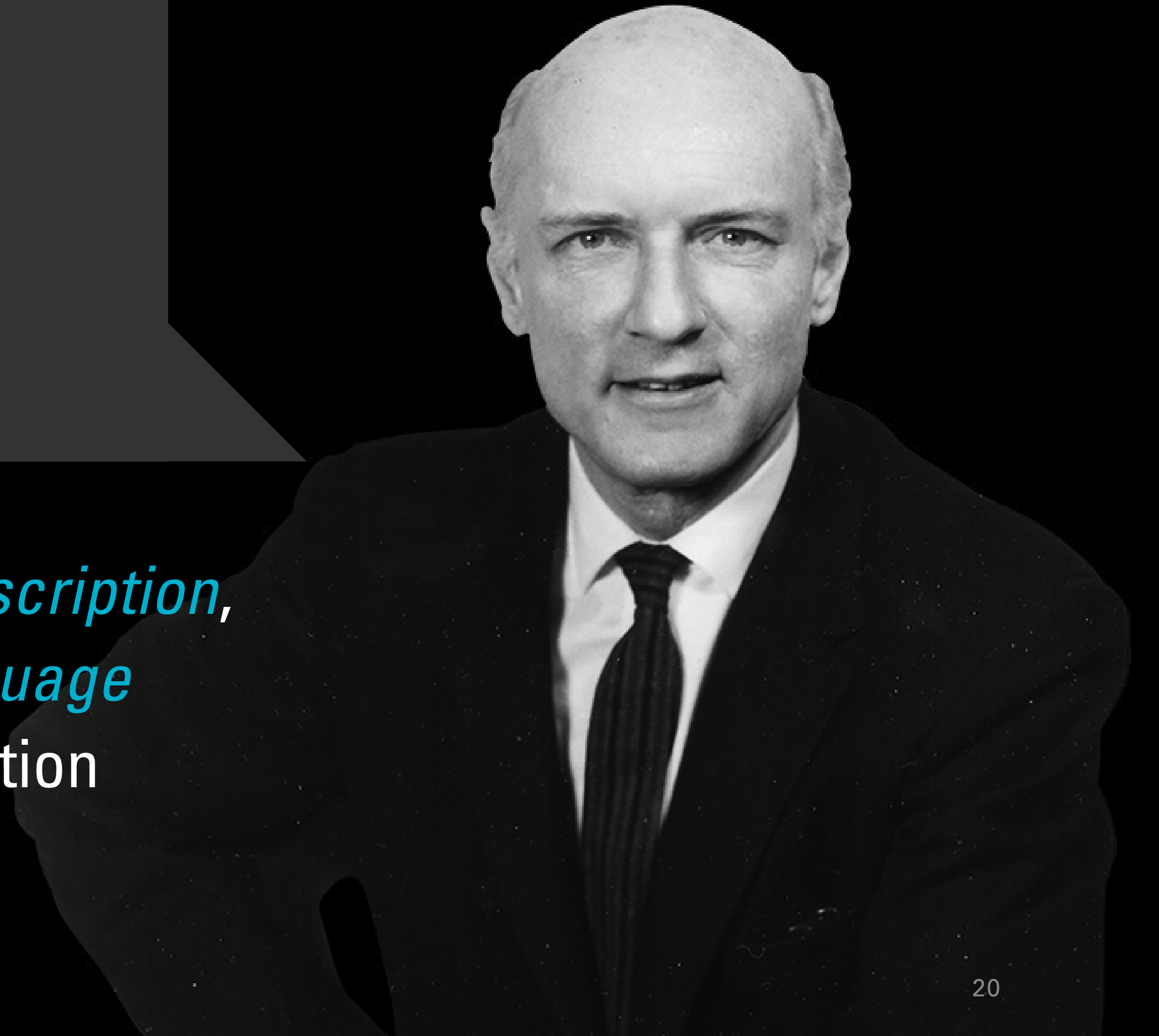
— Humberto Maturana,
Theorem Number 1, 1970

That is, as Stafford Beer said,
"a system is not something given in nature,"
it is something we define—
even as we interact with it.



“Anything said
*is said **to an observer**.”*

— Heinz von Foerster,
Corollary Number 1, 1979



What the observer “says” is a *description*, said to another observer in a *language* (they “share”), creating a connection that forms the basis for a *society*.

Now, we can ask a simple question:
How should we describe systems?

**Or more precisely,
how should we describe systems that are
complex, *evolving*, *probabilistic*—
and *“hidden”*—and *“observed”*?**

What is systems literacy?

Churchman outlines four approaches to systems:

efficiency expert:
reducing time and cost

scientist:
building (mathematical) models

humanist:
looking to our values

anti-planners:
living *in* systems, not imposing plans

We might consider a fifth approach:

designer:
prototyping and iterating systems
or representations of systems

Basic systems literacy includes:

- **vocabulary** (content):
  a set of distinctions and entailments (relationships)

- **“reading”** (skills of analysis):
  recognizing common patterns in specific situations
  e.g., identifying—finding and naming—a control loop

- **“writing”** (skills of synthesis):
  describing the function of systems to others,
  mapping and diagramming

Systems literacy is enriched with:

- **literature:**
  a canon of key works of theory and criticism
- **history:**
  context, sources, and development of key ideas
- **connections:**
  conversations among and between disciplines
  e.g., design methods and management science

A vocabulary in systems begins with

system, environment, boundary
stocks, flows, delay (lag)
source, sink
process, transform function, cycle
information (signal, message),
goal (threshold, set-point), feedback

circular processes, circularity
closed-loop, open-loop
viscous cycle, virtuous cycle
explosion, collapse, dissipation
negative feedback, positive feedback
reinforcing, dampening, balancing
stability, invariant organization,
dynamic equilibrium, homeostasis
tragedy of the commons

behavior, action (task), measurement
range, resolution, frequency
sensor, comparator, actuator (effector)
current state, desired state
error, detection, correction
disturbances, responses

controlled variable, command signal

servo-mechanism, governor
hunting, oscillation, prediction

control, communication
teleology, purpose
goal-directed, self-regulating
co-ordination, regulation

emergence
feedforward

static, dynamic
first order, second order

essential variables
variety, "requisite variety"
transformation (table)

autopoiesis
constructivism
recursion

observer, observed
controller, controlled

agreement, (mis-)understanding
"an agreement over an understanding"
learning, conversation
bio-cost, bio-gain
back-talk

structure, organization,
co-evolution, drift

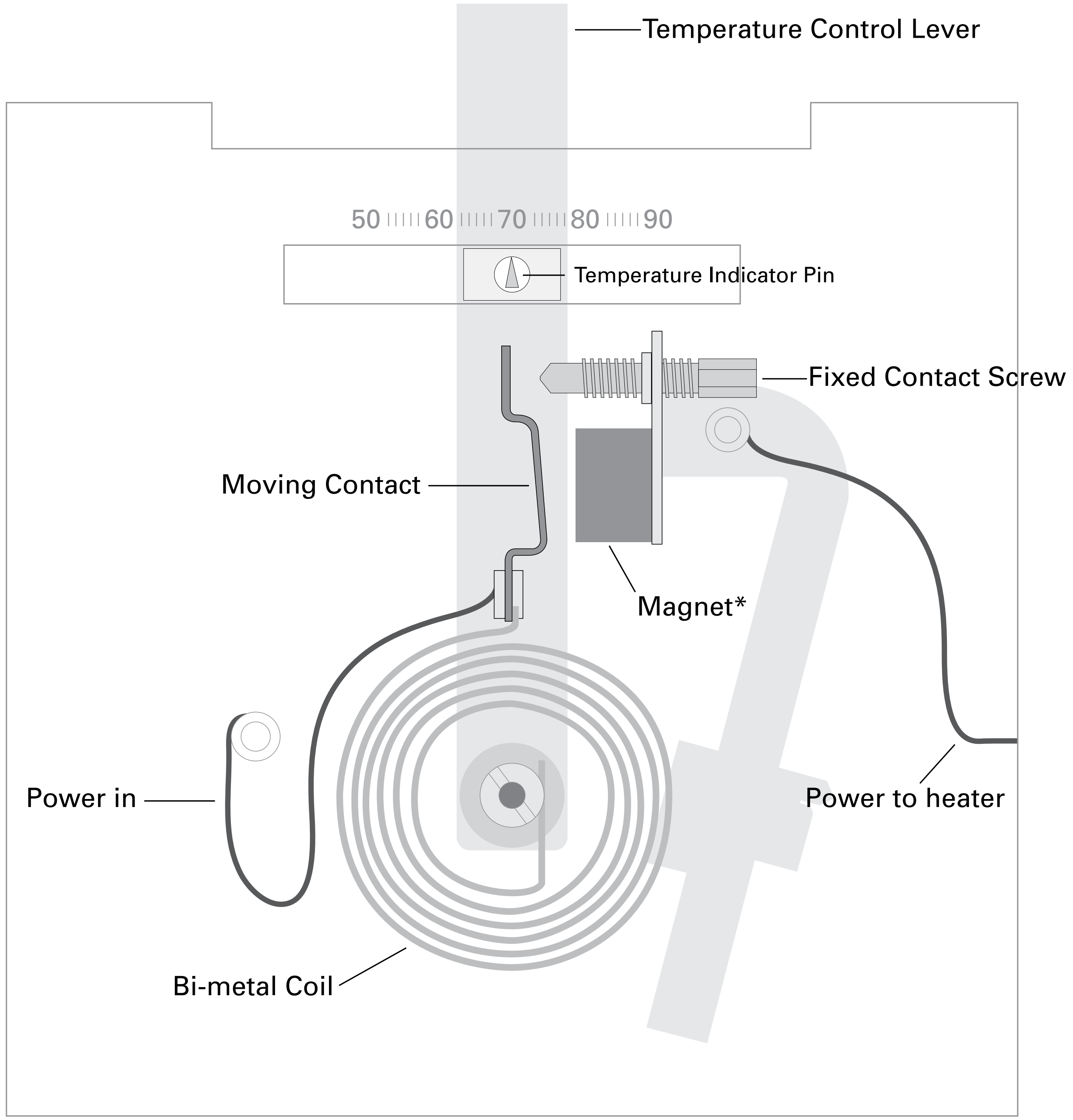
black box
explanatory principle
"organizational closure"
self-reference, reflexive
ethical imperative
"generosity in design"
structural coupling
"consensual co-ordination of consensual co-ordination"
"conservation of a manner of living"

Reading systems means recognizing common patterns in specific situations.

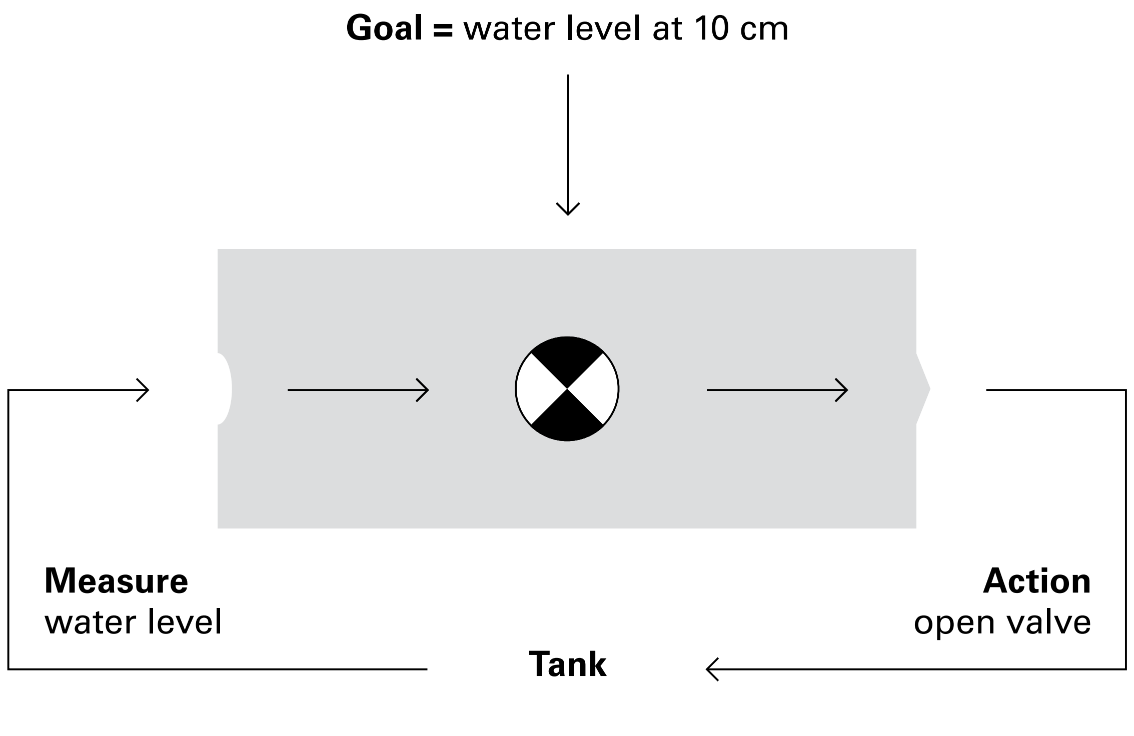
e.g.,

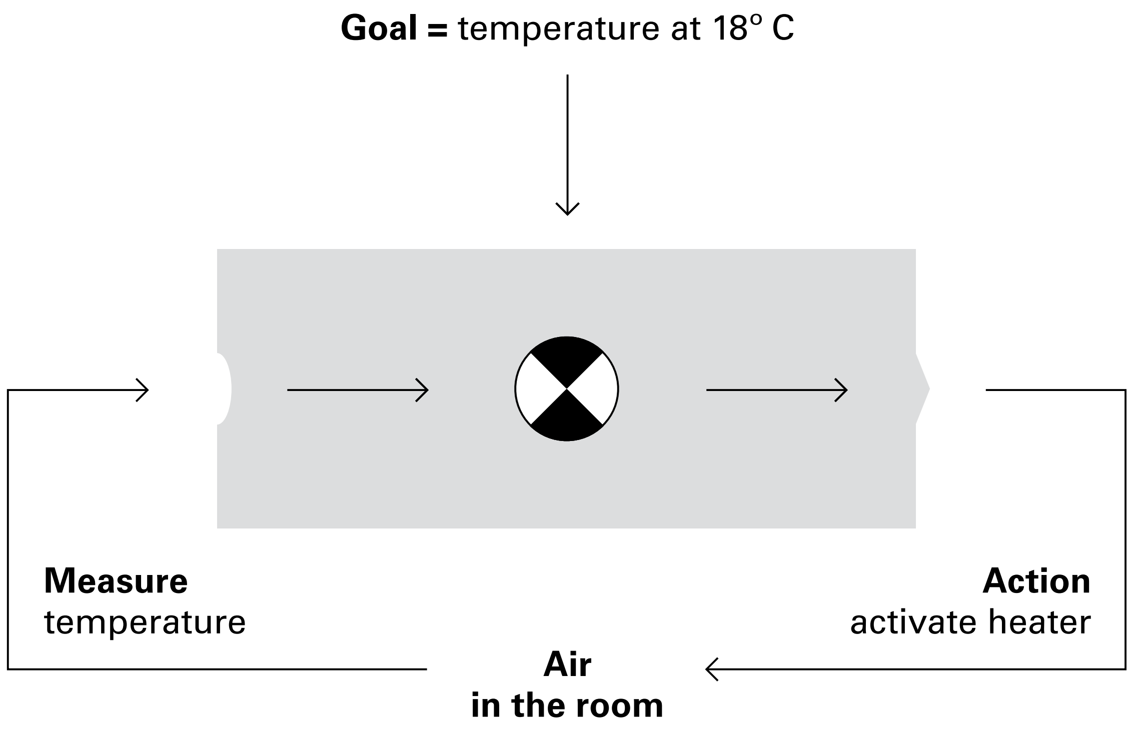
- resource flows and cycles
- transform functions (processes)
- feedback loops
- feed-forward
- requisite variety
- second-order feedback
- goal-action trees

Consider the toilet and thermostat, different in form and structure.



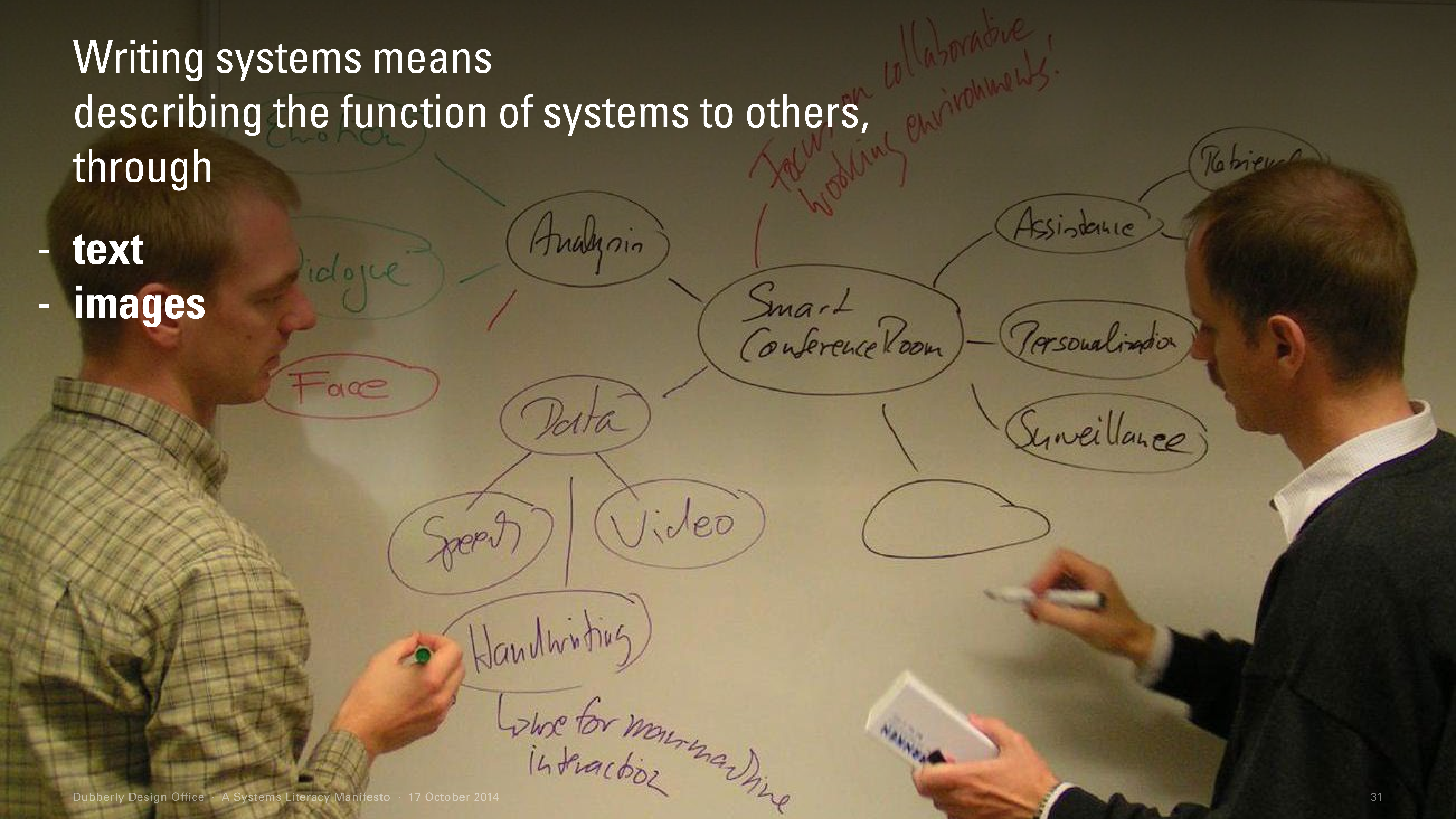
Yet the toilet and thermostat are the same in function. Both are governors.





Writing systems means
describing the function of systems to others,
through

- **text**
- **images**



Text can describe a system's function, linking it to a common pattern.

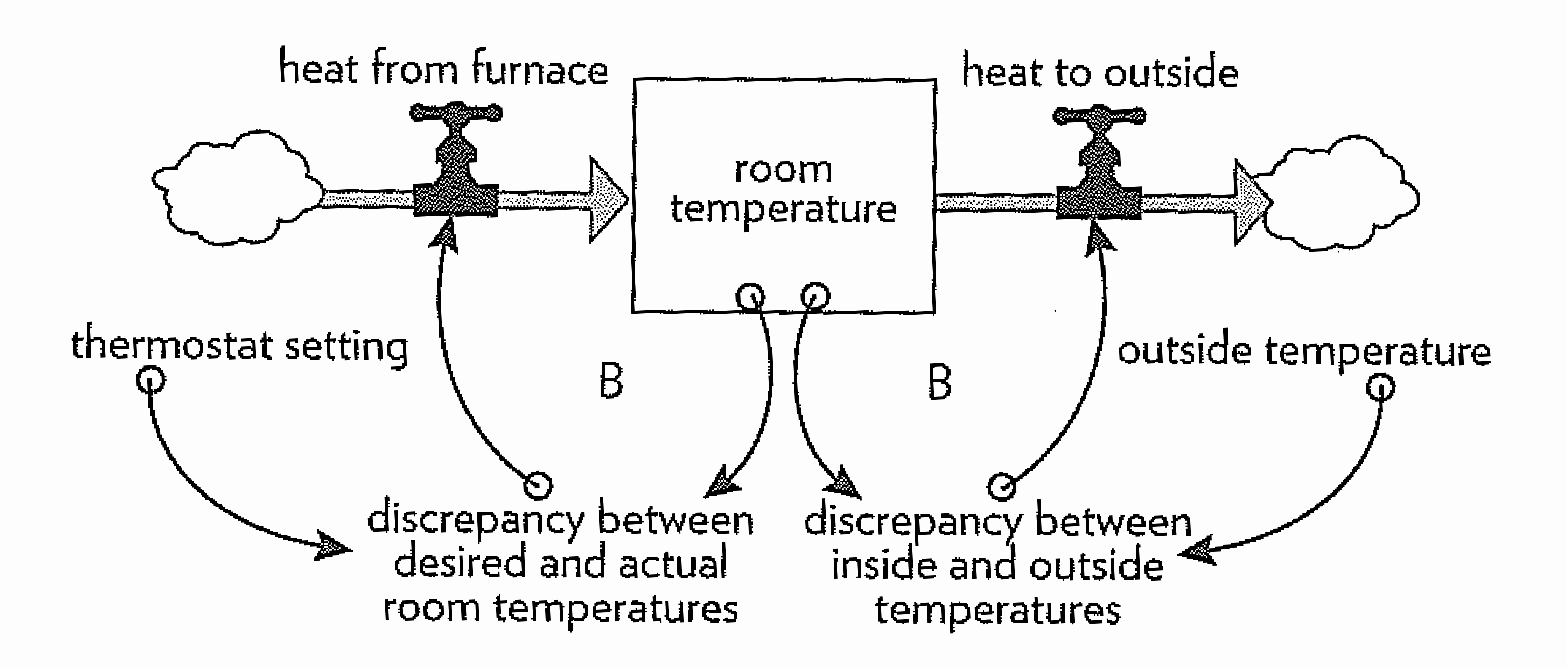
But text descriptions require
mental gymnastics from readers—
imagining both the behavior of the system
and the abstract functional pattern—
and then linking the two.

Images of physical systems aid readers, though behavior can be difficult to depict.

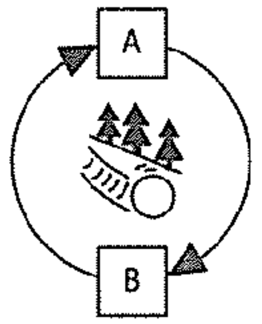
But function must be represented in diagrams, often with some degree of formalism.

Learning to read and write
one or more systems function formalisms
is an important part of systems literacy.

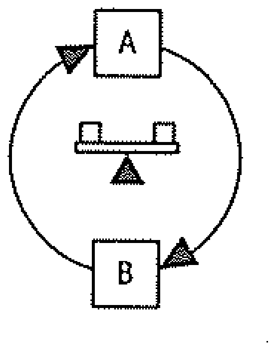
Donalla Meadows has a particular formalism.



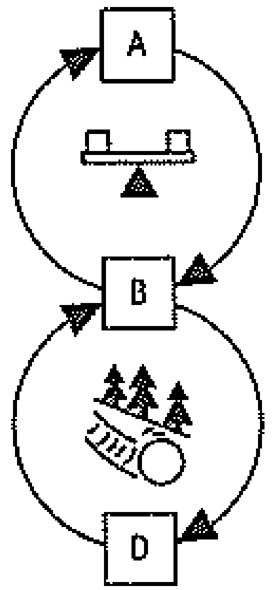
O'Connor & McDermott have another formalism.



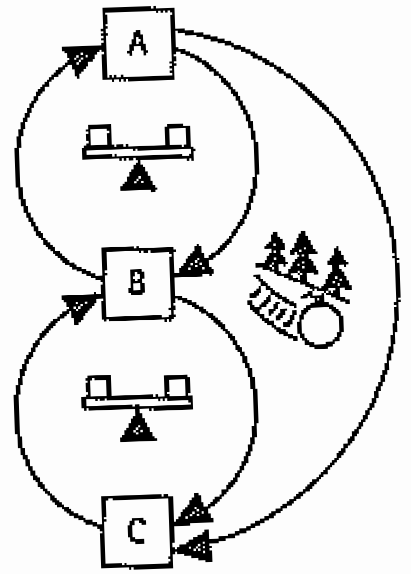
Reinforcing



Balancing

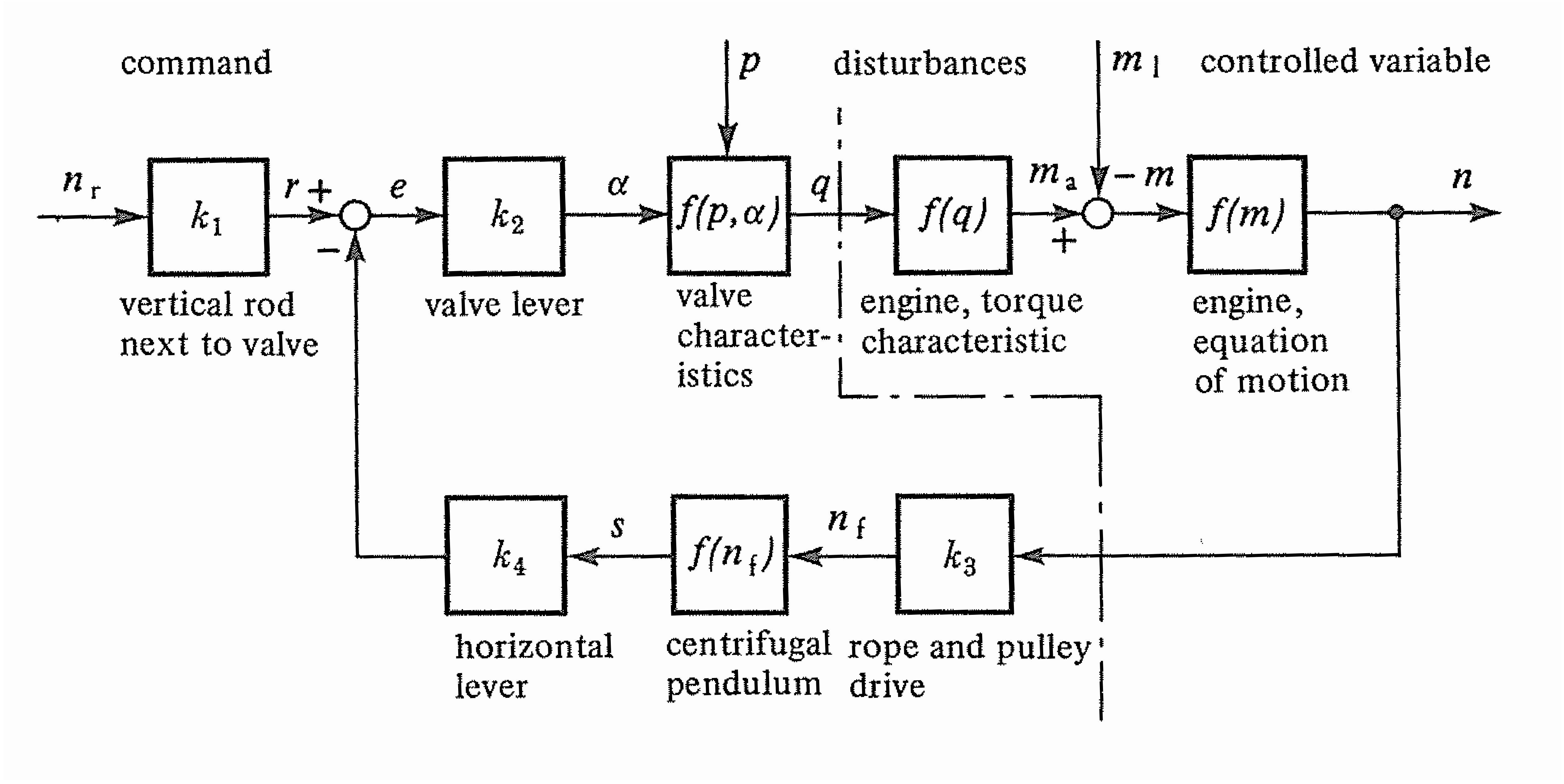


Limits to Success



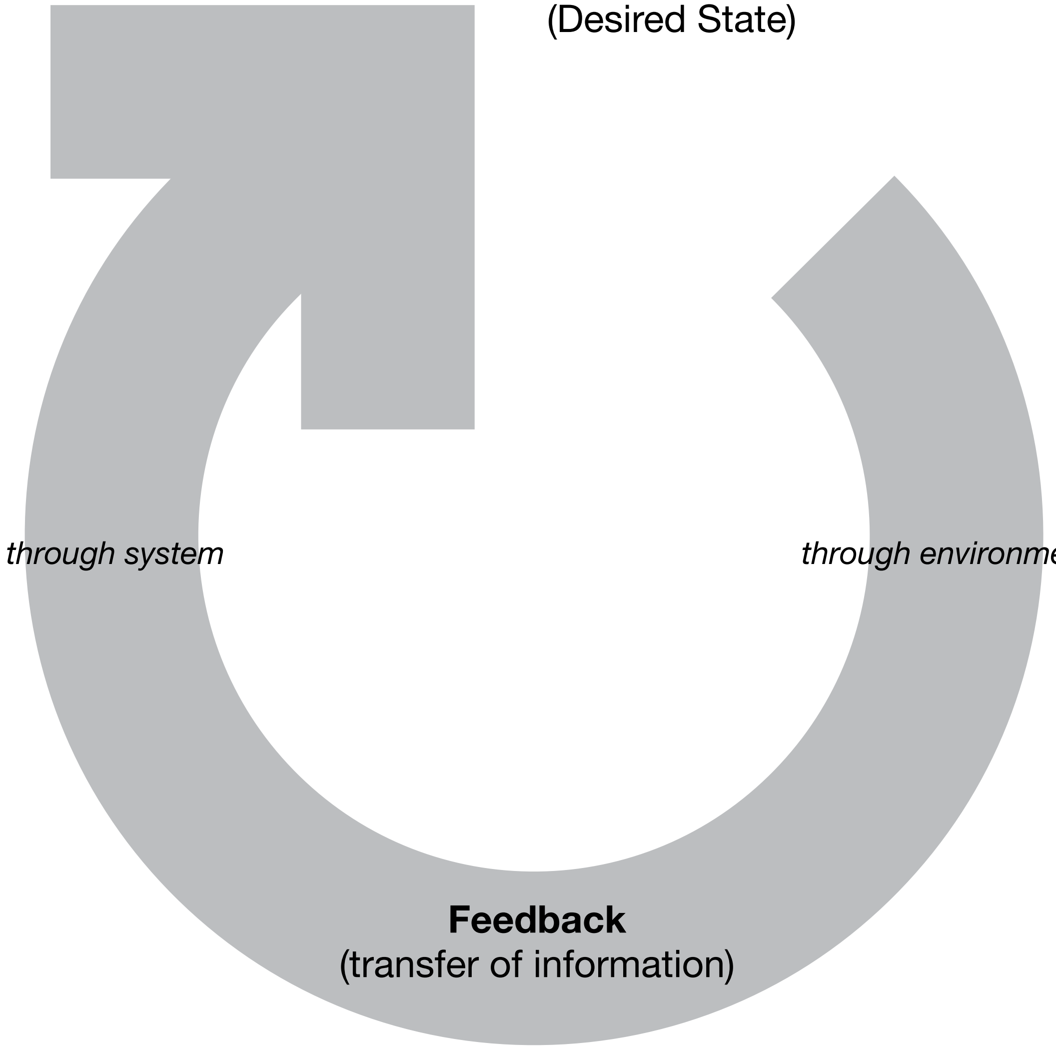
Addiction

Otto Mayr has a block diagram formalism.



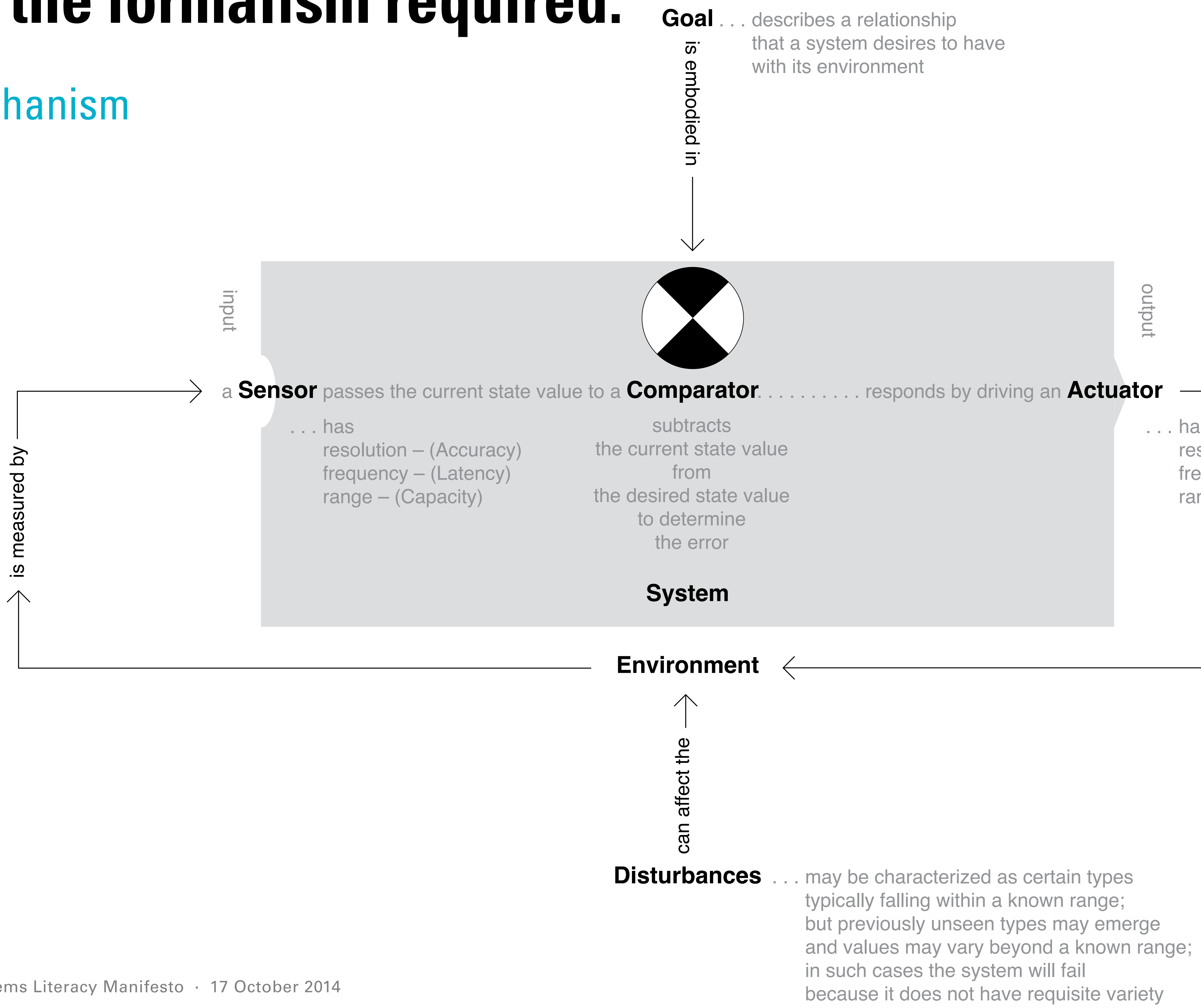
Yet in many cases, simple concept maps may be all the formalism required.

Feedback: Overview

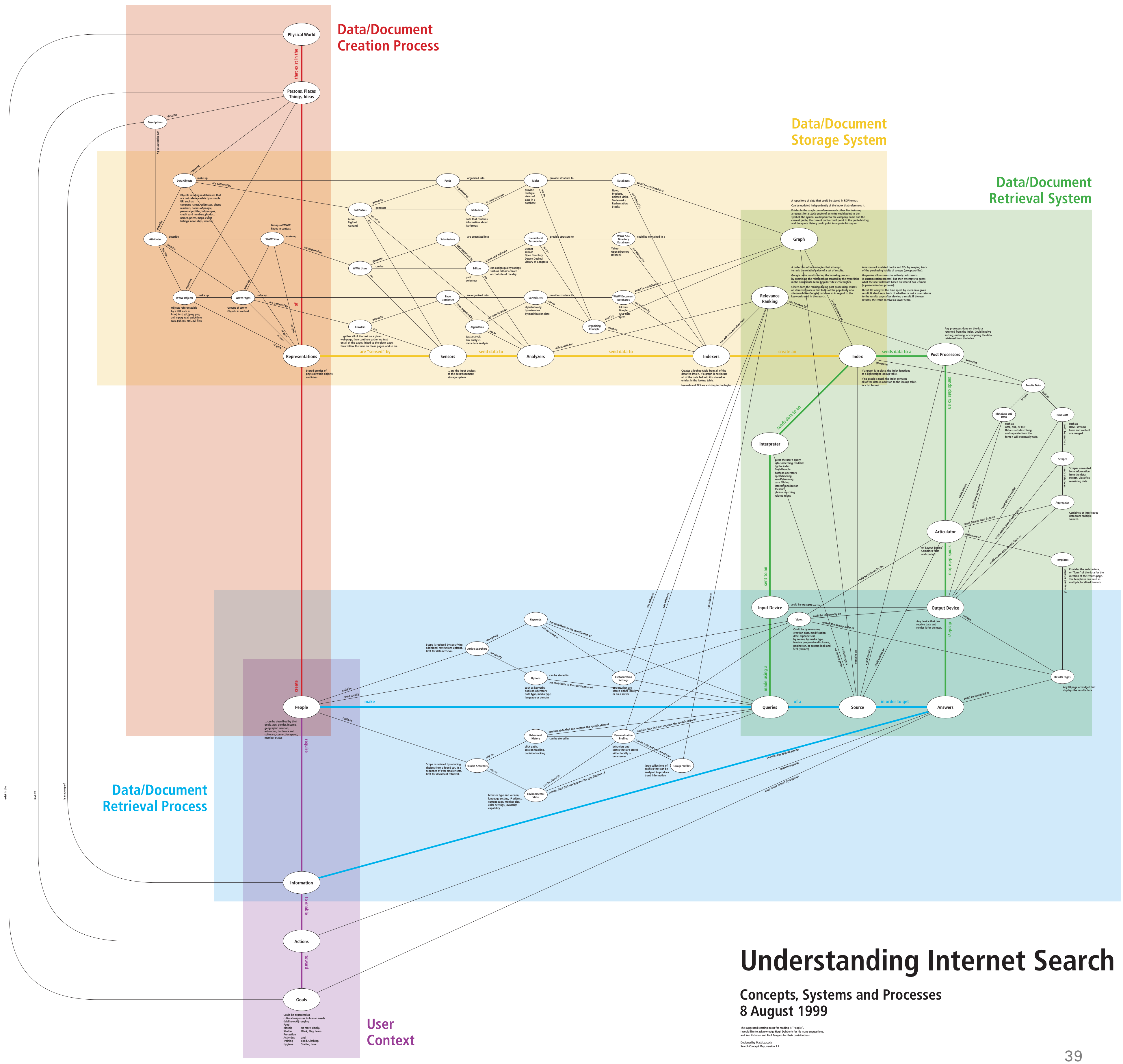


Yet in many cases, simple concept maps may be all the formalism required.

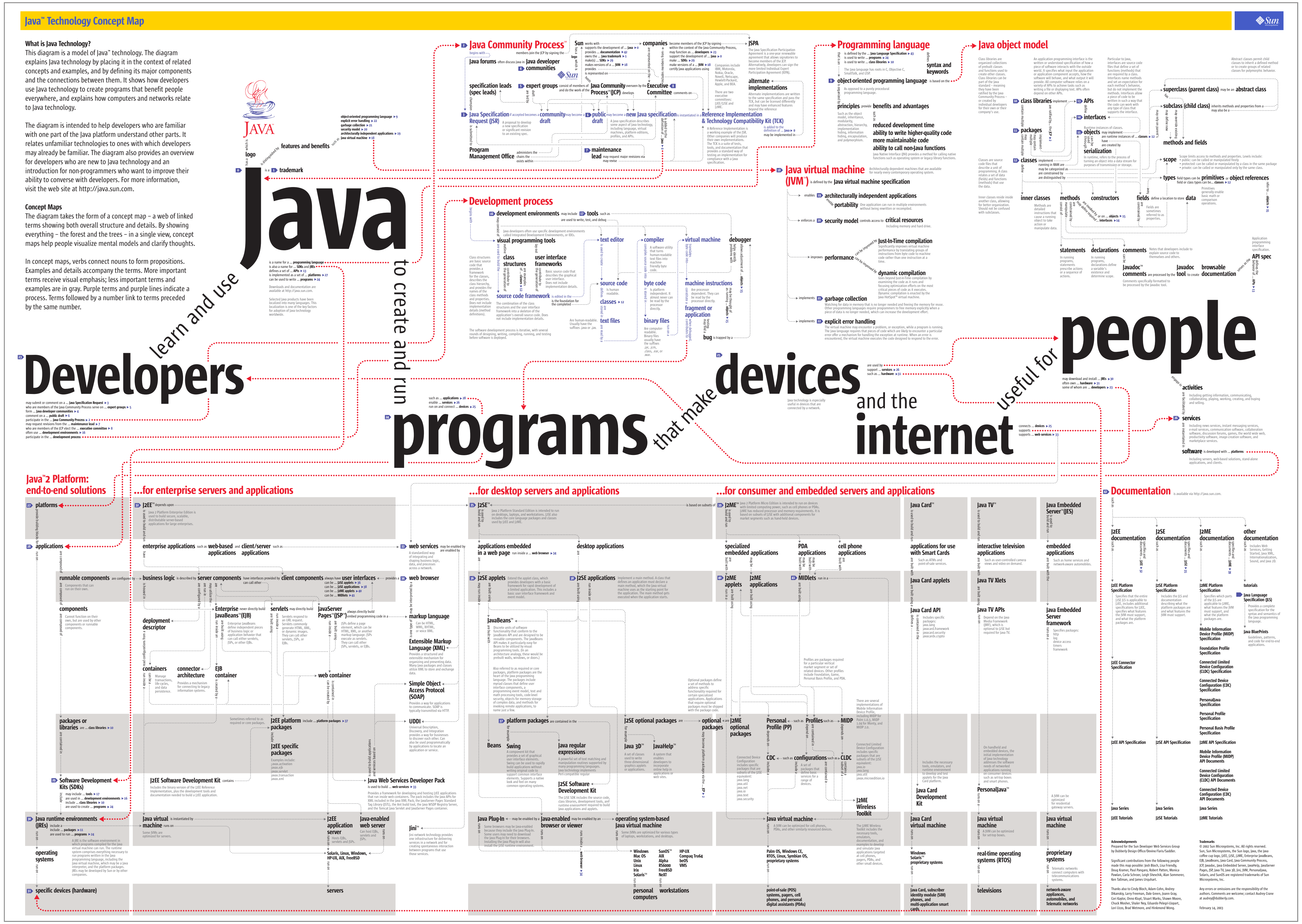
Feedback: Mechanism



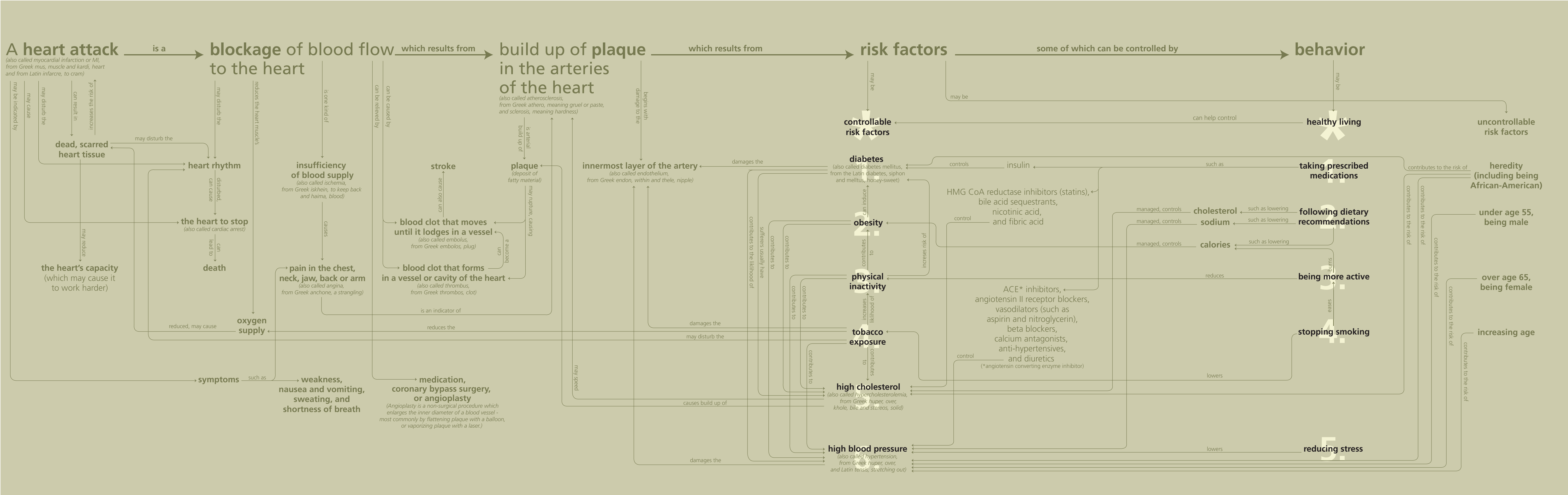
Netscape search concept map



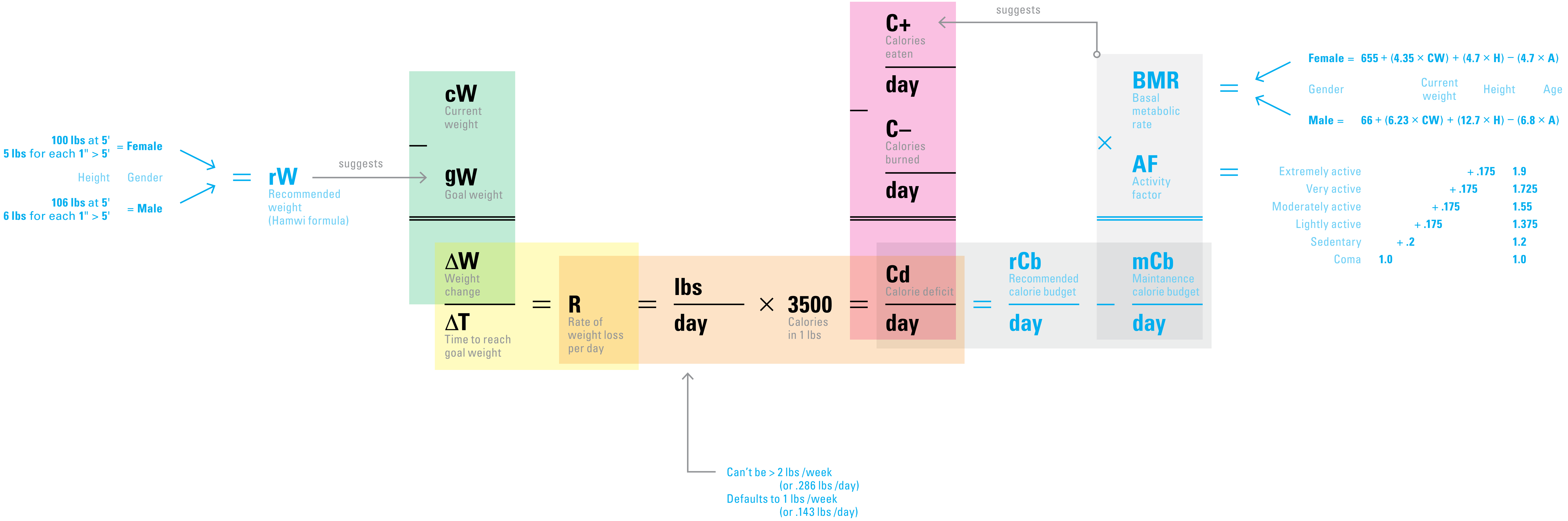
Java concept map



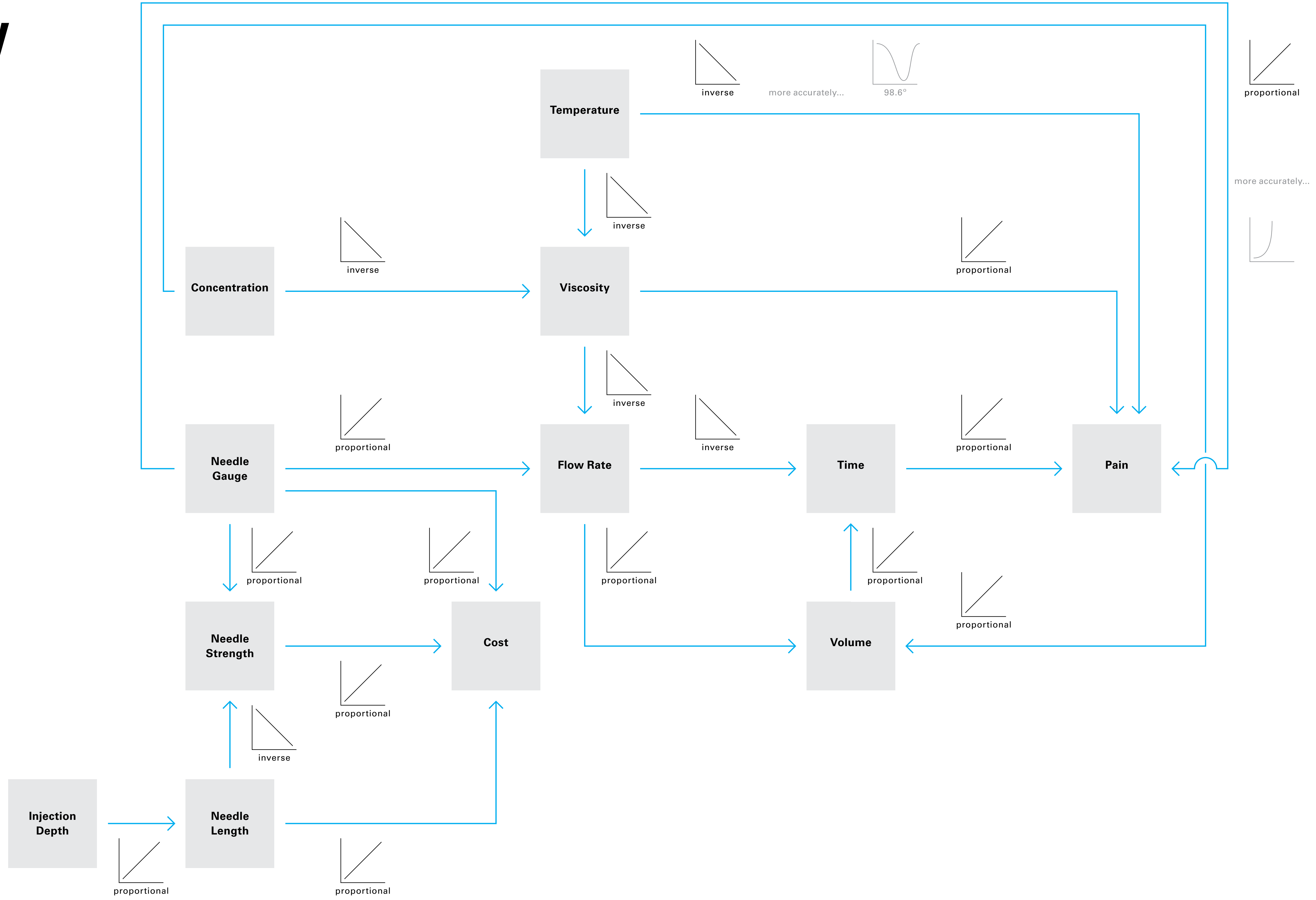
Heart attack concept map



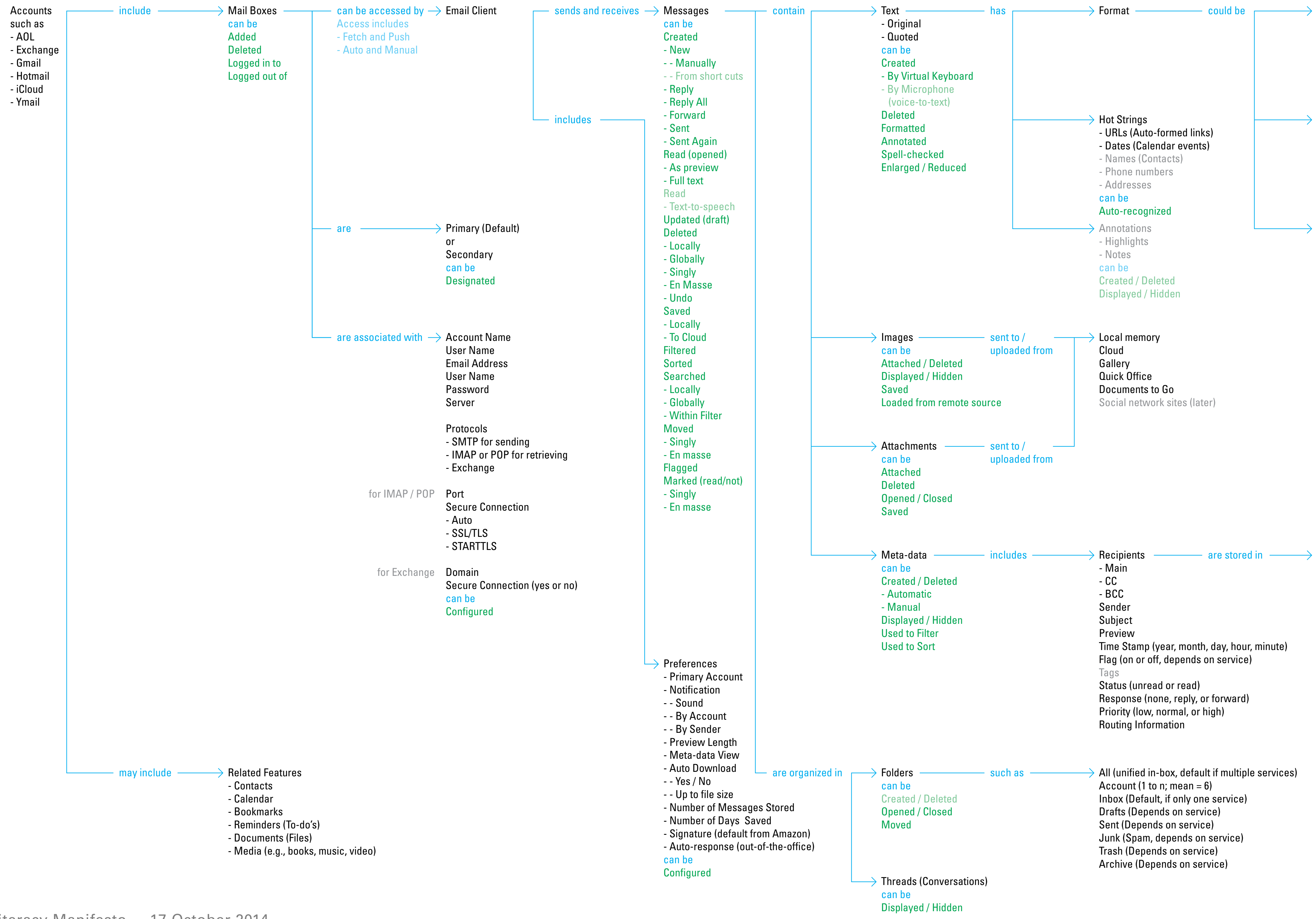
Weight control concept map



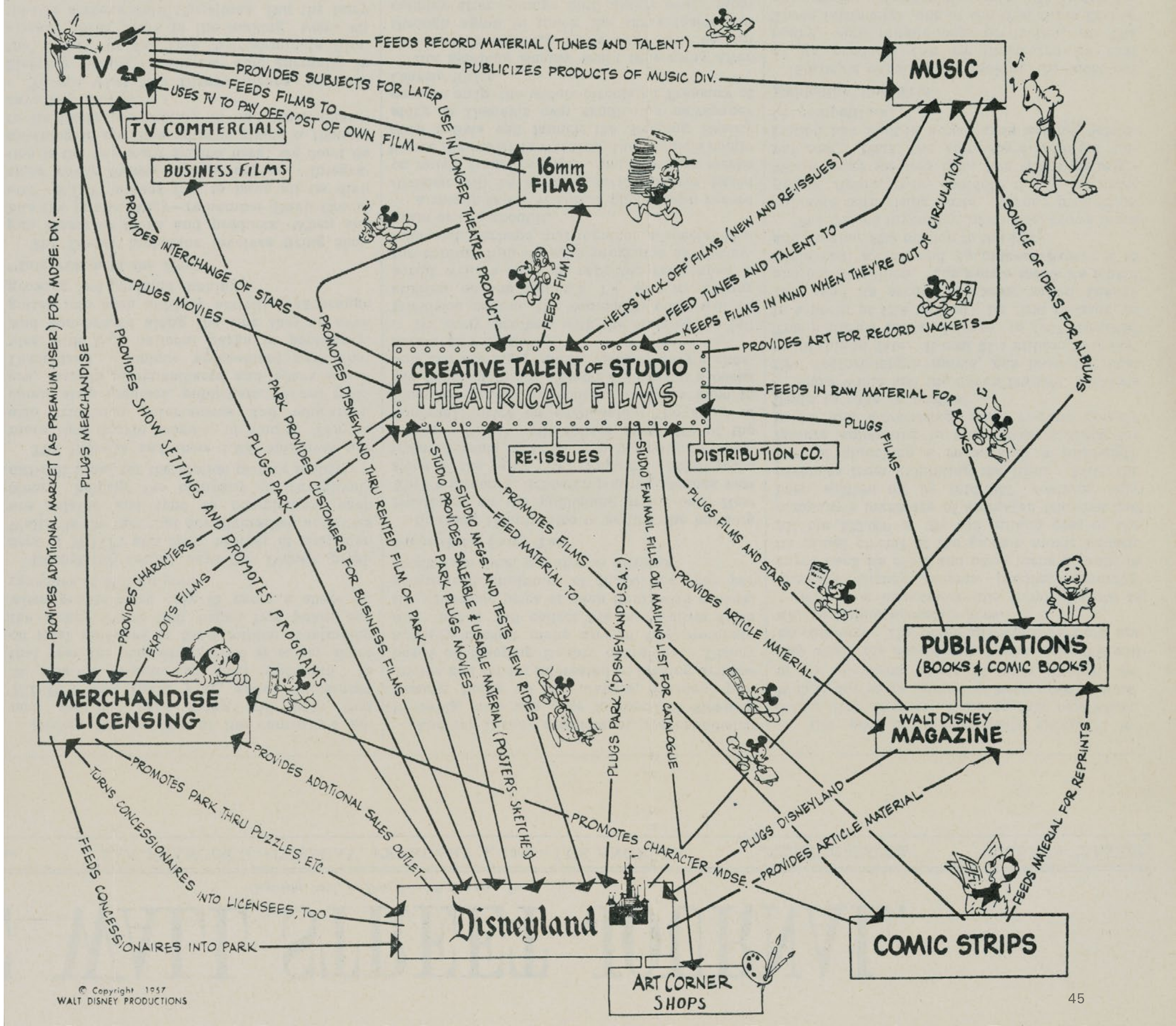
Drug delivery device map



Email conceptual model



Disney map



TV
MUSIC
TV COMMERCIALS
BUSINESS FILMS
16mm FILMS
CREATIVE TALENT OF STUDIO
THEATRICAL FILMS
RE-ISSUES
DISTRIBUTION CO.
PUBLICATIONS (BOOKS & COMIC BOOKS)
WALT DISNEY MAGAZINE
MERCHANDISE LICENSING
Disneyland
COMIC STRIPS
ART CORNER SHOPS
FEEDS RECORD MATERIAL (TUNES AND TALENT)
PUBLICIZES PRODUCTS OF MUSIC DIV.
PROVIDES SUBJECTS FOR LATER USE IN LONGER THEATRE PRODUCT
FEEDS FILMS TO
USES TV TO PAY OFF COST OF OWN FILM
FEEDS FILM TO
HELPS 'KICK OFF' FILMS (NEW AND RE-ISSUES)
FEED TUNES AND TALENT TO
KEEPS FILMS IN MIND WHEN THEY'RE OUT OF CIRCULATION
SOURCE OF IDEAS FOR ALBUMS
PROVIDES ART FOR RECORD JACKETS
FEEDS IN RAW MATERIAL FOR BOOKS
PLUGS FILMS
PROVIDES ADDITIONAL MARKET (AS PREMIUM USER) FOR MDSE. DIV.
PLUGS MERCHANDISE
PROVIDES SHOW SETTINGS AND PROMOTES PROGRAMS
PROVIDES INTERCHANGE OF STARS
PLUGS MOVIES
PLUGS PARK
PARK PROVIDES CUSTOMERS FOR BUSINESS FILMS
PROMOTES DISNEYLAND THRU RENTED FILM OF PARK
PROVIDES CHARACTERS
EXPLOITS FILMS
STUDIO PROVIDES SALEABLE & USABLE MATERIAL (POSTERS, SKETCHES)
PARK PLUGS MOVIES
STUDIO MFGS AND TESTS NEW RIDES
FEED MATERIAL TO
PROMOTES FILMS
PLUGS PARK ("DISNEYLAND U.S.A.")
STUDIO FAN MAIL FILLS OUT MAILING LIST FOR CATALOGUE
PLUGS FILMS AND STARS
PROVIDES ARTICLE MATERIAL
PROVIDES ADDITIONAL SALES OUTLET
PROMOTES PARK THRU PUZZLES, ETC.
TURNS CONCESSIONAIRES INTO LICENSEES, TOO
FEEDS CONCESSIONAIRES INTO PARK
PROMOTES CHARACTER MDSE.
PLUGS DISNEYLAND
PROVIDES ARTICLE MATERIAL
FEEDS MATERIAL FOR REPRINTS
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How do we achieve systems literacy?

Teaching systems in design is not a new idea.
HfG Ulm had courses in operations research and cybernetics in the 1960s.

All graduate design programs should have courses in systems literacy— as should under grad programs in

- product design
- interaction design
- service design
- information design
- and any program in innovation or social entrepreneurship

One course, 3 hours per week for 12 to 15 weeks is a bare minimum survey of systems.

Ideal would be 3 semesters:

- **Intro to Systems:**
  systems dynamics, regulation, requisite variety
- **Second-Order Systems:**
  observing systems, autopoiesis, learning, ethics
- **Systems for Conversation:**
  co-evolution, co-ordination, and collaboration

Recommended readings:

- *A Systems View of Life*, Capra
- *Thinking in Systems*, Meadows
- *An Introduction to Cybernetics*, Ashby

- “Second-order Cybernetics,” Glanville
- “Ethics and Second-order Cybernetics,” von Foerster
- “Systemic and Meta Systemic Laws,” Maturana + Davila

- “What is conversation?” Pangaro
- “The Limits of Togetherness,” Pask
- *Decision and Control*, Beer
- “Meta-design,” Maturana

Recommended format: seminar + studio

- Readings and discussions
- Review of common patterns (via canonical diagrams)
- In class exercises to apply the patterns
- Homework to apply the patterns again
- In class critiques of previous week's homework
- Final project to design a new system
  or repair (or improve) a faulty one

Literacy requires fluency in a language.

As with any language,
learning the language of systems requires immersion, practice, and time.

The reward is that practice becomes habit,
and habit becomes a way of thinking—
an other (another) point of view.

Implications of (and for) observing systems

*"Designers need to be able to **observe**, describe, and understand the context and environment of the design situation…*

…a designer is obliged to use whatever approaches provide the best possible understanding of reality…"

— Harold Nelson, Erik Stolterman

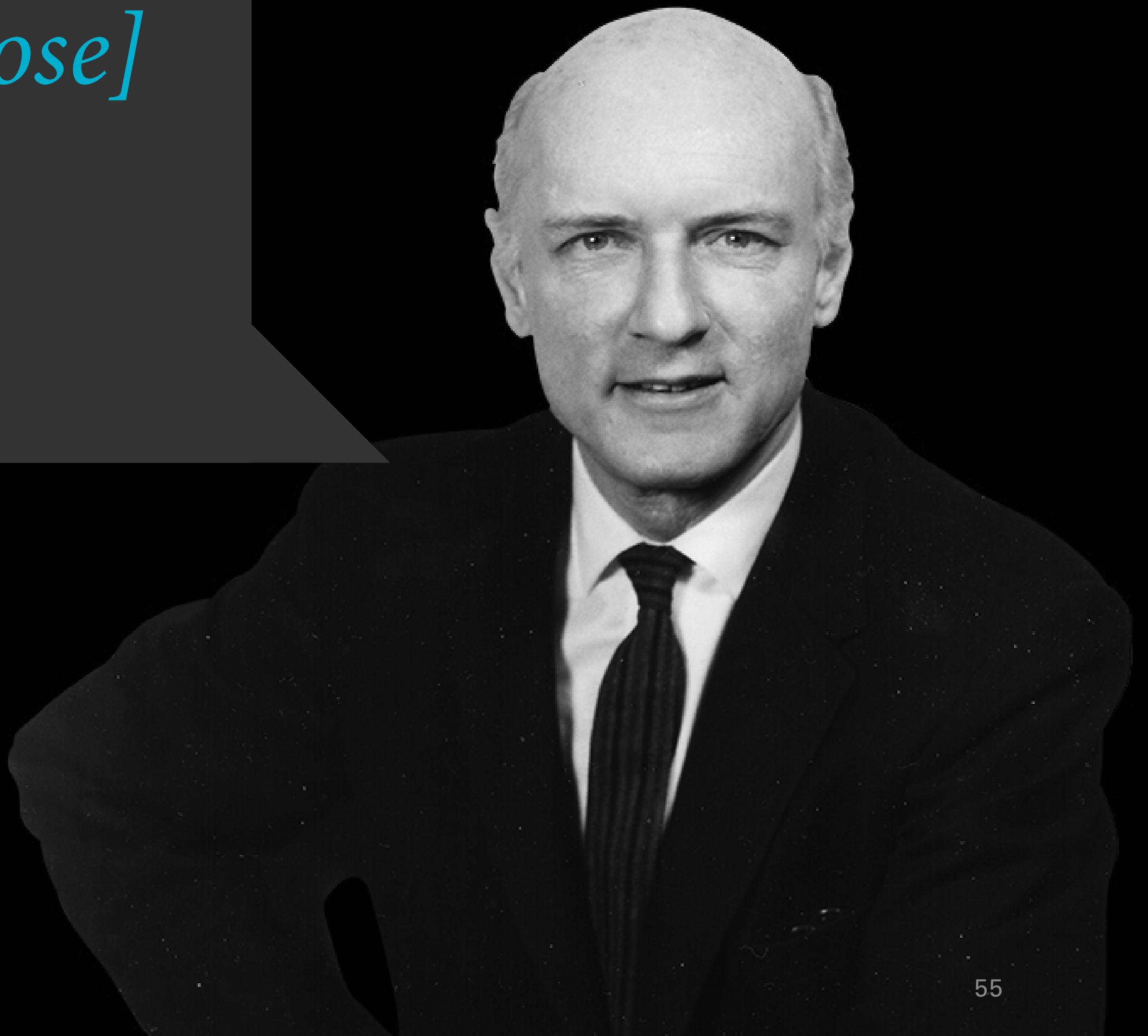
“Pask… distinguishes two orders of analysis.

The one in which the observer enters the system by stipulating ***the system’s purpose****…*

[the other] by stipulating ***his own purpose****… [and because he can stipulate his own purpose]*

he is autonomous… [responsible for] his own actions…”

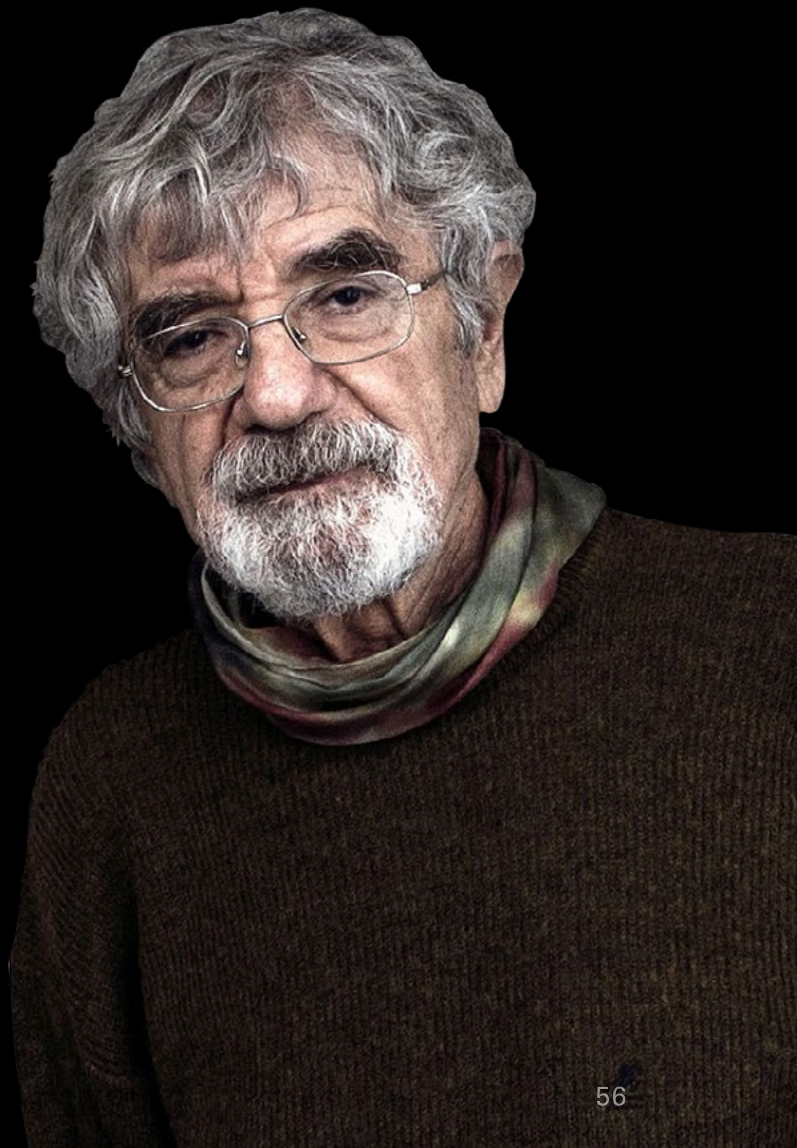
— Heinz von Foerster, 1979



"…if we know that the reality that we live
arises through our emotioning,
and we know that we know,
we shall be able to act
according to our awareness of our liking
or not liking the reality
that we are bringing forth with our living.

That is, we shall become responsible
of what we do."

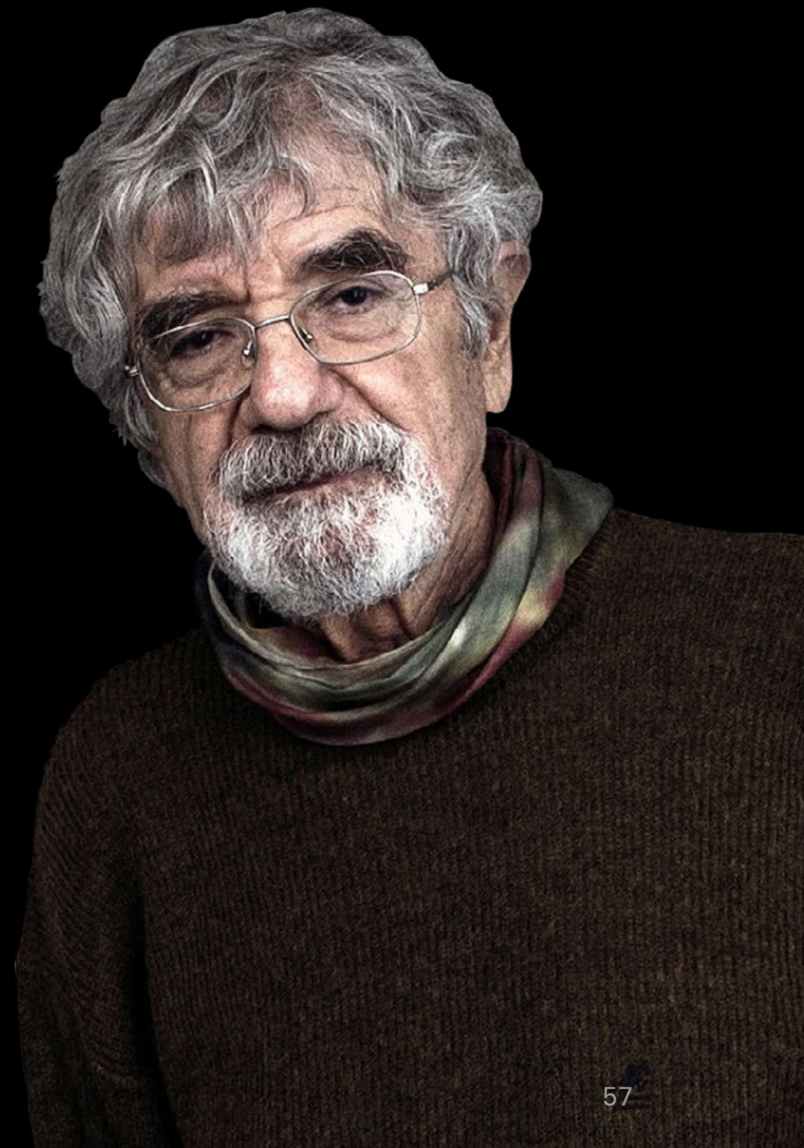
— Humberto Maturana, 1997



"We human beings can do whatever we imagine if we respect the structural coherences of the domain in which we operate.

But we do not have to do all that we imagine, we can choose, and it is there where our behavior as socially conscious human beings matters."

— Humberto Maturana, 1997



We have a responsibility to try to make things better.

If we want decision makers to have a basis to judge
the effects of their decisions,
or if we acknowledge that almost all the challenges that matter—
and most social and economic innovation—involve systems,

**and if we know that tools exist to help us think about systems,
then we must put those tools into circulation.**

We must build systems literacy.
To not do so would be irresponsible.

Special thanks to
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Birger Sevaldson

Paul Pangaro
Ryan Reposar

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Presentation posted at
www.dubberly.com/presentations/system_literacy.pdf