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A Systems Literacy Manifesto (for Designers)

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presentations.dubberly.com/system_literacy_2.pdf

Systems literacy is crucial to our future

The challenges that matter—
our biggest opportunities and most wicked problems—
involve systems.

A body of knowledge about systems is growing;
it can be learned and applied to our challenges;
yet schools (and design discourse) largely ignore it.

We must bring systems thinking to public discourse,
and we must strive for universal systems literacy.

Systems in design practice

Designers have an intuitive feel for systems;
they approach things holistically, look for connections, seek order.

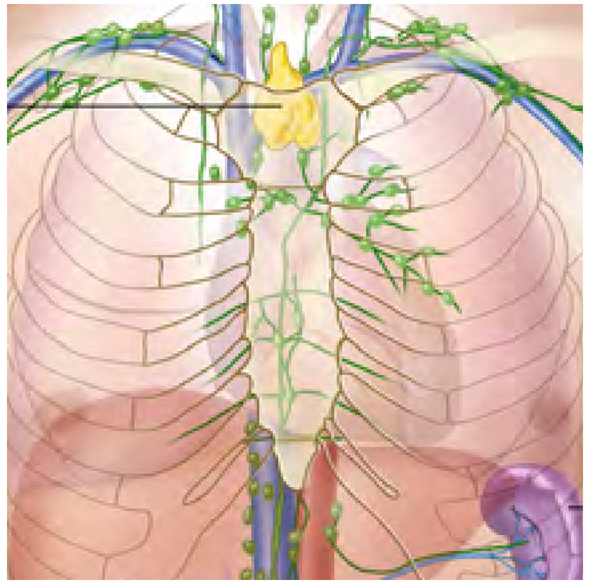
Systems are everywhere.

Columbia Broadcasting System (CBS)

Federal Reserve System

Justice system

Honor system



Immune system

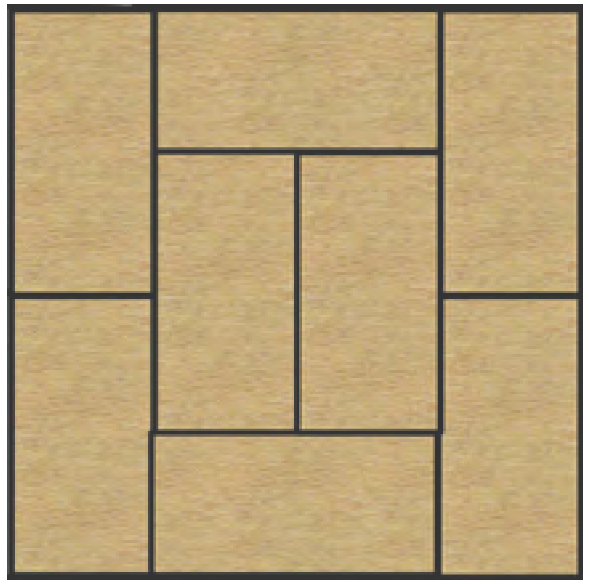
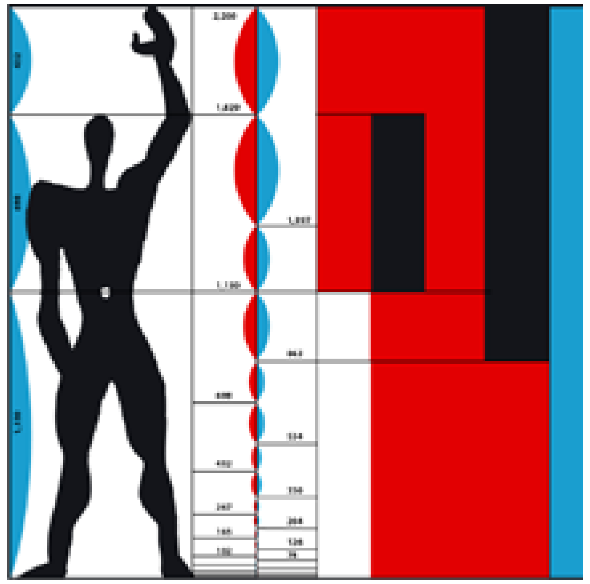
Linux operating system

Mojave desert ecosystem

Domain Name System (DNS)

Designers tend to think of systems in formal terms,
a theme and rules for variation and extension.



The Alhambra
Granda, ~1250

Münster Cathedral Cloister
Basel, ~1421

Tatami mats
Japan, ~1650

Le Modulor
Le Corbusier, 1950



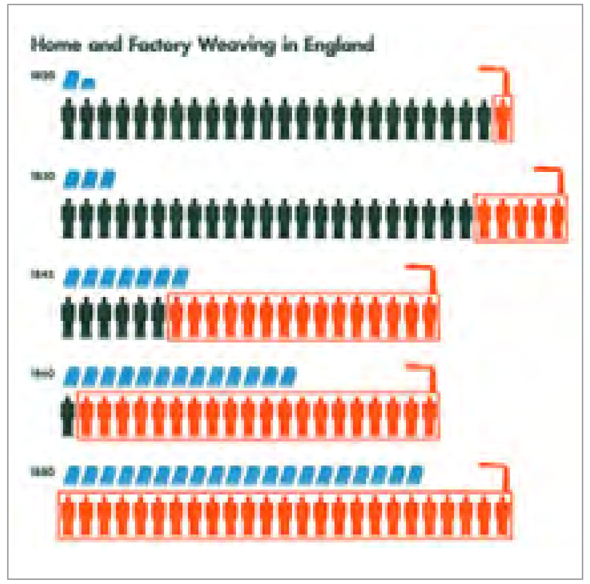
Univers
Adrian Frutiger, 1957

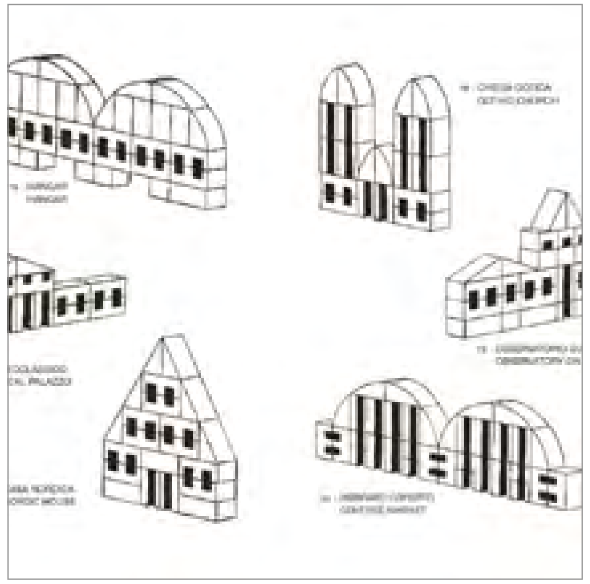
Schiphol airport signage system
Benno Wissing, 1967

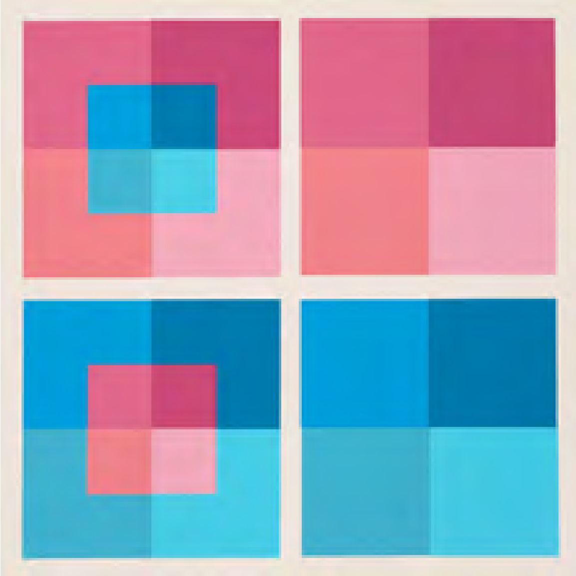
Münich Olympics graphic standards
Otl Aicher, 1972

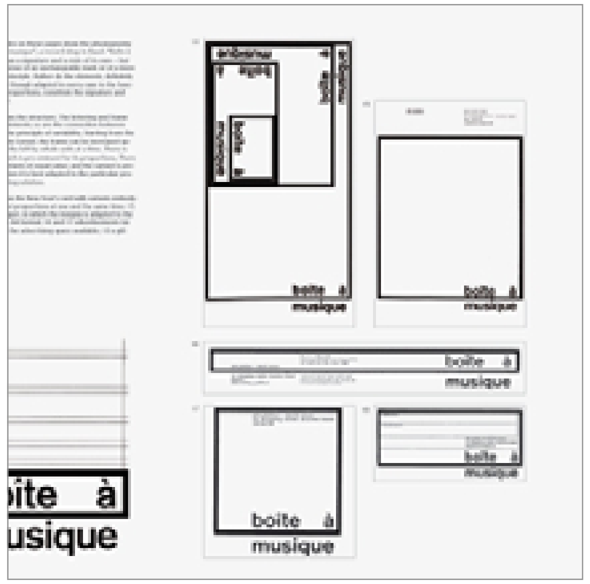
Oxo Good Grips
Sam Farber, 1989

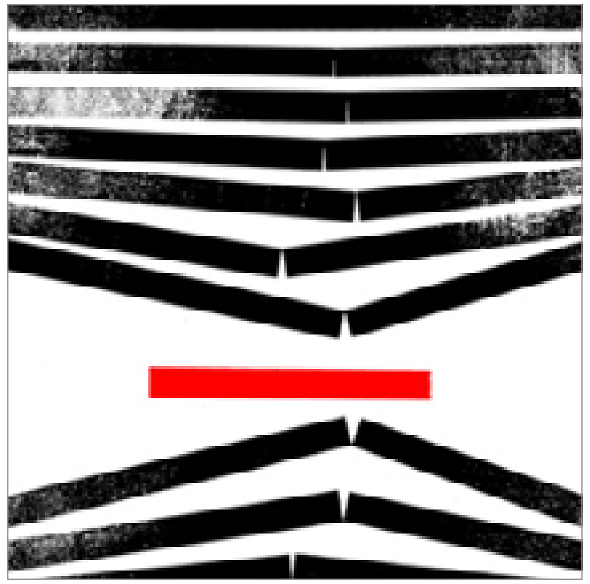
Modernism's formal principles were codified in a series of classic books—pillars of design education.











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International Picture Language,
Otto Neurath, 1936

Scatola di Architettura
Bruno Munari, 1945

Visual Design in Action
Ladislav Sutnar, 1961

Interaction of Color
Josef Albers, 1963

—

Designing Programmes
Karl Gerstner, 1964

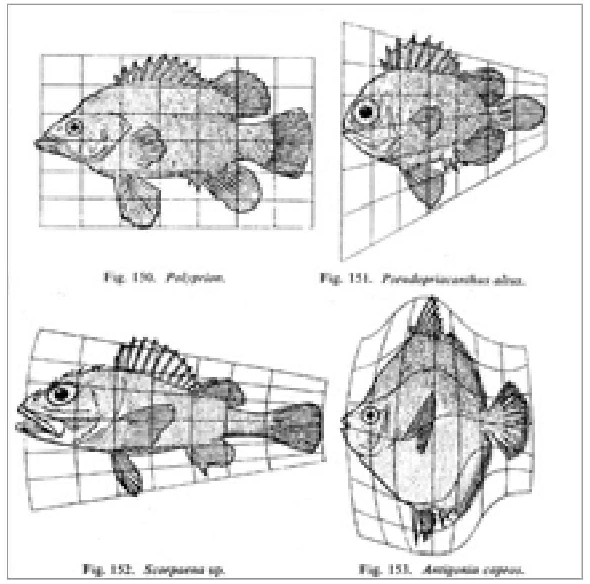
Typography
Emil Ruder, 1967

Visual Presentation of Invisible Processes
Anton Stankowski, 1967

Grid Systems
Josef Müller-Brockmann, 1981

Designers also looked to natural systems for form and structure, producing a growing literature.

Bionics
Biomimetics
Biomimicry
Bio-inspired Engineering
Bio-inspiration
Biognosis



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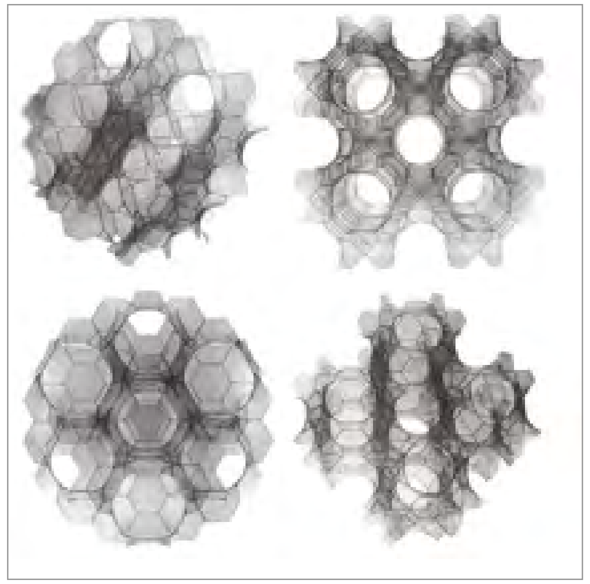
On Growth and Form
D'Arcy Thompson, 1917

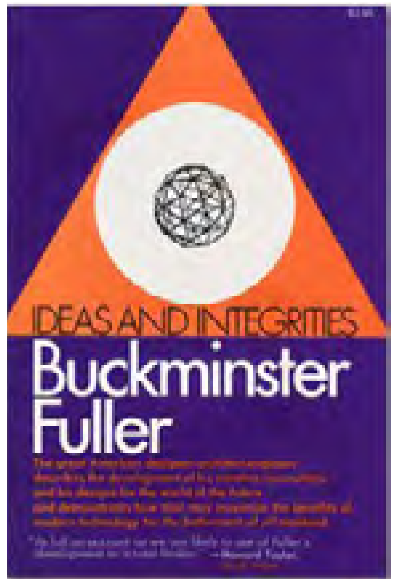
Design with Nature
Ian McHarg, 1969

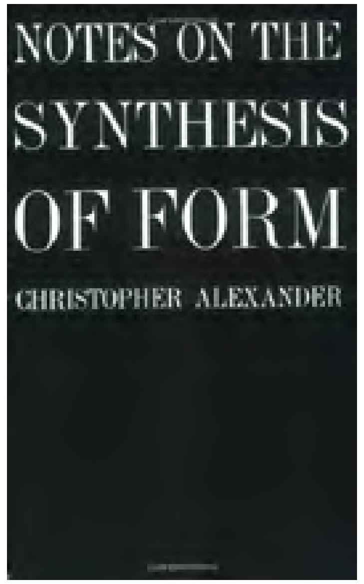


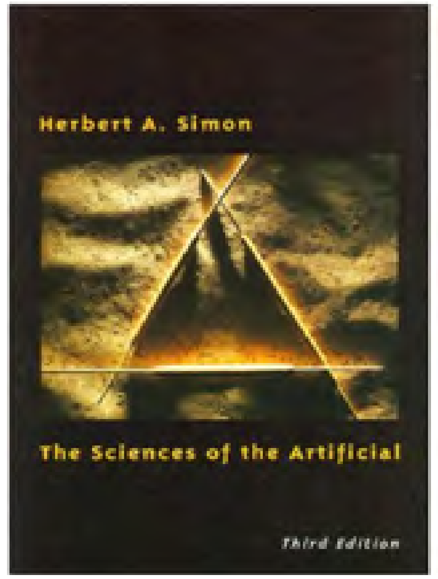
—
Structure in Nature is a Strategy for Design
Peter Pearce, 1978

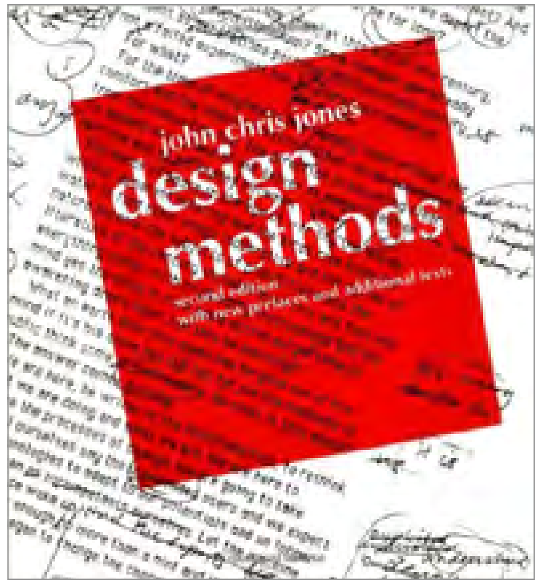
Biomimicry: Innovation Inspired by Nature
Janine Benyus, 1997

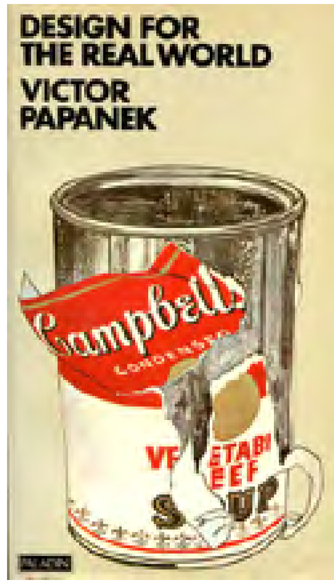
Advances in systems science led to design methods— the 1960s movement that preceded "design thinking."

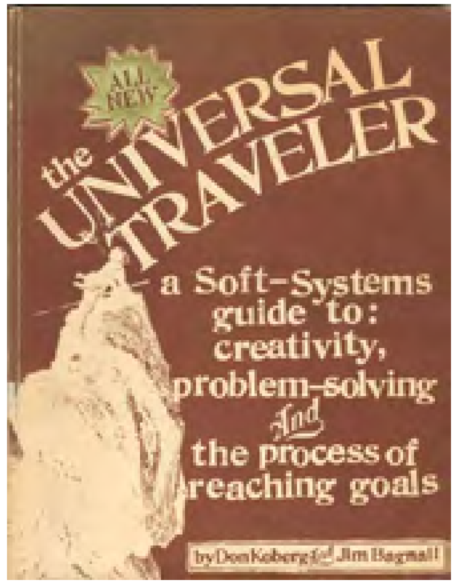












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Ideas and Integrities
Buckminster Fuller, 1963

A Systematic Method for Designers
Bruce Archer, 1963-64

Notes on the Synthesis of Form
Christopher Alexander, 1964

The Universe of Design
Horst Rittel, 1964 (2013)

—

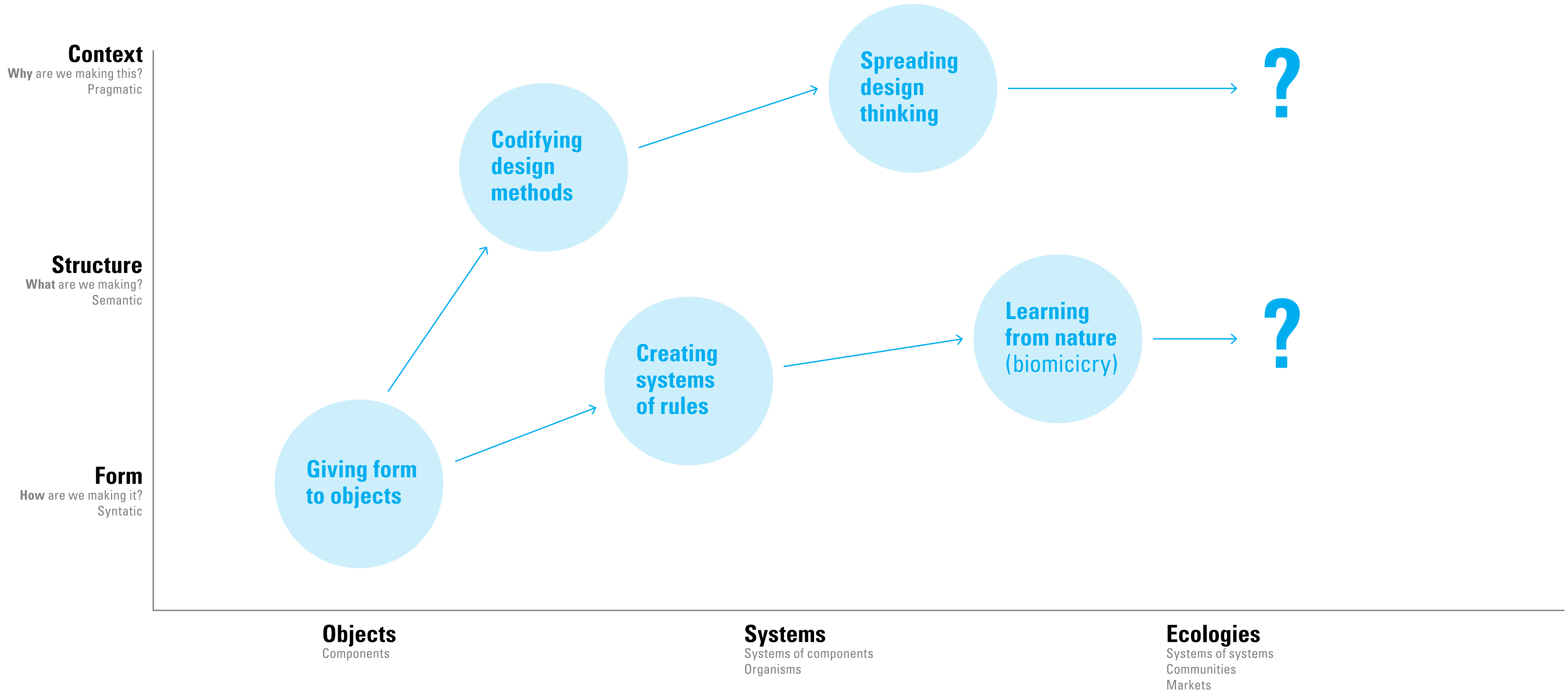
Sciences of the Artificial
Herbert Simon, 1969

Design Methods
John Chris Jones, 1970

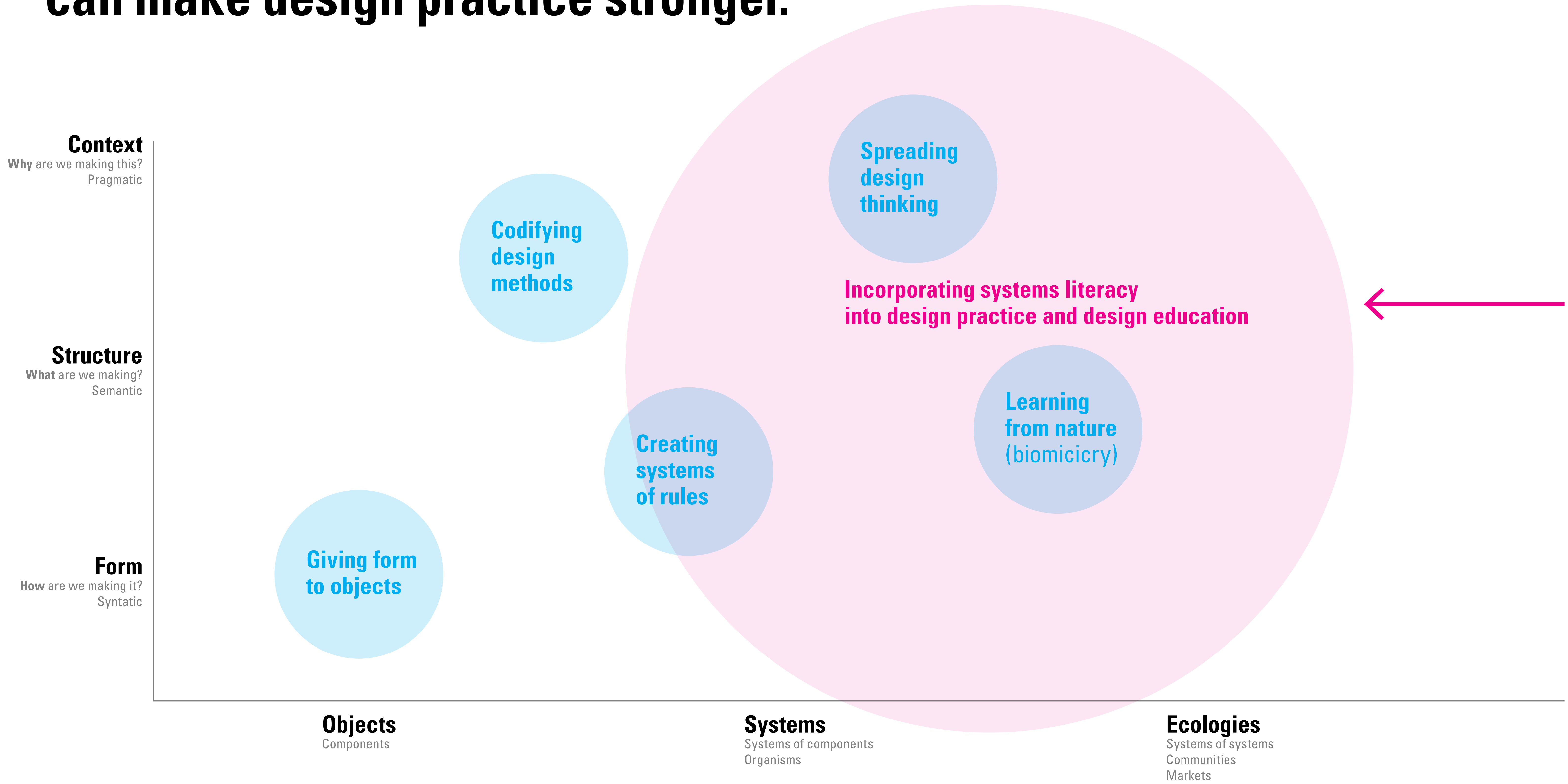
Design for the Real World
Victor Papanek, 1971

The Universal Traveler
Koberg & Bagnall, 1973

The scope of design practice is expanding.

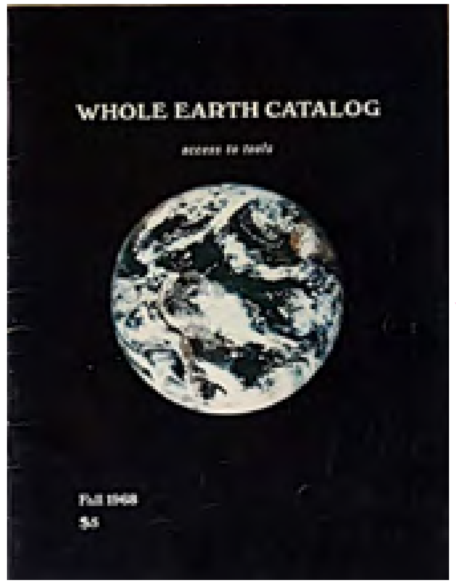


Knowledge from other disciplines can make design practice stronger.



Stewart Brand connected design and systems.

Stewart Brand connected design and systems— creating what amounts to a syllabus for grad students.



Whole Earth Catalog
Stewart Brand, 1968-1972

—

The Human Use of Human Beings
Norbert Wiener, 1950

The Image
Kenneth Boulding, 1956

General Systems Yearbook
von Bertalanffy and Rapoport, 1956

—

An Introduction to Cybernetics
Ross Ashby, 1968

Purposive Systems
Heinz von Foerster, 1968

Systems Thinking
F. E. Emery, 1969

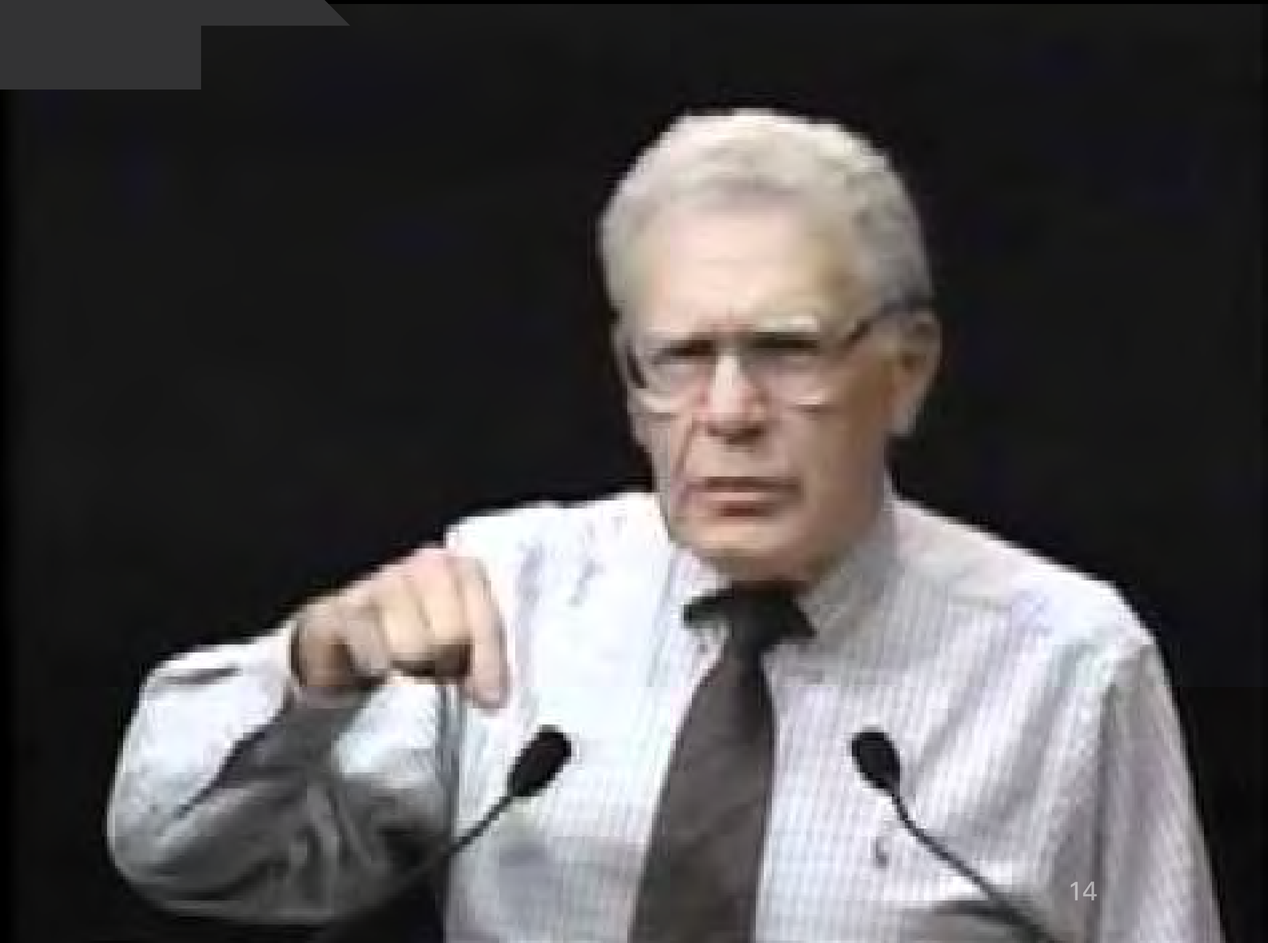
Why do we need systems literacy?

For the public, for managers, and for designers.

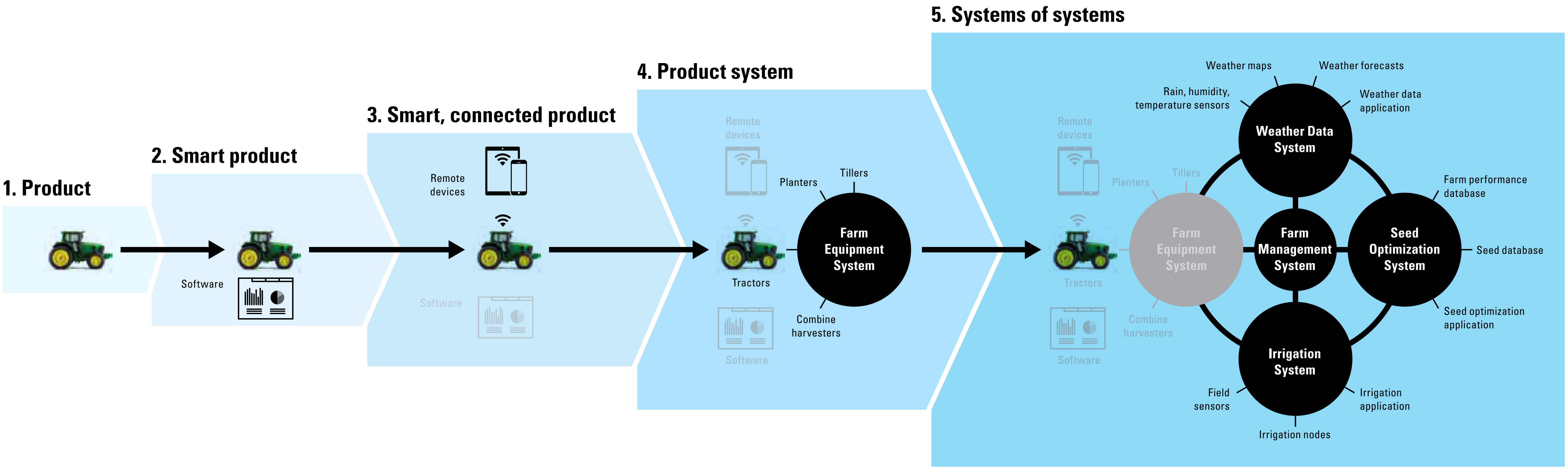
"Managers are not confronted with problems that are independent of each other, but with dynamic situations that consist of complex systems of changing problems that interact with each other. I call such situations messes."

Horst Rittel called them "wicked problems."

—Russell Ackoff, 1979



New products that create high value increasingly involve systems— or product-service ecologies.



— Michael Porter, 2014

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

– The environment, energy, and global warming
– Water, food, and population
– Health, justice, and security

"…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."

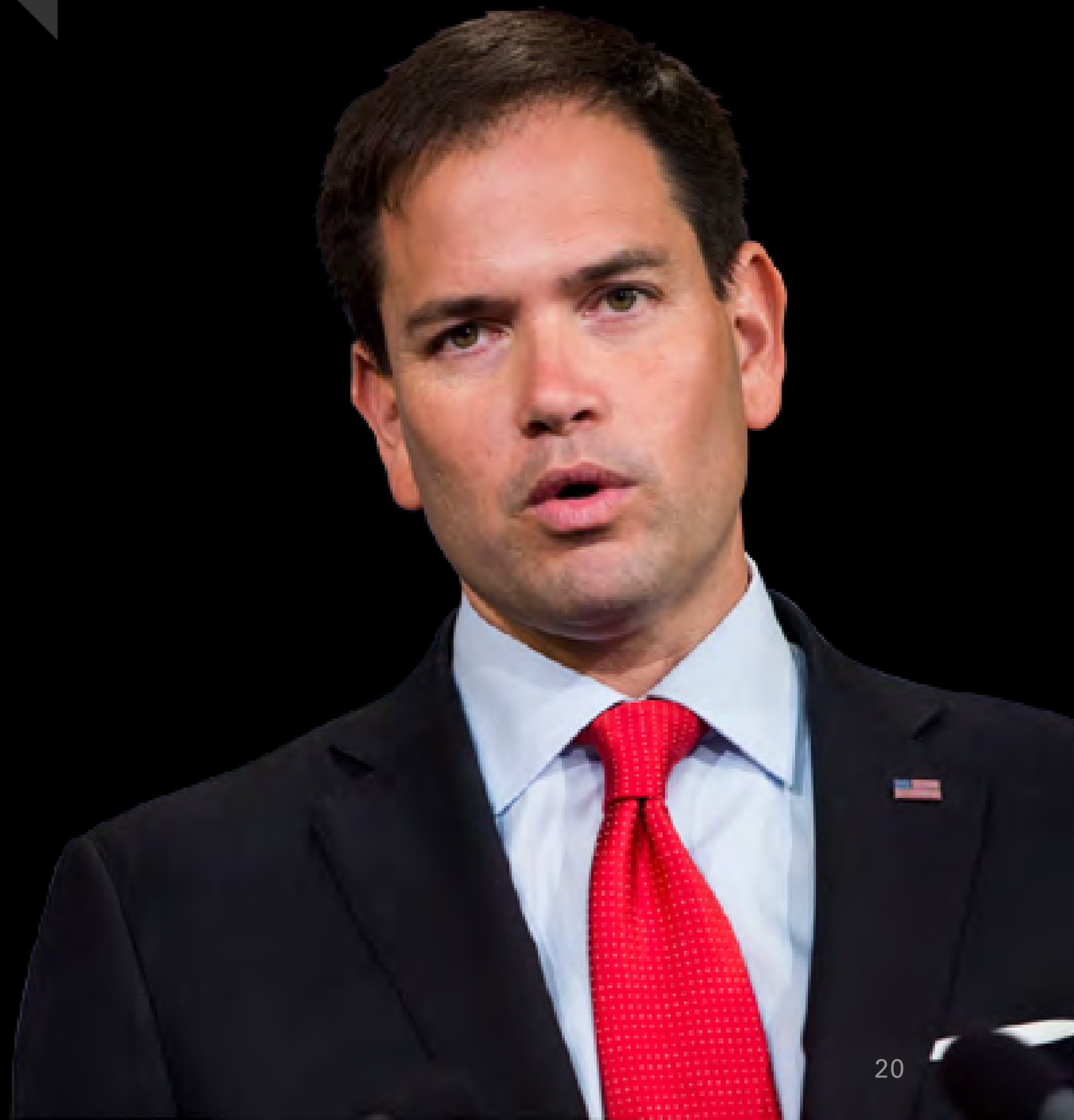
— Ronald Reagan, 1981

"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)



**Rejecting government,
decision makers “not knowing what they are doing,”
lacking “adequate basis to judge effects,”
is not simple 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.

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

– **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 systems may not appear as “wholes.”

Unlike an engine or a tornado or a human being, other systems 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.**

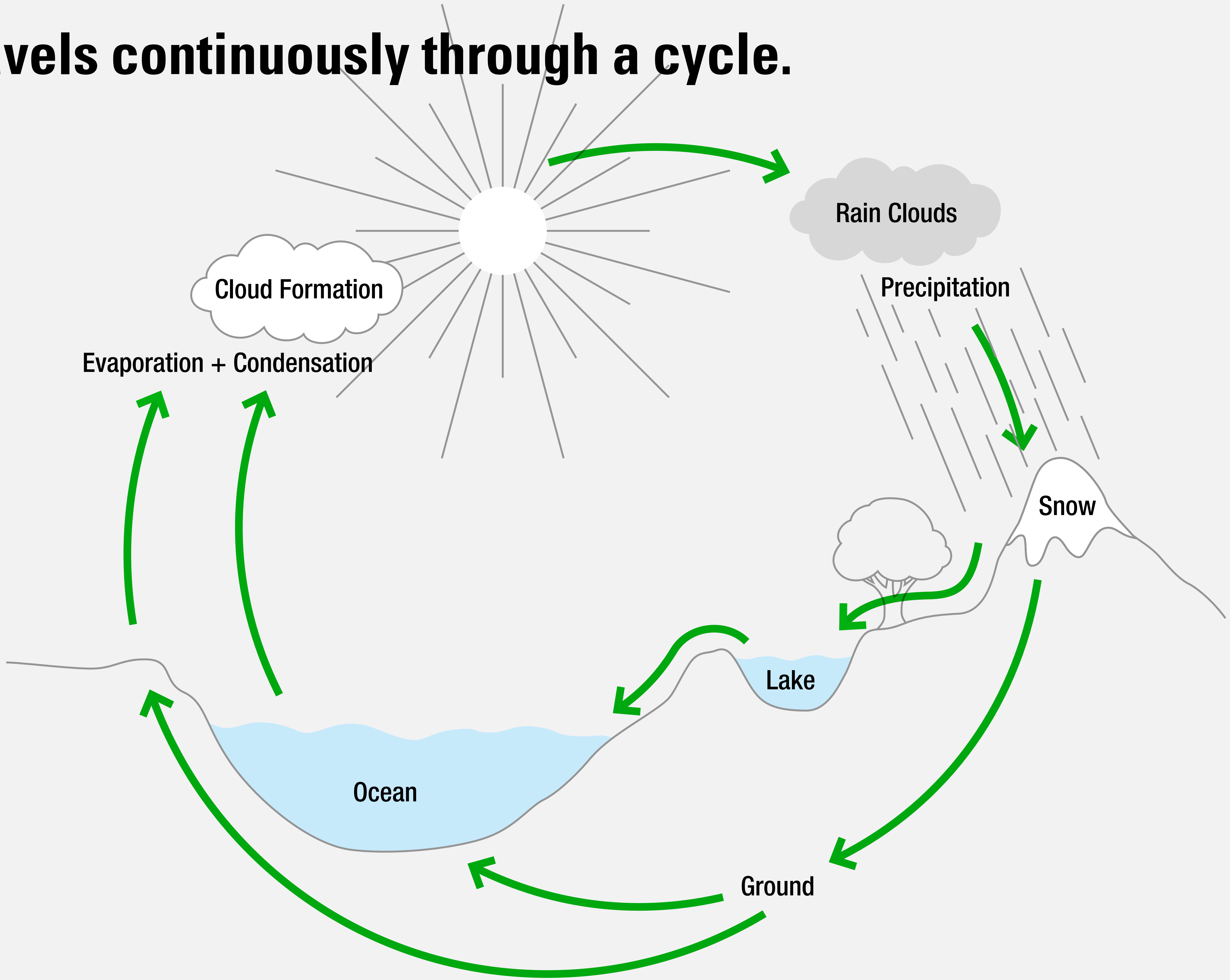
Or we may live within these systems
seeing only a few individual parts,
making the whole easy-to-overlook.

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

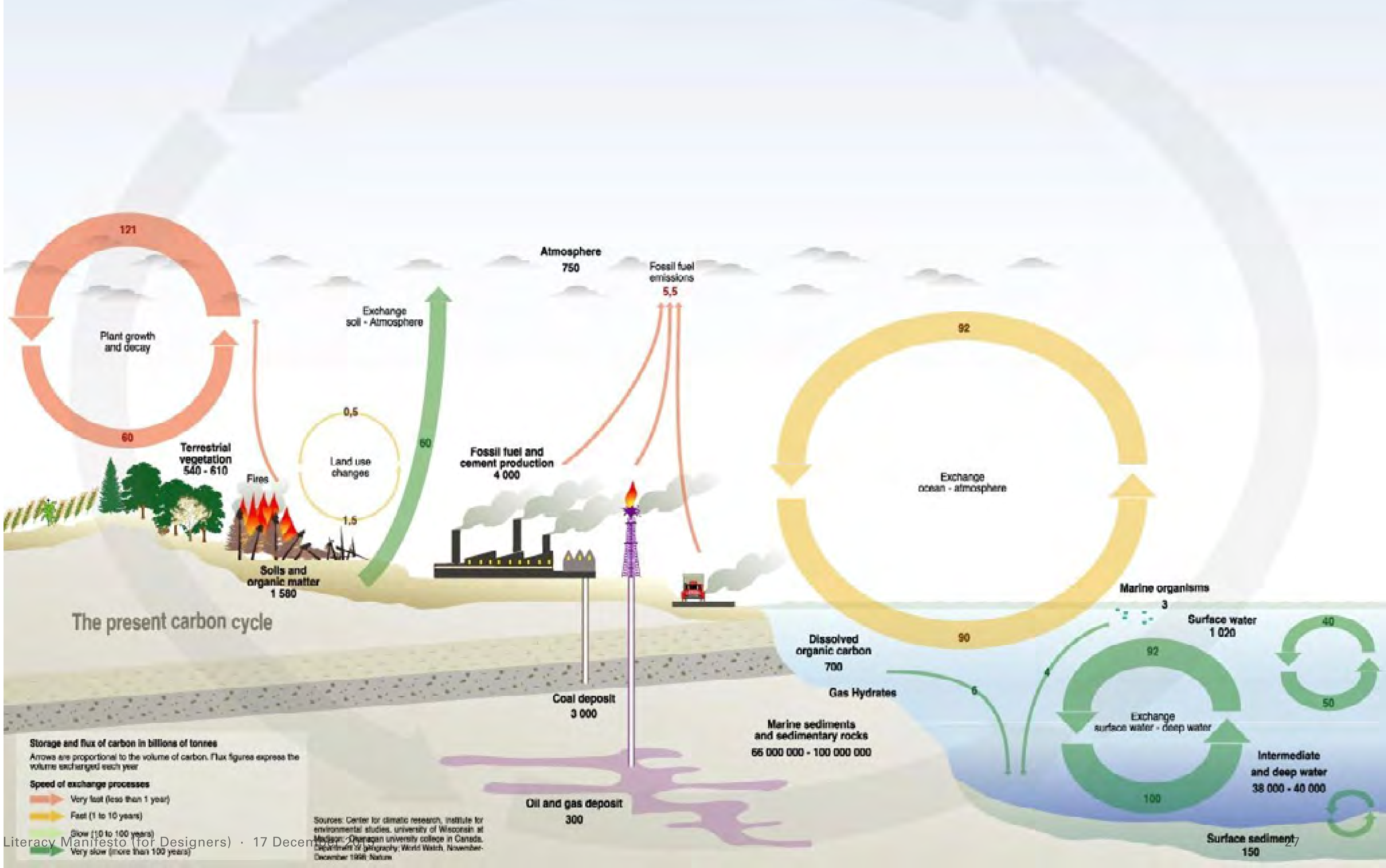
For example,

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

Water travels continuously through a cycle.

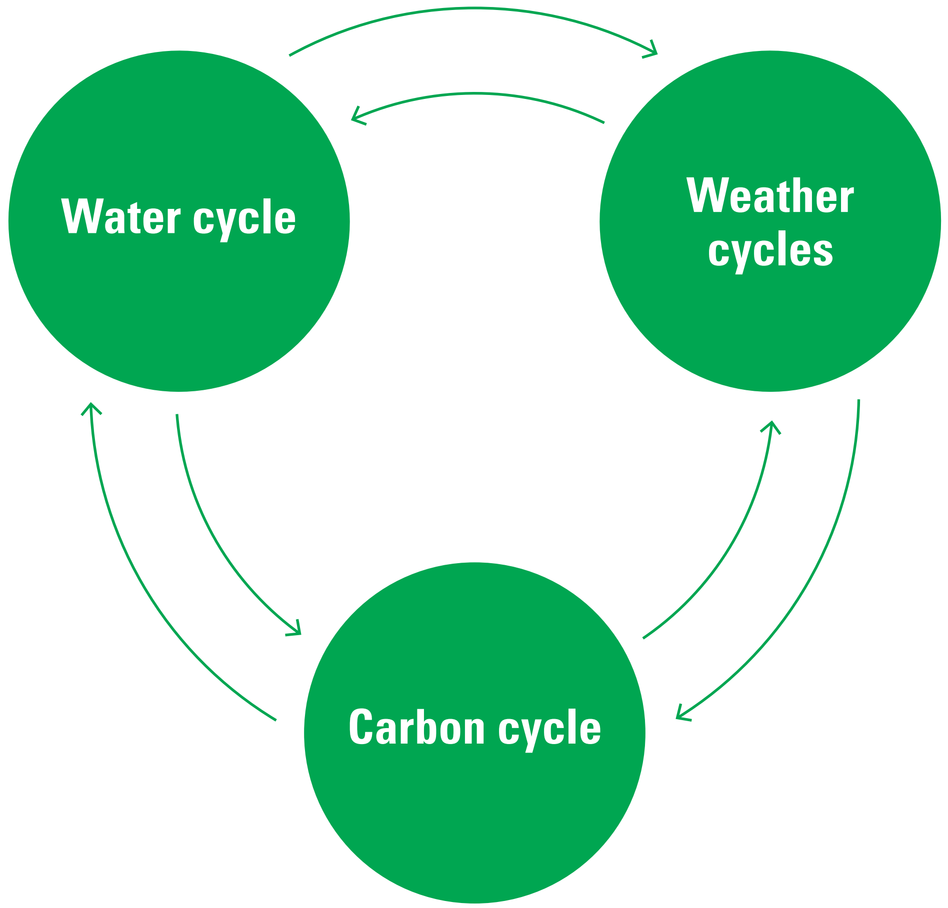


Carbon also travels through a cycle.



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 systems literacy?

What does it mean to read, understand, and write systems?

Churchman outlines four approaches to systems:

efficiency expert:
reducing time and cost

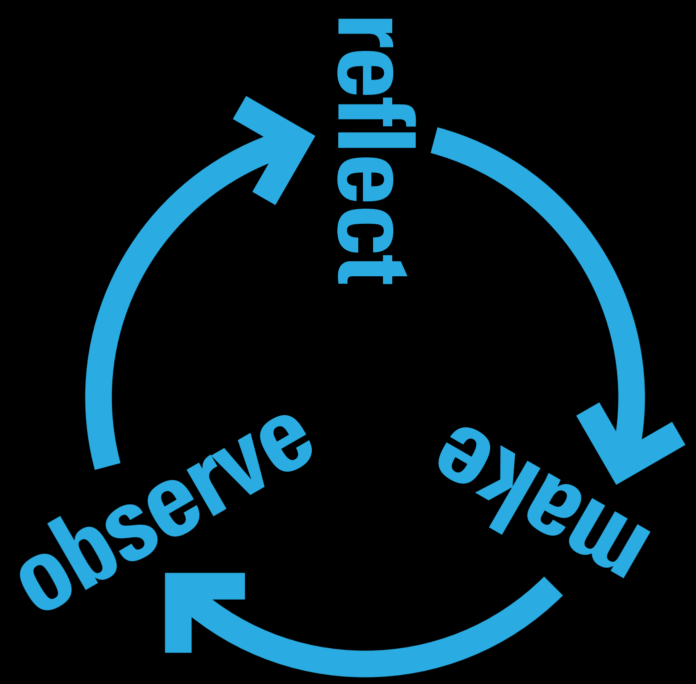
scientist:
building (mathematical) models

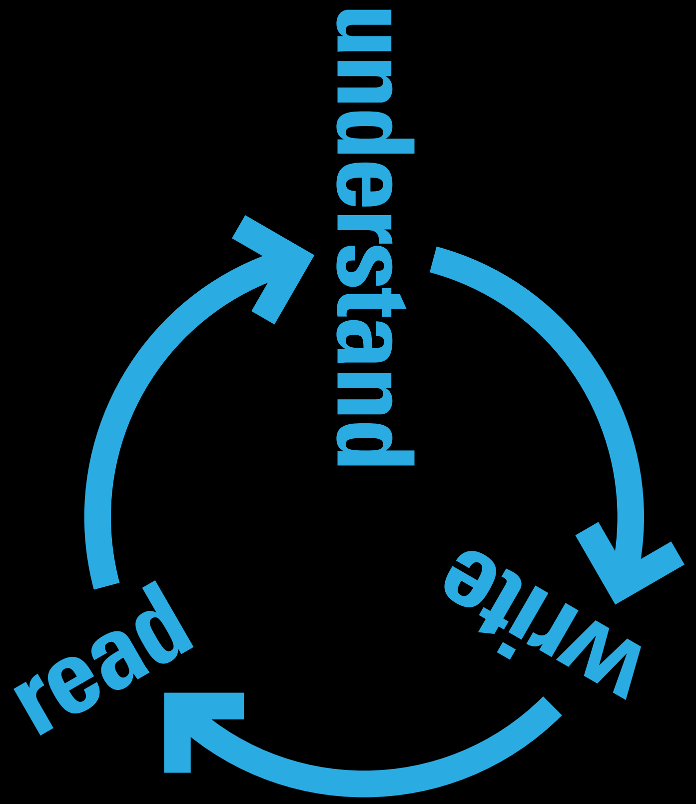
humanist:
looking to our values

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:

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

– **understanding** (vocabulary and frameworks):
a set of distinctions and entailments (relationships)

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

Systems literacy is enriched with:

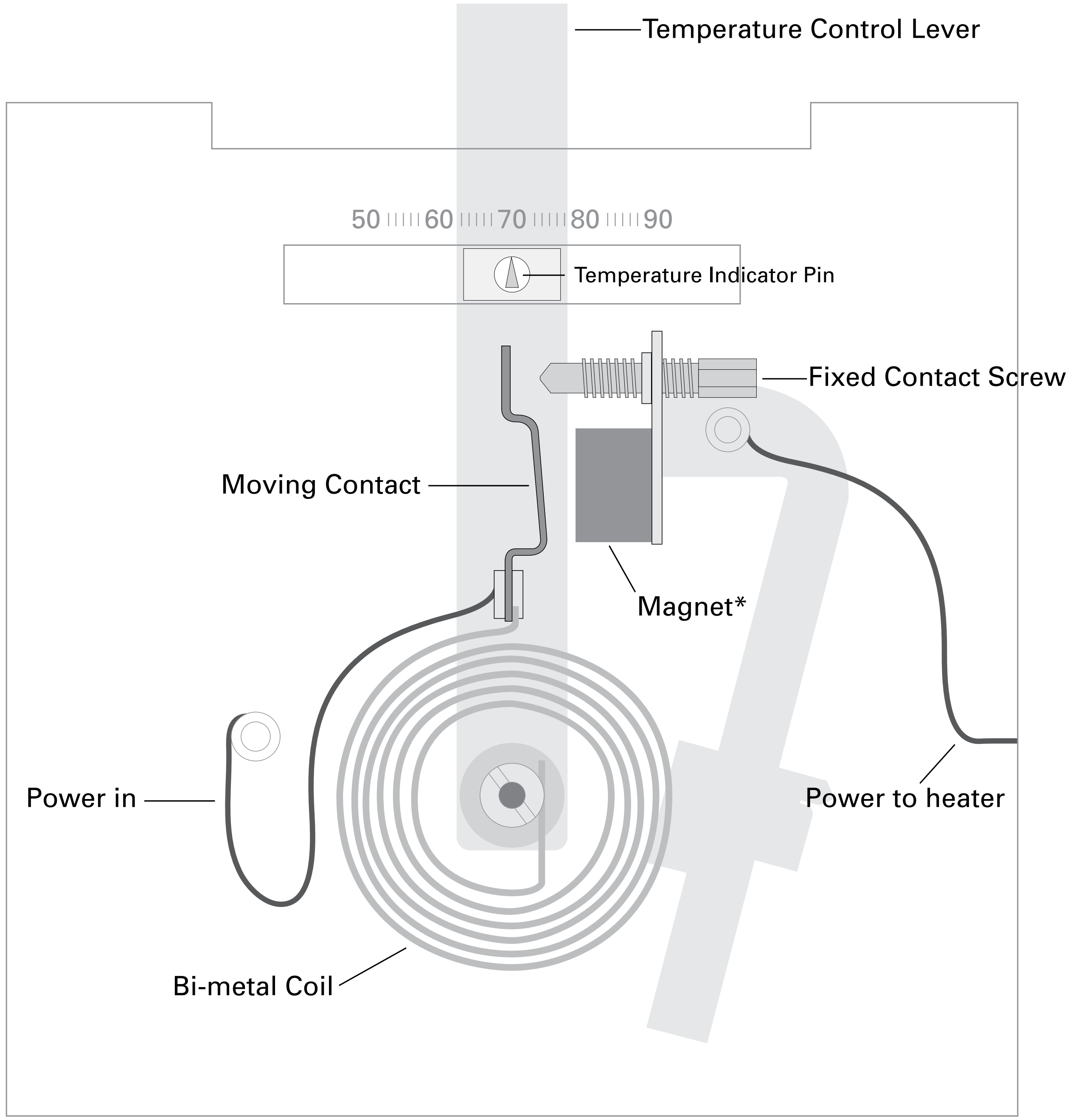
- **literature:**
  a canon of key works of theory and criticism
- **history:**
  context, sources, and development of key ideas
- **connections:**
  conversations among and between disciplines
  e.g., design methods and management science

Reading systems means recognizing common patterns in specific situations.

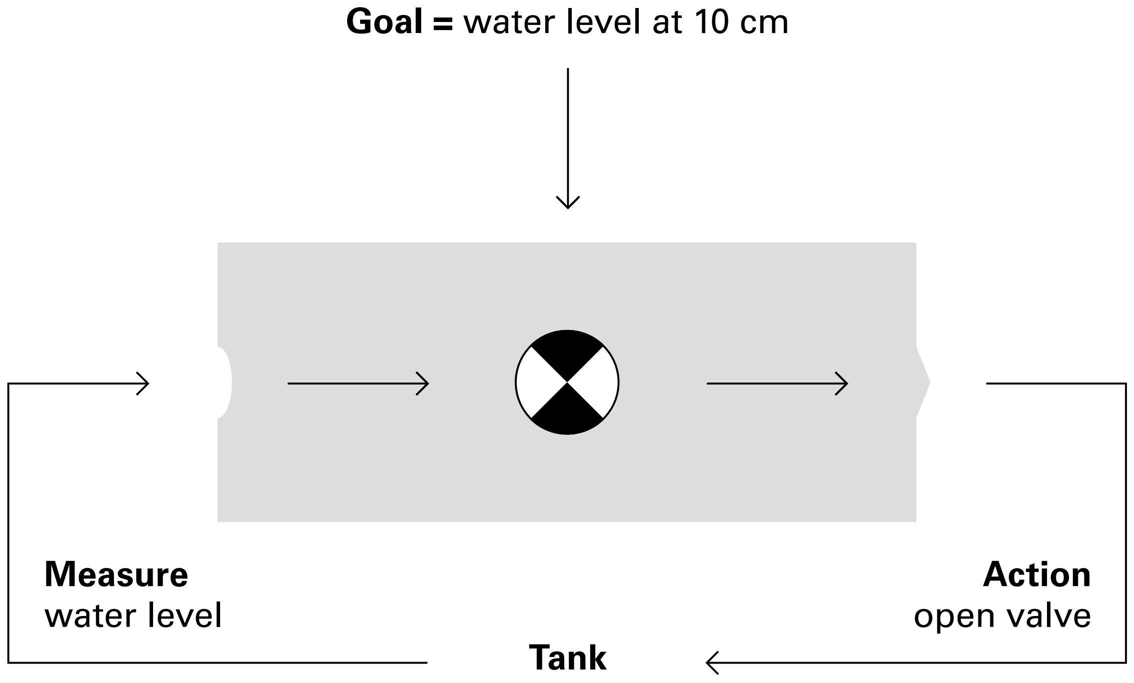
e.g.,

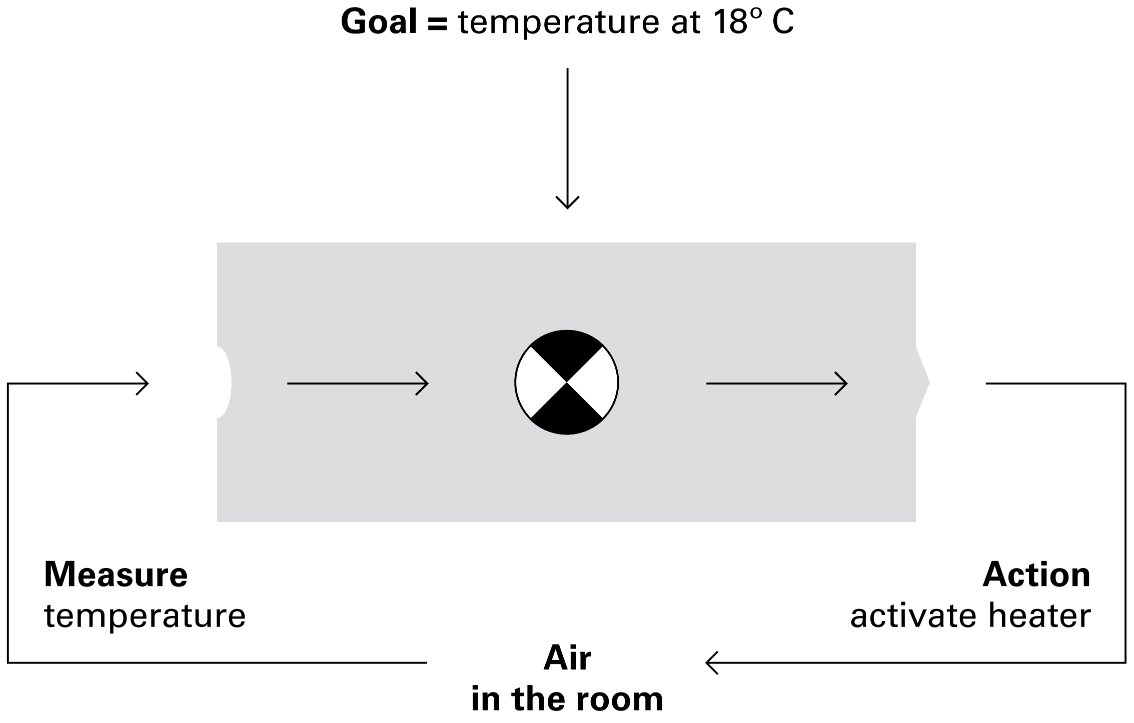
– resource flows and cycles
– transform functions (processes)
– feedback loops
– feed-forward
– requisite variety
– second-order feedback
– goal-action trees

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



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





Understanding systems requires a vocabulary of about 150 terms:

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, allopoetic systems
constructivism
recursion

observer, observed
controller, controlled

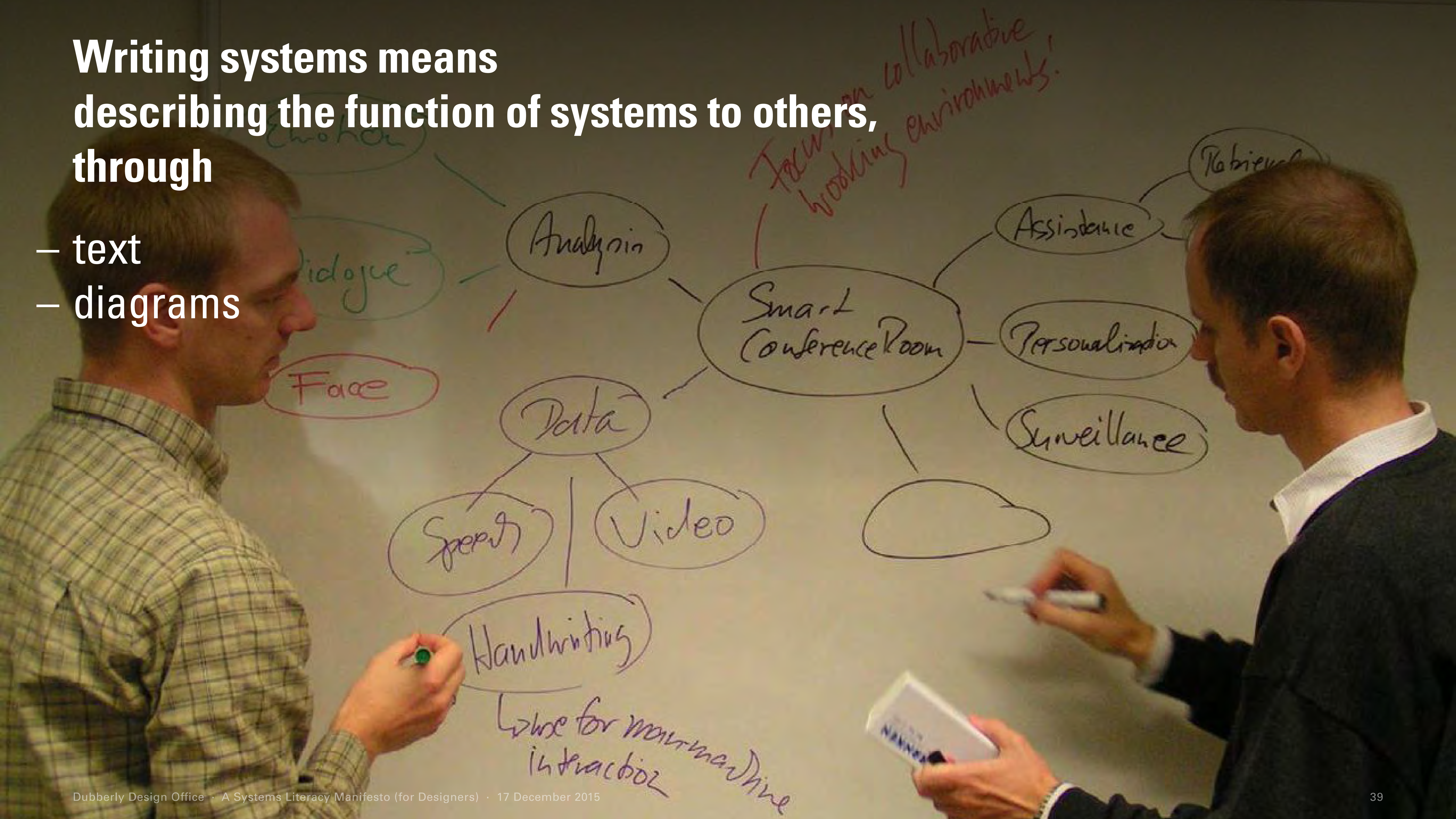
agreement, (mis-)understanding
“an agreement over an understanding”
learning, conversation
bio-cost, bio-gain
back-talk

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”

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

– text
– diagrams



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.

"Sentential representations are sequential, like the propositions in a text. Diagrammatic representations are indexed by location in a plane. Diagrammatic representations also typically display information that is only implicit in sentential representation and that therefore has to be computed, sometimes at great cost, to make it explicit for use."

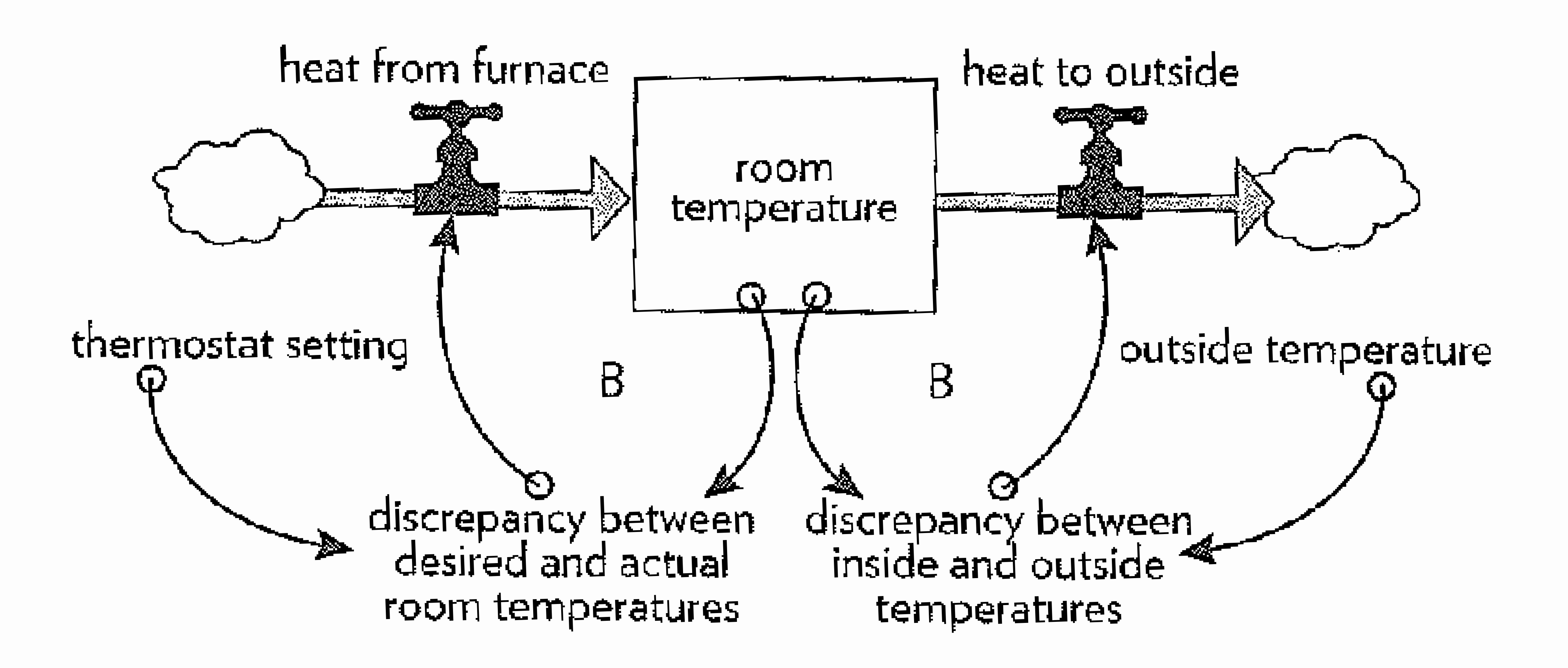
—Herbert Simon
"Why a diagram is (sometimes) worth ten thousand words", 1987

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

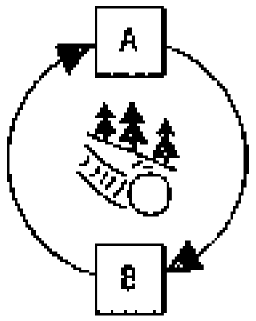
But function must be represented in diagrams, often with some degree of formalism.

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

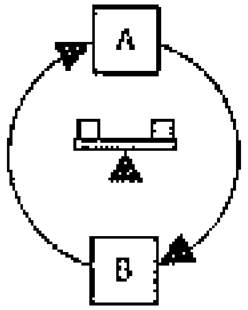
Donalla Meadows has a particular formalism.



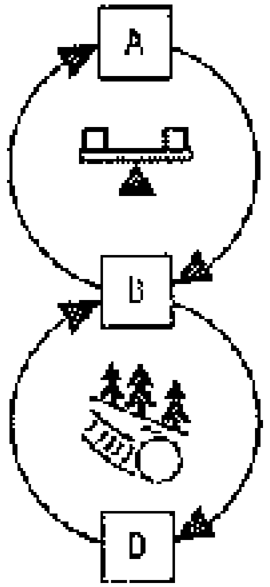
O’Connor & McDermott have another formalism.



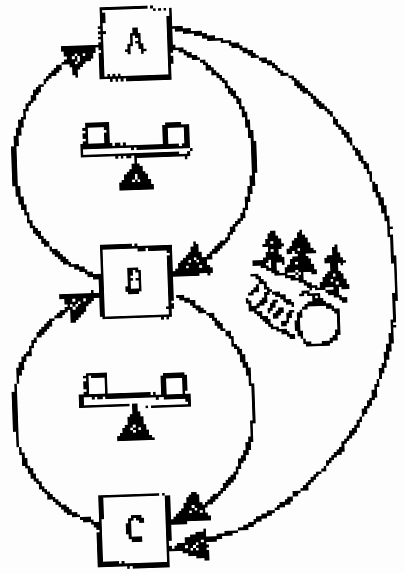
Reinforcing



Balancing

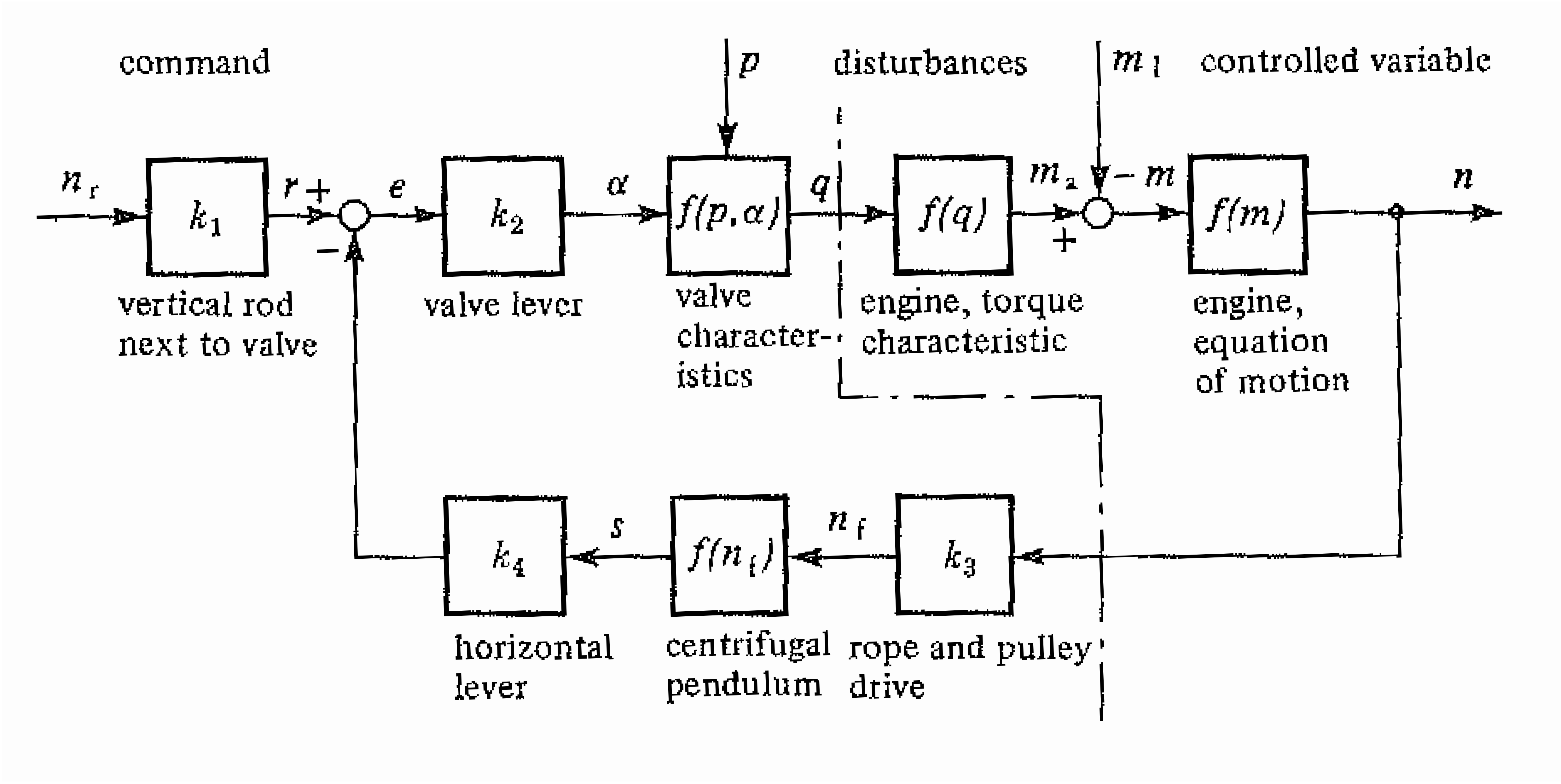


Limits to Success



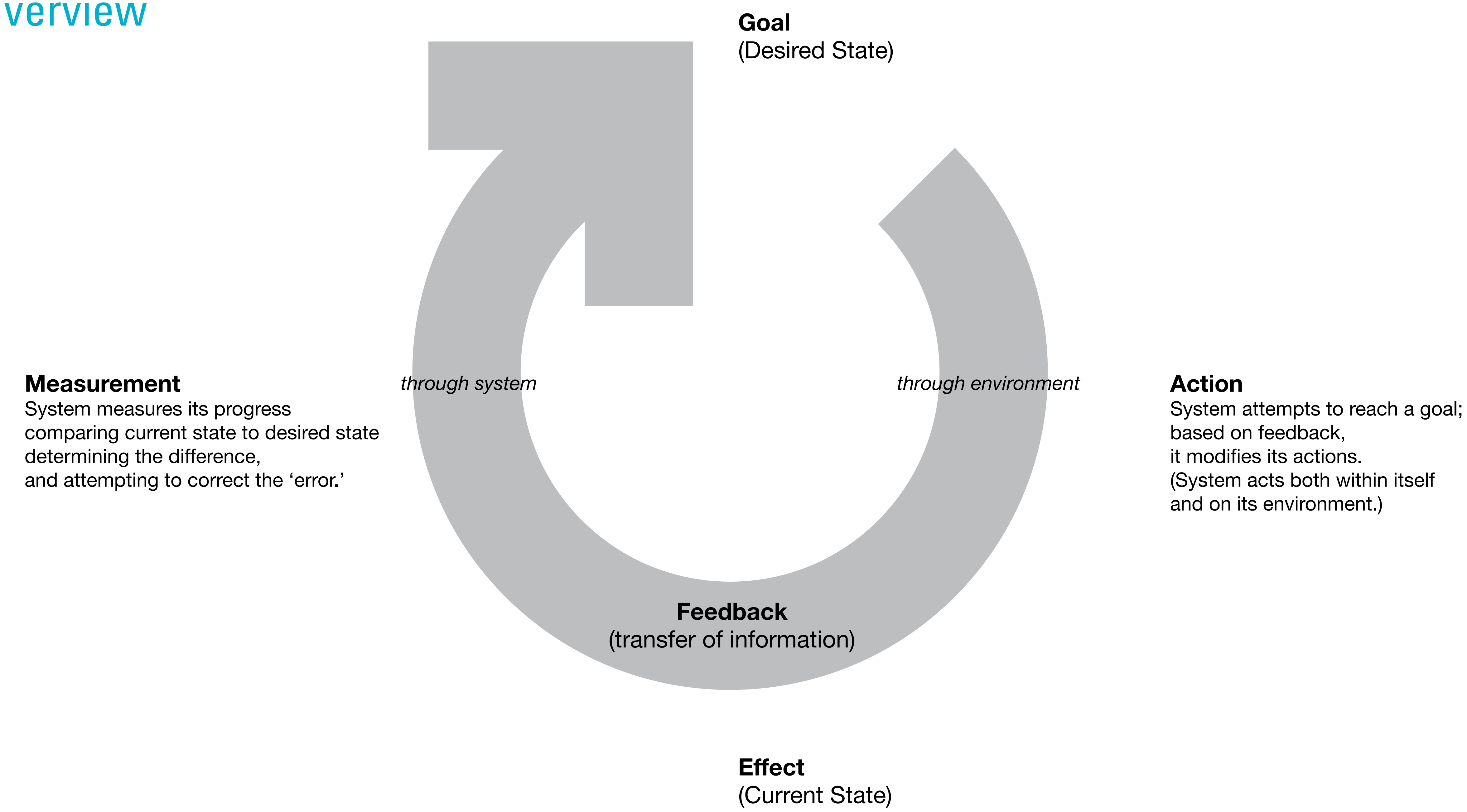
Addiction

Otto Mayr has a block diagram formalism.



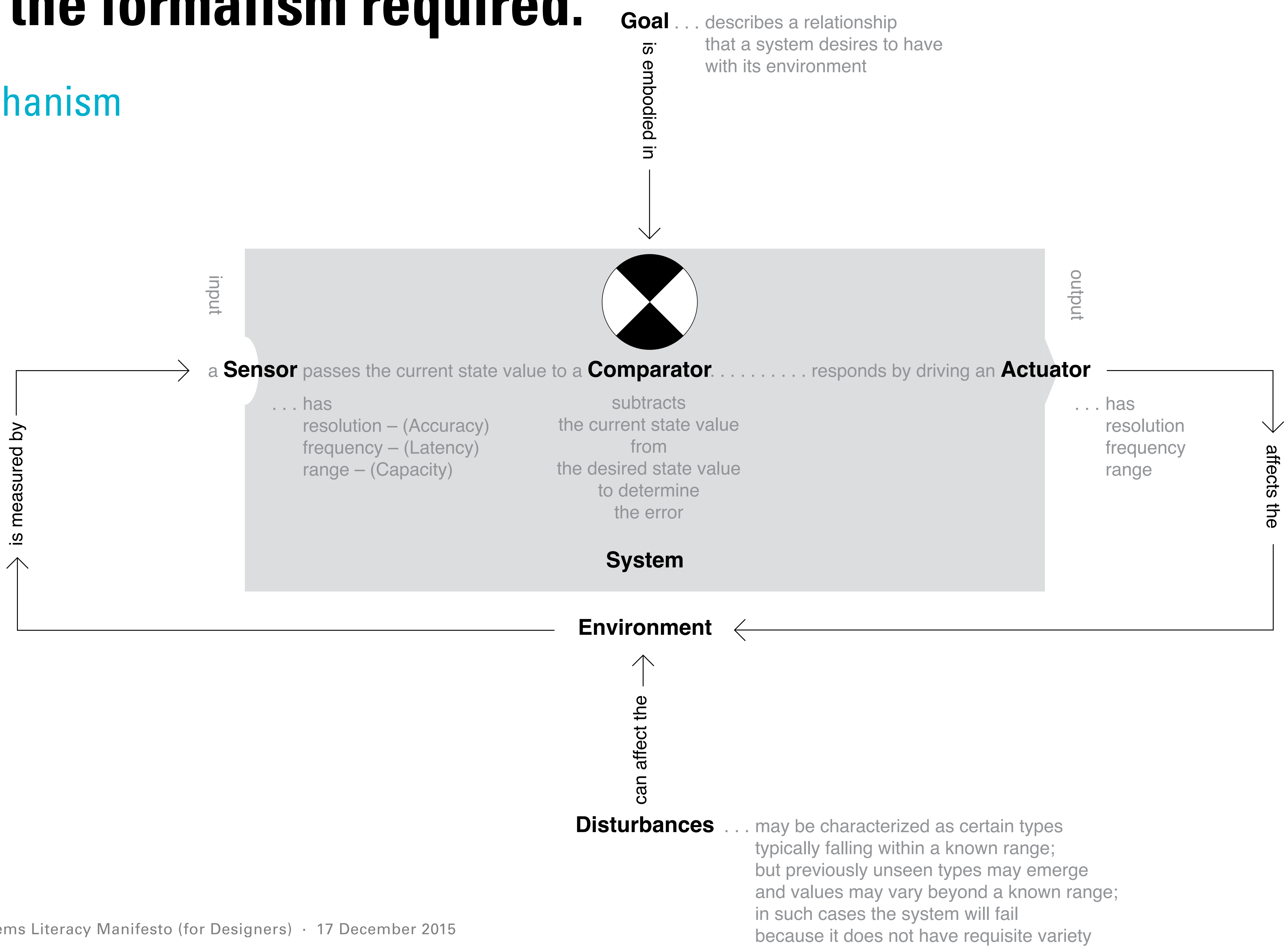
Yet in many cases, simple concept maps may be all the formalism required.

Feedback: Overview

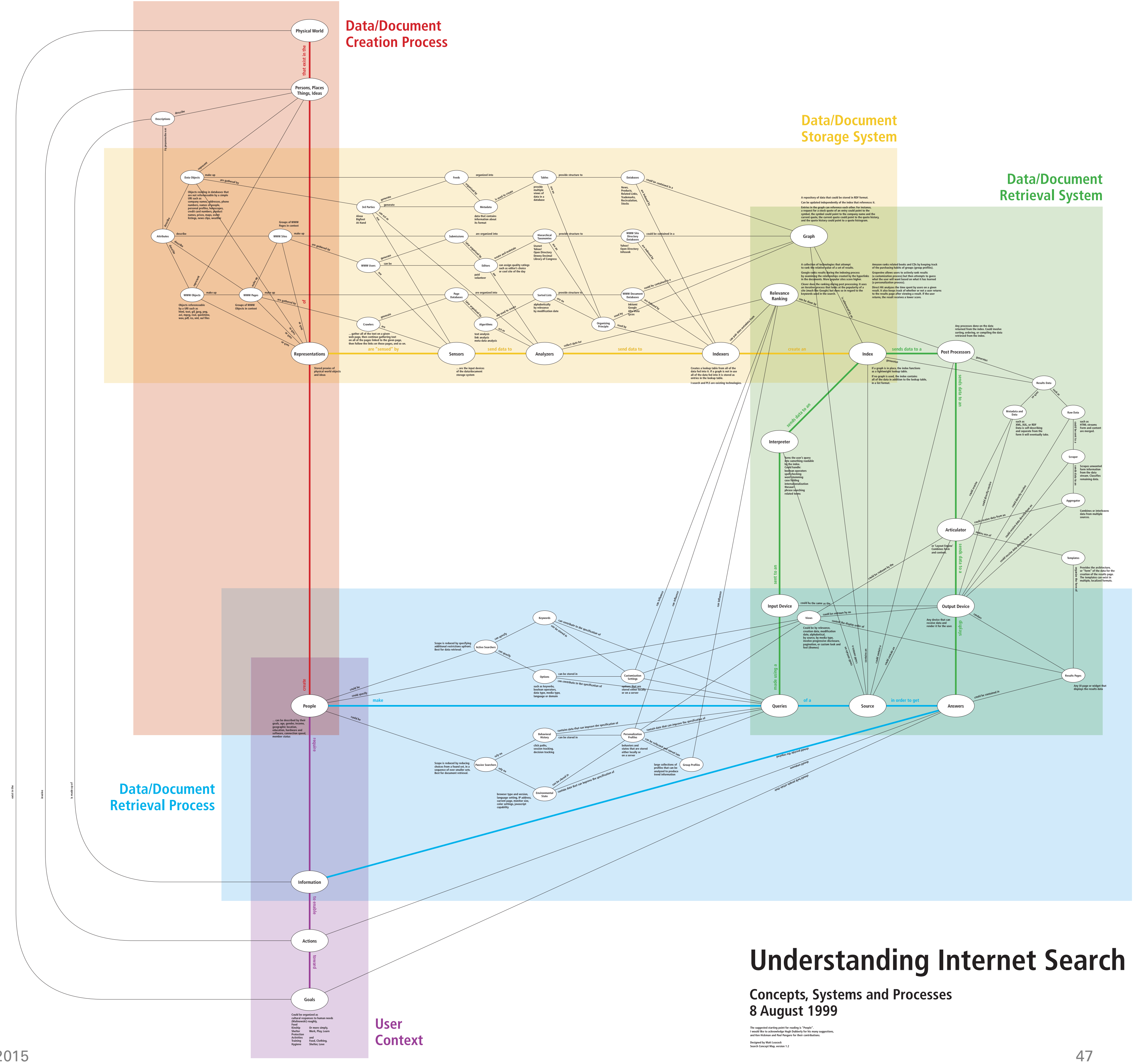


Yet in many cases, simple concept maps may be all the formalism required.

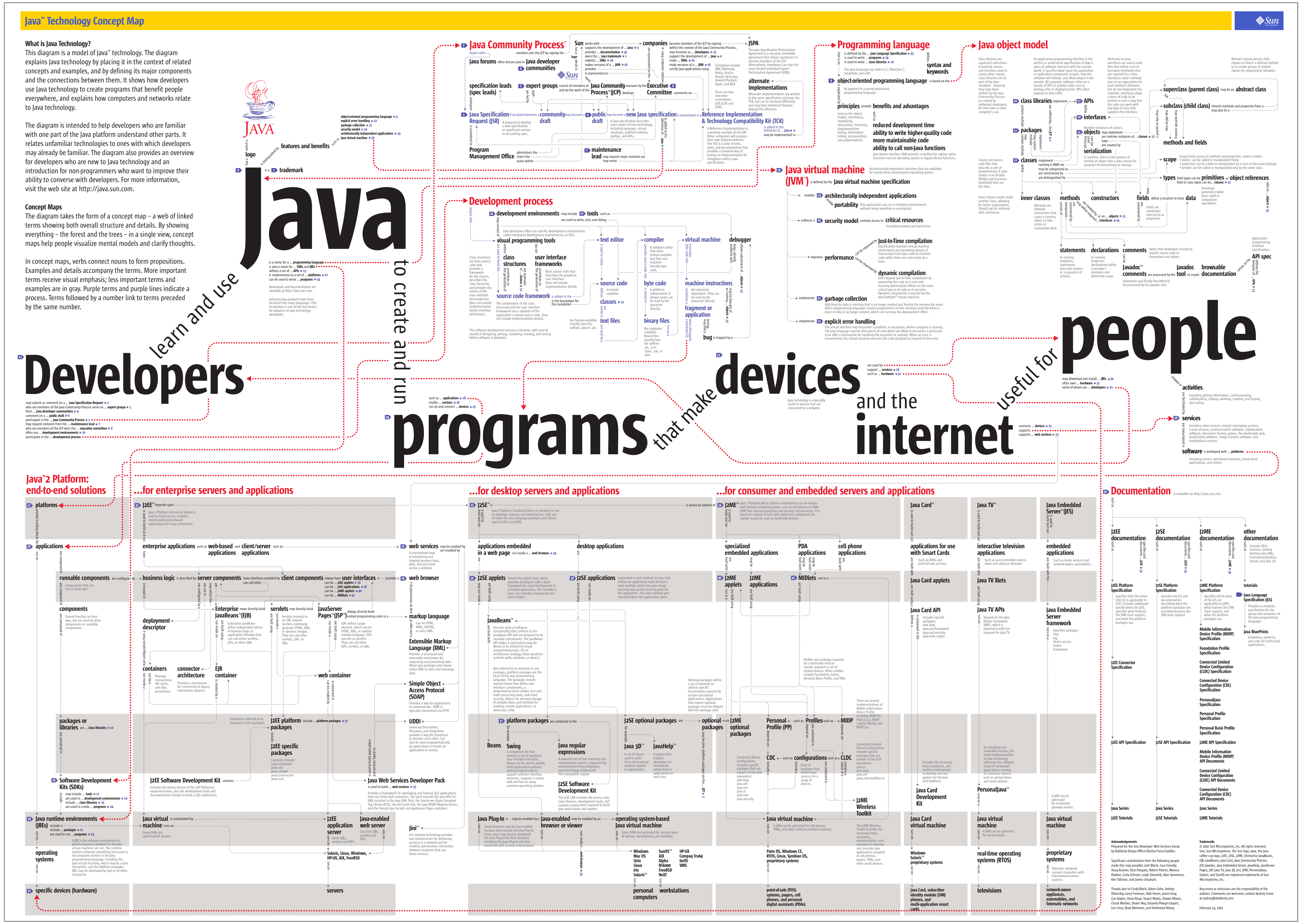
Feedback: Mechanism



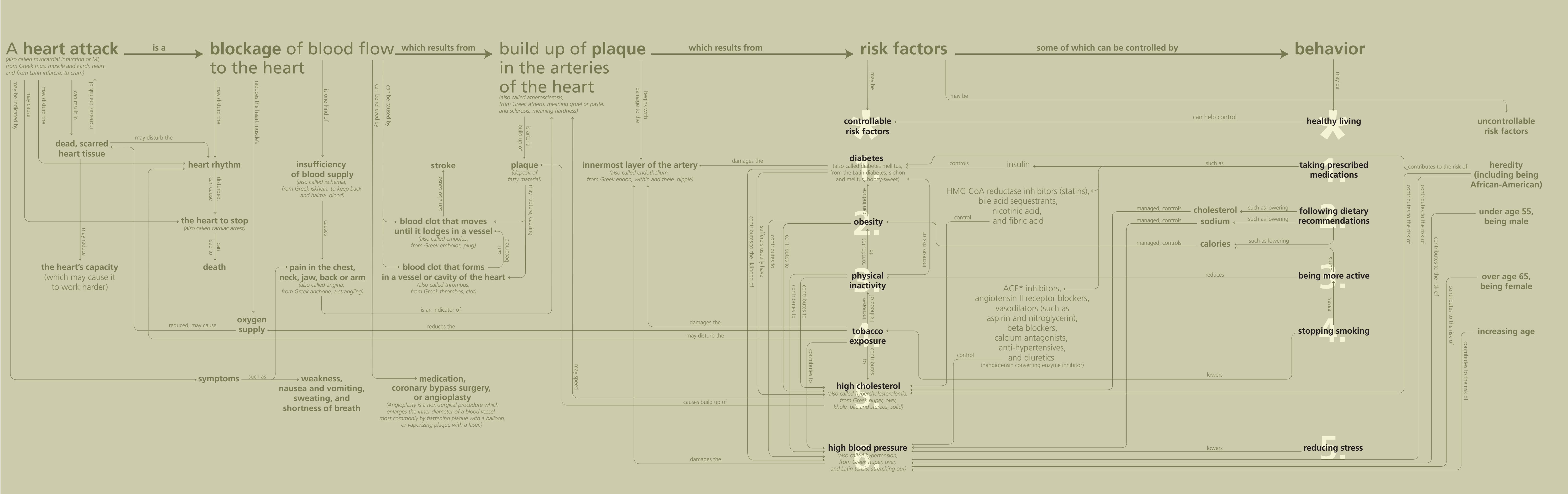
Netscape search concept map



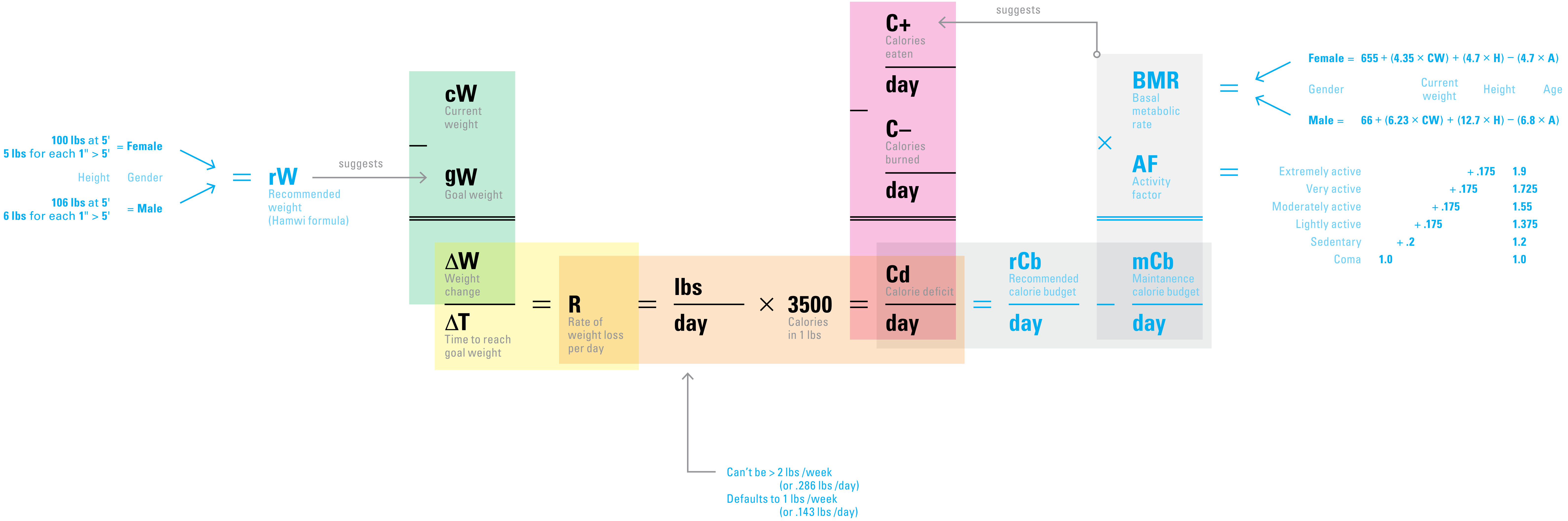
Java concept map



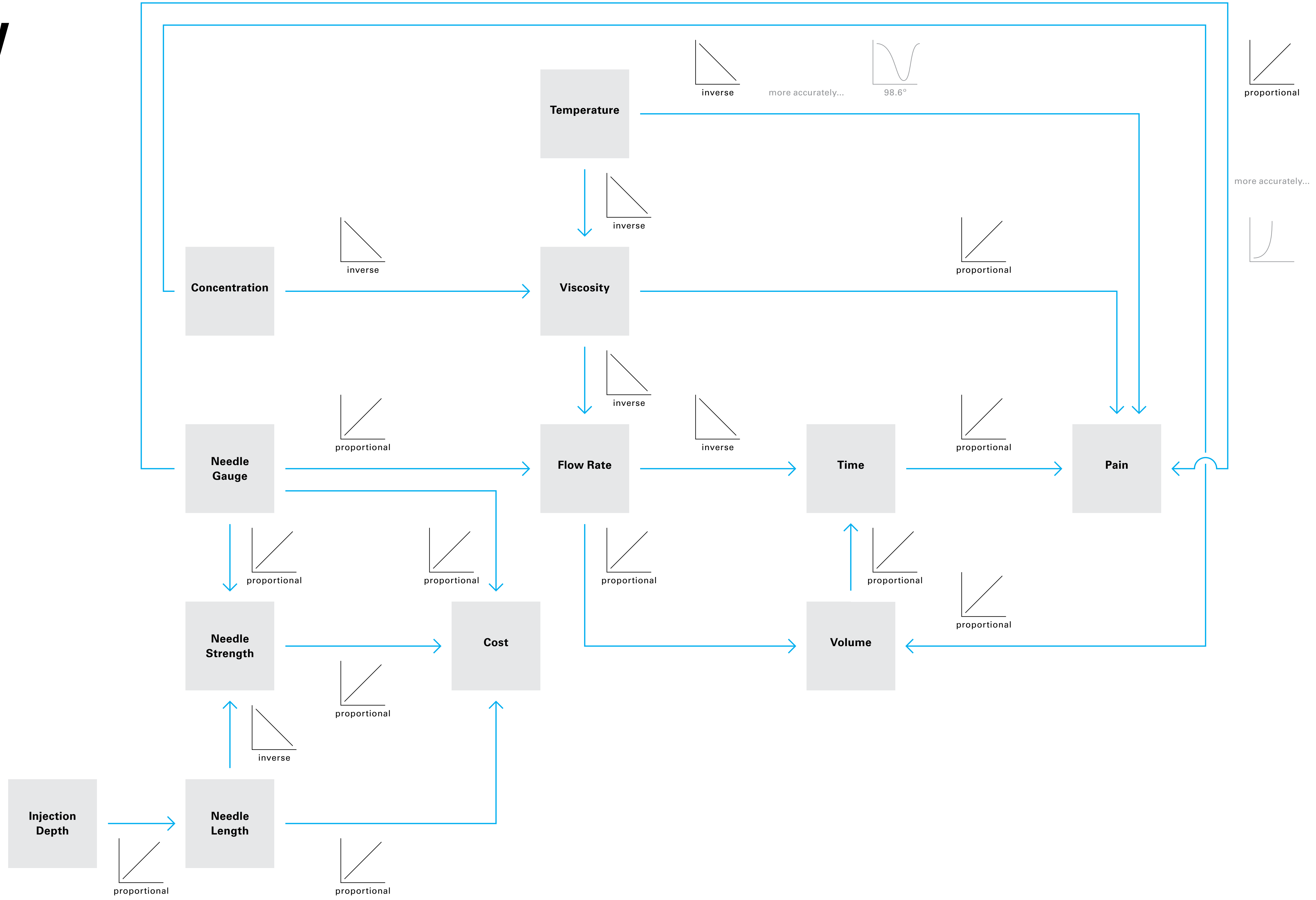
Heart attack concept map



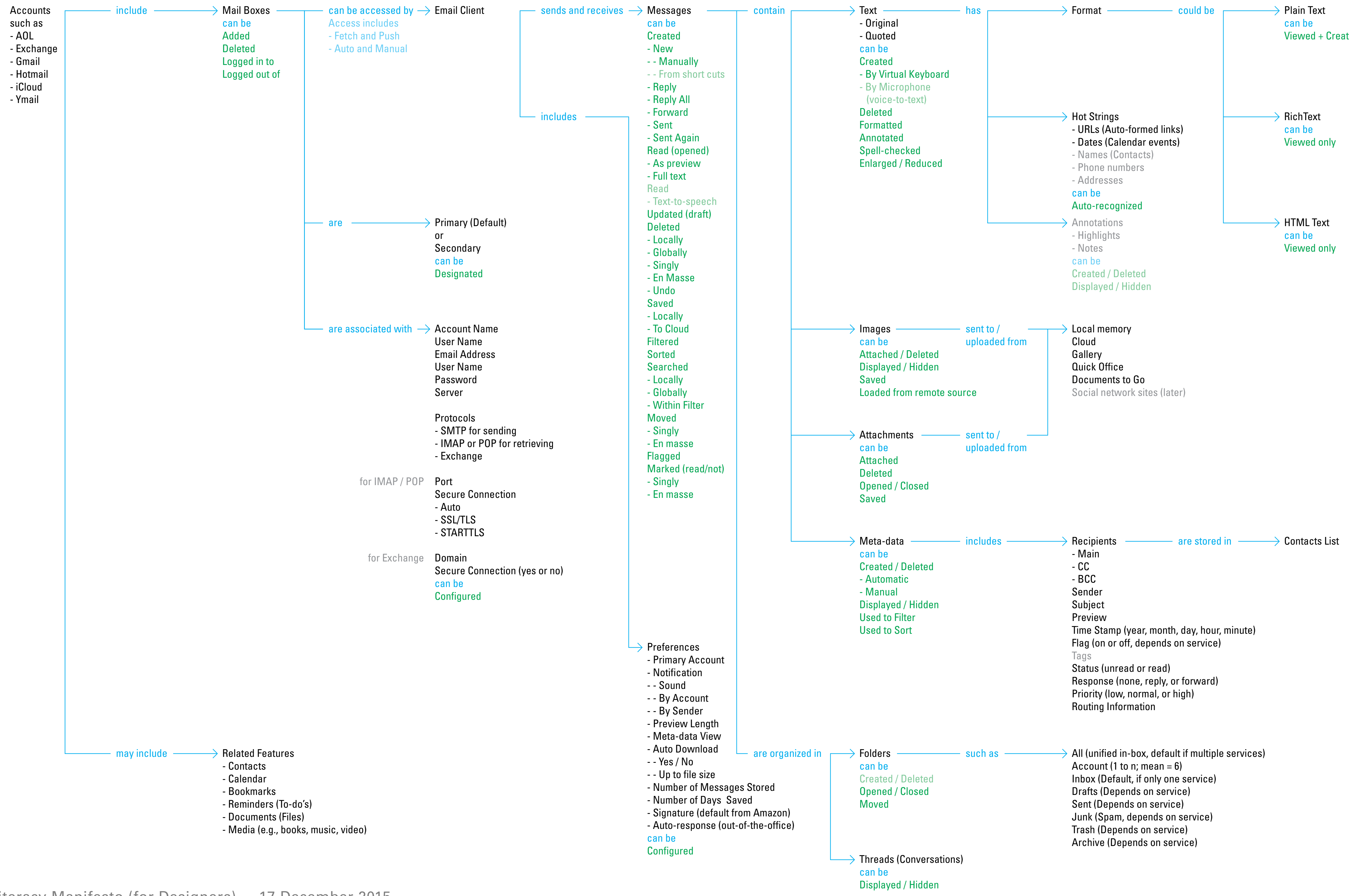
Weight control concept map



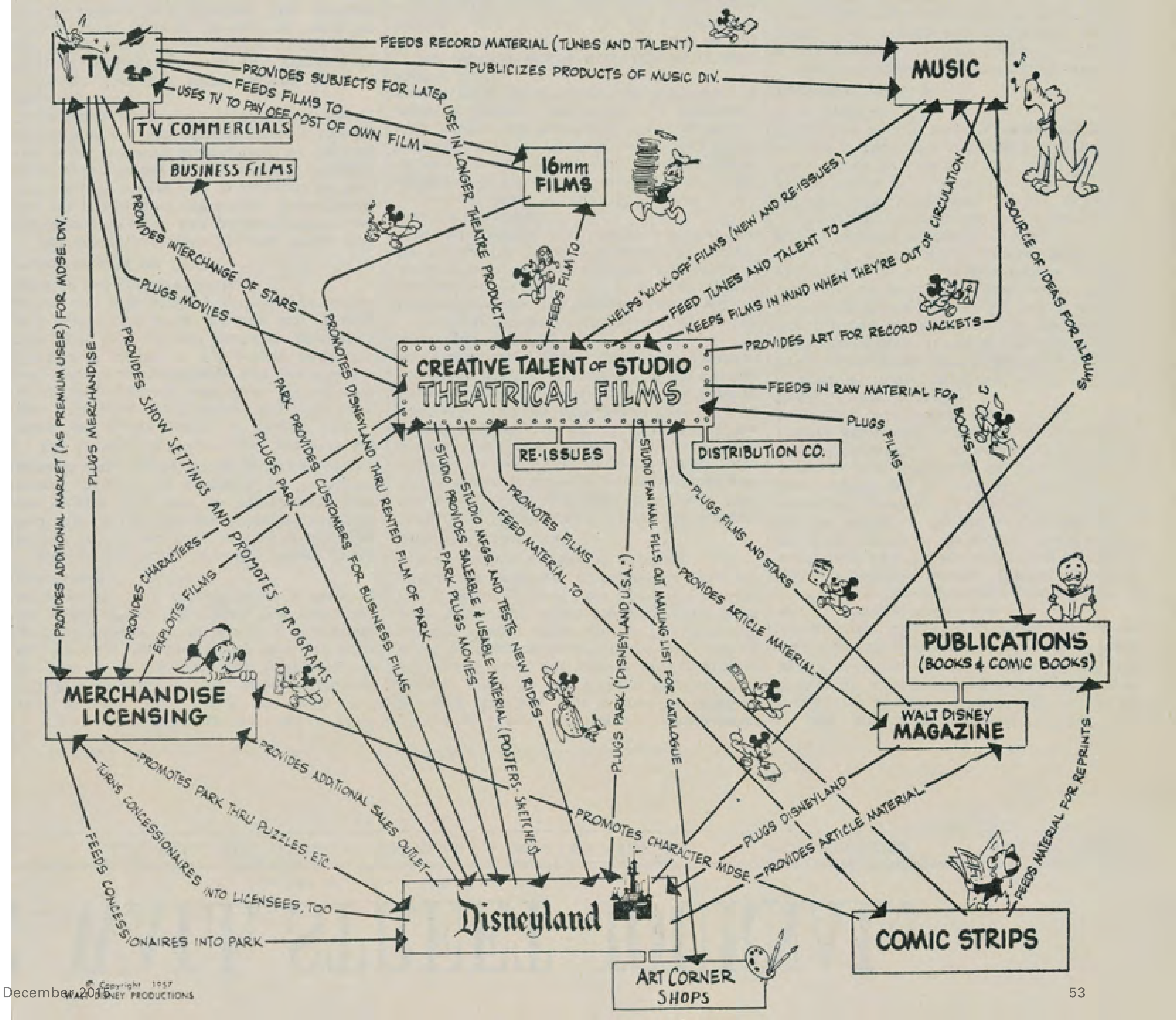
Drug delivery device map



Email conceptual model



Disney product-service ecology map



How do we achieve systems literacy?

In design schools and management schools in particular,
also in general college education,
and in kindergarten through high school.

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
– "The Architectural Relevance of Cybernetics," Pask

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

– "What is conversation?" Pangaro
– *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 systems literacy

Systems and ethics—
our responsibility for our language, our technology,
and the world in which we live.

"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

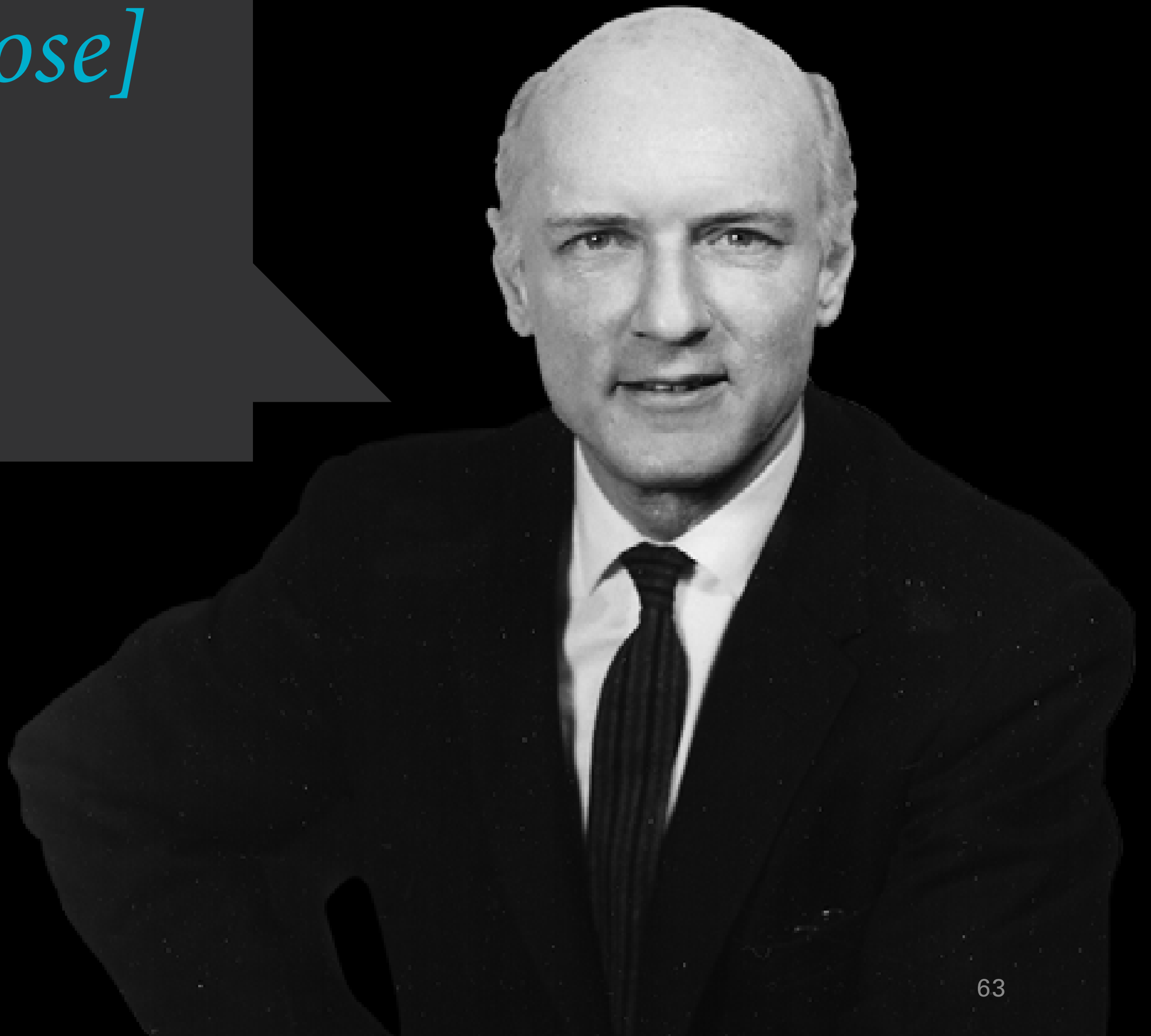
"Pask…distinguishes two orders of analysis.

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…"

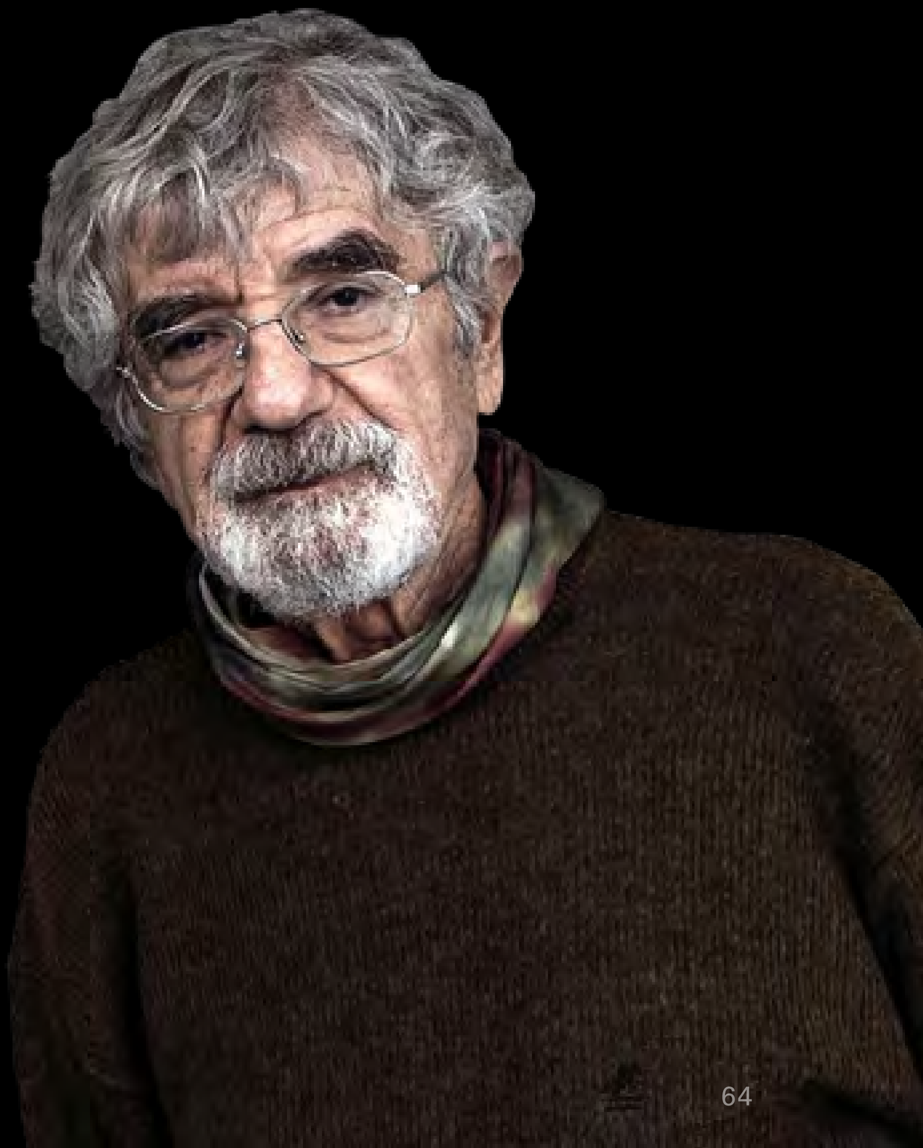
— Heinz von Foerster, 1979



*"...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."*

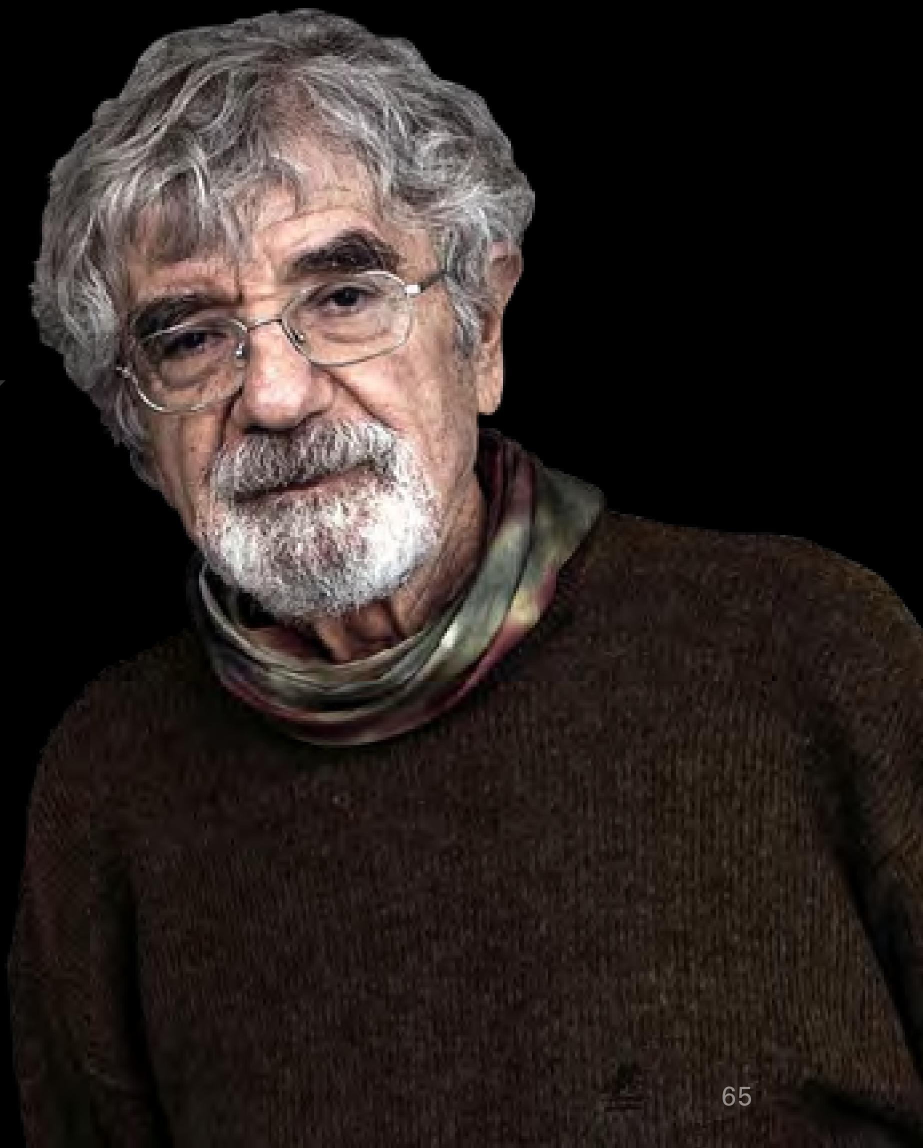
— Humberto Maturana, 1997



*“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.

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