Are *Systems Changes* Different from *System + Change*?

Recasting and reifying systems thinking with theory of change

David Ing

http://systemschanges.com

OCADU SFI – Systemic Design

Toronto, Ontario

January 2020

Synergy, parts, wholes

January 3, 2016 daviding 0 Comments

Synergy is a term that is sometimes used by laymen that could use some more clarification. The Oxford English Dictionary defines synergy as:

> The interaction or cooperation of two or more organizations, substances, or other agents to produce a combined effect greater than the sum of their separate effects: *'the synergy between artist and record company'*
>
> **Origin**: Mid 19th century: from Greek *sunergos* 'working together', from *sun-* 'together' + *ergon* 'work'.

A common understanding is that synergy means that "a whole that is more than the sum of its parts". Since I've said that "Systems thinking is a perspective on parts, wholes, and their relations", a richer appreciation may come through working through a selective history on parts and wholes. Let's step through:

- 1. Wholes as composites differentiating from mechanical addition (Smuts 1926)
- 2. Gestalt psychology "different from" and "something else than" (Koffka 1935)
- 3. Levels as "hierarchization" or "progressive organization (or individualization)" (von Bertalanffy 1932-1949 via Drack 2009)
- 4. Normative model of work group synergy (Hackman 1987)
- 5. Logical type in hierarchy theory (Allen 2008)

A challenge in appreciating a whole is: what is meant by *more than*?

2. Gestalt psychology "different from" and "something else than" (Koffka 1935)

Gestalt, says wiktionary, is a German word that doesn't have quite the same sense in English. Gestalt psychology focuses on innate mental laws leading to principles of perception. A core idea, attributed to Kurt Koffka, was that a whole could be perceived as a shape or form, with parts as secondary. One of Koffka's associate, Grace Heider, commented on the much misquoted phrase from her memory at a meeting circa 1932.

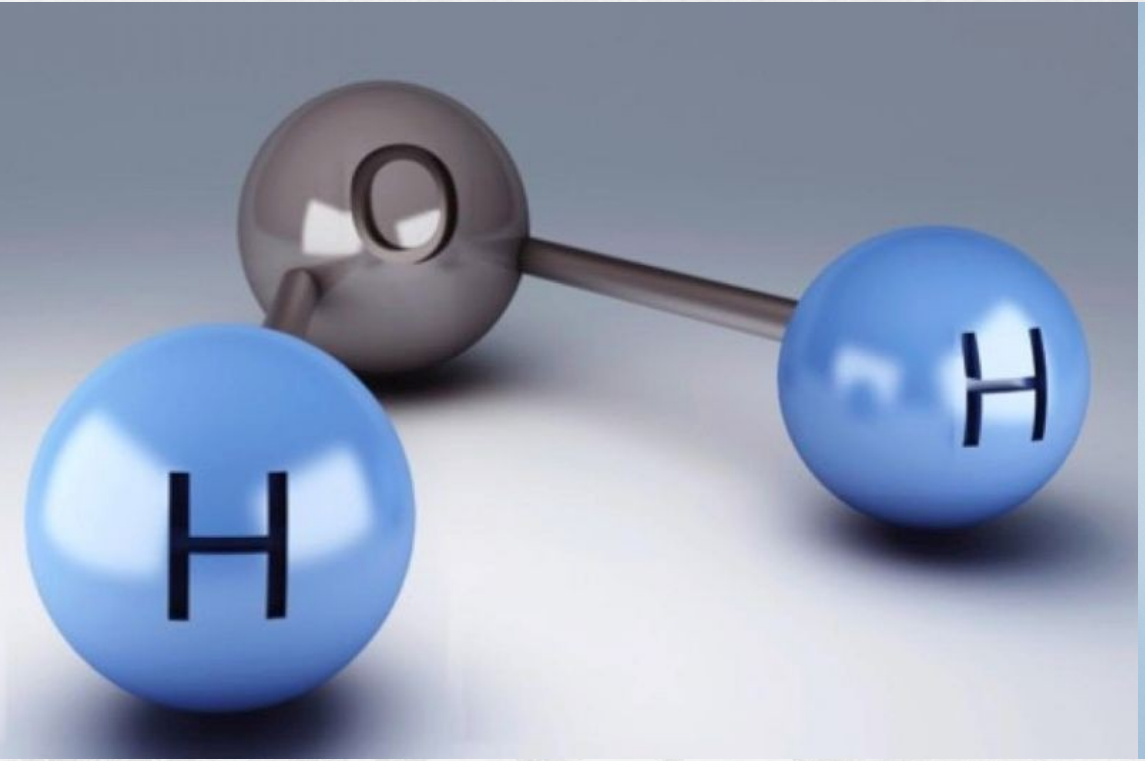
> I also remember [Kurt Koffa] making a fine distinction when a questioner asked him whether Gestalt psychology wasn't mostly a matter of saying that the whole is greater than the sum of its parts: "No, what we mean is that the whole is different from the sum of its parts." [Heider 1977, editorial emphasis added]

By 1935, Kurt Koffa had himself published a clarification in Principles of Gestalt Psychology.

> … our reality is not a mere collocation of elemental facts, but consists of units in which no part exists by itself, where each part points beyond itself and implies a larger whole. Facts and significance cease to be two concepts belonging to different realms, since a fact is always a fact in an intrinsically coherent whole. We could solve no problem of organization by solving it for each point separately, one after the other; the solution had to come for the whole. Thus we see how the problem of significance is closely bound up with the problem of the relation between the whole and its parts.
>
> > It has been said: The whole is more than the sum of its parts. It is more correct to say that the **whole is something else than the sum of its parts**, because summing is a meaningless procedure, whereas the whole-part relationship is meaningful. [Koffka 1935, p. 176, editorial paragraphing and emphasis added]

On the path towards understanding wholes, gestalt would be a topic of discussion in the Macy Conferences from 1945, with the rise of the cybernetics movement.

Wetness is a property of water, not of hydrogen or oxygen



Fisher, Len. 2018. “If Water Contains Hydrogen, Which Is Flammable, Why Doesn’t It Burn?” *BBC Science Focus Magazine*. 2018. https://www.sciencefocus.com/science/if-water-contains-hydrogen-which-is-flammable-why-doesnt-it-burn/

Rosenthal, Joel, and Daniel G. Nocera. 2006. “Why Does Combining Hydrogen and Oxygen Typically Produce Water Rather than Hydrogen Peroxide?” Scientific American. October 30, 2006. https://www.scientificamerican.com/article/why-does-combining-hydrog/

What can we learn about *systems changes* from *systems thinking*?

"Warming Seas and Melting Ice Sheets" CC-BY Nasa Goddard Space Centre 2015

Full version: "Rethinking Systems Thinking: Learning and coevolving with the world", Aalto University, 2012/11/26

April 1, 2013 daviding 11 Comments

A guest lecture on systems thinking for the Creativity Sustainability program at Aalto University provided an opportunity to stretch out on the plenary presentation that I had given at ISSS 2012. In San Jose last July, plenary speakers (including myself) were constrained to 45 minute slots preceding dialectic panelists. In Helsinki in November, the luxury of time allowed me to explain the ideas more fully. The lecture took 85 minutes, and was then followed by a question and answer session.

2013/10/07 Lectures at Aalto University (web video)

October 27, 2013 daviding 1 Comment

The Creative Sustainability program at Aalto University recorded the two lectures that they hosted on October 7. They've done the post-production work to make the videos available on the web. The recordings are HD-quality, so they can be viewed full screen on Vimeo.

The first talk on "Service Systems, Natural Systems: Systems Approaches to Urban Issues", given at the Aalto University Design Factory, is at https://vimeo.com/76852952. The slides, on the Coevolving Commons, were originally written for a City Sciences meeting at the University of Toronto, about a year ago.

The second talk on "Design Flaws and Service Systems Breakdowns: Learning from Systems Thinking", given at the Aalto University Media Factory, is at https://vimeo.com/77131431 . The slides, on the Coevolving Commons, were a preview of the presentation for the Relating Systems Thinking and Design 2 2013 meeting at AHO (The Oslo School of Architecture and Design) later that week.

David Ing – Design Flaws and Service System Breakdowns: Learning

Systems Thinking, Systems Design

Information Workshop INF1005H, section 0105, Winter 2018, University of Toronto Faculty of Information

- Official course operations are on Blackboard

Time and place:

- Six Wednesdays, 1:00 pm to 4:00 pm: January 10, January 17, January 24, January 31, February 7, February 14
- Bissell 417

Instructor: David Ing

- https://plus.google.com/u/0/+DavidIng
- http://coevolving.com/commons/contact
- http://twitter.com/daviding

Contents

A. Course objectives

Much of education is organized along disciplinary lines. Information professionals often work in contexts, where transdisciplinarity may be better approached with systems thinking. (Note that it's systems in plural, and not the singular!)

A.1 What is systems thinking?

Systems Changes formed late 2018, meeting regularly 2019 into 2020

Not secure | systemschanges.com/online/

Systems Changes Home Participation Wiki Maps Pattern_Language Errors_Breakdowns Social_Innovation Learning About

In which *systems* would you like to see *changes* occur?

Systems Changes is a collaborative open research program, initiated from Toronto, Canada. A call for participation was launched in January 2019 at the monthly Systems Thinking Ontario meeting. The web site was will evolve as contributions and knowledge are added.

The plurals in the program name are significant.

- There are multiple system**s** simultaneously at play, not just a single system.
- Change**s** include those within a field that individual and groups can influence, and those in an extended environment that are beyond our abilities.

Should we *recast* (speak about) and *reify* (make things as) *systems changes* – as different from *systems* and *changes*?

Recasting is defined as a discourse adjustment through which basic semantic information is retained while syntactic structure is altered ....

In a typical recasting sequence, a child's utterance is followed by an adult's recast, as follows:

C: Baby cry.

A: The baby is crying. [1]

In contrast, a model presents syntactic information through meanings which are not necessarily contingent on those expressed by the child. [2]

[1] Watkins, Ruth V., and Elizabeth F. Pemberton. 1987. "Clinical Applications of Recasting : Review and Theory." *Child Language Teaching and Therapy* 3 (3): 311–25. https://doi.org/10.1177/026565908700300308

[2] Pemberton, Elizabeth F., and Ruth V. Watkins. 1987. "Language Facilitation through Stories: Recasting and Modelling." *First Language* 7 (19): 79–89. https://doi.org/10.1177/014272378700701905 .

… reification (Verdinglichung) refers to the transformation of human properties, relations, processes, actions, concepts, etc. into things.

As a technical term, the term reification emerged in the English language in the 1860s out of the contraction of the verb *facere* (to make) and the substantive *res* (thing), which can refer both to concrete and empirically observable things (*ens*) and to abstract indeterminate things (*aliquid*).

As a synonym of 'thingification,' the inverse of personification, reification metaphorically refers to the transformation of human properties, relations, processes, actions, concepts, etc. into *res*, into things that act as pseudopersons, endowed with a life of their own.

Depending on the grammatical subject of reification – who reifies what: is it the analyst who reifies the concepts or is it society that alienates the subjects? – the transformation of human properties, social relations, abstract concepts, etc. into things and types can operate both on a methodological and on a social level. [3]

[3] Vandenberghe, Frederic. 2015. "Reification: History of the Concept." In *International Encyclopedia of the Social & Behavioral Sciences* (Second Edition), edited by James D. Wright, 203–6. Oxford: Elsevier. https://doi.org/10.1016/B978-0-08-097086-8.03109-3 .

Systems change: a field building convening

Wasan Island, Canada
18th - 21st June 2018

Who participated?

Jennifer Berman *Garfield Foundation*	Ed Krishok *Academy for Systems Change*	Loretta Rose *Bertha Centre at Capetown University*
Anna Birney *Forum for the Future*	Annabel Membrillo Jimenez *Vibrancy Network*	Wendy Schultz *Infinite Futures*
Valeria Budinich *Ashoka*	Praveen Nahar *National Institute of Design India*	Rachel Sinha *The Systems Studio*
Tim Draimin *McConnell Foundation*	Darius Polok *International Alumni Center*	Mary Tangelder *Mastercard Foundation*
Alice Evans *Lankelly Chase Foundation*	Bill Reed *Regenesis Group*	Benjamin Taylor *RedQuadrant*
David Ford *Expert Link*	Vanessa Reid *Living Wholeness Institute*	Marieke Verhagen *DRIFT*
Tatiana Fraser *Meta Lab*	Rob Ricigliano *Omidyar Foundation*	Laura Winn *Forum for the Future*
Russ Gaskin *CoCreative Consulting*	Darcy Riddell *McConnell Foundation*	
Peter Jones *OCADU*	Ruth Rominger *Garfield Foundation*	

Further contributors to pre-read

Gurpreet Singh *Skoll Foundation*	Marta Ceroni *Academy of Systems Change*	Elisabeth Cramer *Impact Hub*
Ray Ison *Open University*	Heather Grady *Rockefeller Philanthropy Advisors*	Katherine Milligan *Schwab Foundation*
Cheryl Rose *Banff Centre*	Darya Shaikh *Leaders Quest / Future Stewards*	Bill Sharpe *H3Uni / Future Stewards*

Our intent

In the context of growing use of the term “systems change” and increasing interest in systemic approaches to address some of the world’s most complex challenges, we wanted to convene a retreat bringing together practitioners, academics, funders to explore together how we might work together to build the field of systems change.

Birney, Anna, and Darcy Riddell. 2018. “Systems Change: A Field Building Convening.” Wasan Island, Canada: McConnell Foundation, Forum for the Future. https://www.forumforthefuture.org/systems-change-field-building-convening

What is Systems Change?

In the run-up to the retreat, we asked people attending and unable to attend to offer their definitions of systems change, and of field-building. The following pages are a collation of these multiple definitions we shared in the pre-read.

Birney, Anna, and Darcy Riddell. 2018. “Systems Change: A Field Building Convening.” Wasan Island, Canada: McConnell Foundation, Forum for the Future. https://www.forumforthefuture.org/systems-change-field-building-convening.

What is your definition of systems change?

Taking a complexity-based approach to social change, looking at many aspects of systems - economic, political, psycho-cultural, ecological - and working together from different locations in the system to address root causes. Systems change is a deliberate approach to work with the self-organizing and evolutionary properties of our human and natural systems to create more just, sustainable, compassionate societies.

Cultivating the conditions for our current systems (e.g. institutions, markets, industries, organizations) to evolve in service of different values

Changing the mindsets, patterns, and underlying structures in a given system for the purpose of building conditions for/creating a new reality

Tackling a challenge and pursuing solutions through a systems lens. This means looking at the interconnected nature of elements within a system and identify how and where to best influence change, vs. approaching the challenge from a technical, programmatic, or sector-based perspective.

Systems change means fundamentally, and on a large scale, changing the way a majority of relevant players solve a big social challenge, such that a critical mass of people affected by that problem substantially benefit.

We support leaders with the power to convene systems. We support them to raise their 'inner game' in order to meet the challenges of the 'outer game'. These leaders are willing to pioneer new approaches that are outside the dominant paradigm and who will use their agency to stand up for new patterns as they take root. We distinguish innovation that simply improves the existing system and innovation that transforms it, shifting towards new patterns and configuring new sources of abundance.

Changing the structures, relationships, and dynamics of a given system in ways that are resilient and lasting so that the system systematically produces better results for all stakeholders.

System change is…

shifting
- mind-sets, mental models, paradigms

changing
- patterns, underlying structures, ways of operating,

transforming
- dynamics, reconfiguring relationships

...in order to
- address underlying root causes,
- deal with complex, uncertain, interconnected systems that are ever changing,
- engage in the potential of living systems,
- solve big social challenges

through
- taking a complexity approach, living systems approach
- Growing the number of people who think and act systemically
- cultivating the conditions
- enabling/ supporting leaders with the power to convene systems
- Capacity, capability and processes to engage
- strategic, multi-stakeholder approaches, coming together across systems, working together
- working with many aspects of systems
- having an inner awareness of the whole

intentional process and design
purposeful interventions
consciously attempting
deliberate approaches
such as...

with the outcome of

creating
ensuring
positively affecting
- different behaviours and outcomes
- resilient and lasting /better results
- Building a bridge to a better tomorrow
- increased systems health
- social change
- positive change
- just, sustainable, compassionate societies
- a more sustainable society
- a new normal, the emergence of a new system, a new reality

Systemic change, shifting root causes at the systems, structure & cultural levels

Systems change as practiced by the philanthropy sector can be described as an intentional process to alter the status quo with purposeful interventions. Funders increasingly recognize that many of the chronic challenges we want to address sit within complex, adaptive systems, and have no easy solutions. Systems change aims to transform underlying structures and the mechanisms that support them. Funding is designed to go beyond piecemeal approaches and incremental change, and aim instead at creating more fundamental changes in policies, routines, relationships, resources, power structures, values, attitudes, and behaviors. At its most ambitious, this approach encompasses altering the linkages and interactions that form a system’s architecture – the rules and standards, goals and norms that make systems work the way they do. Systems approaches compel funders, as well as those they fund, to challenge the mental models and ways of thinking that so often drive human behavior toward outcomes that are, in the long-term, negative.

I see System Change as both an outcome – the large-scale transition we are working towards to create a more sustainable society – and as a process. I hold the belief that creating the change we want to see in the world (outcome) will require a growing number of people to think and act more systemically (process).

The emergence of a new pattern of organisation or system structure - systems change is both a process and an outcome. A process of that embodies a living systems perspective and seeks a transformational shift in our deep structures of organising (including paradigms).

Enabling people to recognise complexity and sustainability in their everyday lives and how to apply & harness principles & activities that are in line with those. The fact that everyone and everything on this planet is interconnected and we all have power because we are making up the (sub)systems. So that complexity and sustainability will become mainstream; the new normal.

I define transformational change as a reconfiguration of the relationships of identity and viability. This is what most people are interested in when talking about systems change.

I define systems change as referring to positively affecting complex dynamic systems in order to increase their health and the outcomes they produce (poverty, violence, well-being, etc.). I am careful to distinguish this level of change from affecting "structural systems" like the healthcare or education system, which consists of institutions, policies, people, etc. These systems are complicated, but still clock like, versus the adaptive, infinite, ever-changing nature of complex systems.

Systems change is the process whereby a collection of inter-connected parts whose sum is more than those parts starts to change. it could be for the better or for the worse. we think about it as people seeing themselves as part of an interconnected whole. And it's a place where people want to, know how to and are free to change the systems they're working within.

It's a process and an outcome that involves deep shifts in mental models, relationships, and taken-for-granted ways of operating as much as it involves shifts in organizational roles and power structures, metrics and performance management, and goals and policies. Some of this change might be visible and measurable (such as the shift of an ecosystem or a community towards higher wellbeing) and some of it might be intangible and invisible, and yet very substantial.

Transformation of practices and mindsets within a critical social system or institution on which people in a society depend upon for social and economic support.

Shifting the dynamics of a system so that the system has different behaviours and produces different outcomes. This means shifting the dynamics and relationships of, e.g. power, norms and beliefs, and resource distributions across the different scales of the system.

Rather than actors from government, civil society, or the private sector pulling levers for change from their own individual perches, a coming together across sectors to affect positive outcomes for communities from a position that is aware of the whole. A shift from “ego-system” (blinded by individual biases and priorities) to “ecosystem” awareness and ensuing action.

* to me systems change change field building relates to capturing, mapping and connecting various knowledge and practice domains/linkages whah in some ways helps understand and practice ideas of systems and systems change.
* Understring elements, bounties, relations, cause and qualities of existing system and seeks tradition towards change.

It is an organising principle or badge which connotes working towards change that is both systemic and systematic in situations usefully framed as (complex, uncertain, messy, wicked etc); it also implies working purposefully with purpose to realise a system or systems that can actually effect transformations that deliver on purpose.

Consciously attempting profound transformations in the current state of play to build a bridge to better tomorrow.

I'm not a big fan of definitions - and only partly because I'm not very good at them. Changing things for the better in a sustainable, or preferably a way that develops positive adaptation. Change rooted in understanding systems. Change rooted in understand the energy effort and learning the system is putting into staying the same.

Systems change is the deliberate approach of tackling the underlying causes of complex social, economic, environmental and cultural problems

For me is to move from a Theory of Systems Change to a Theory of Impact Resilience based on systemic, strategic, multi-stakeholders approaches that allow to build up the internal awareness and capacity of the system to shift including a professionalization of how we approach systems change that includes systemic scorecards, rigorous and comprehensive strategies, consciousness of the development stages and pathways (individually and collectively), short, medium and long term vision, etc.

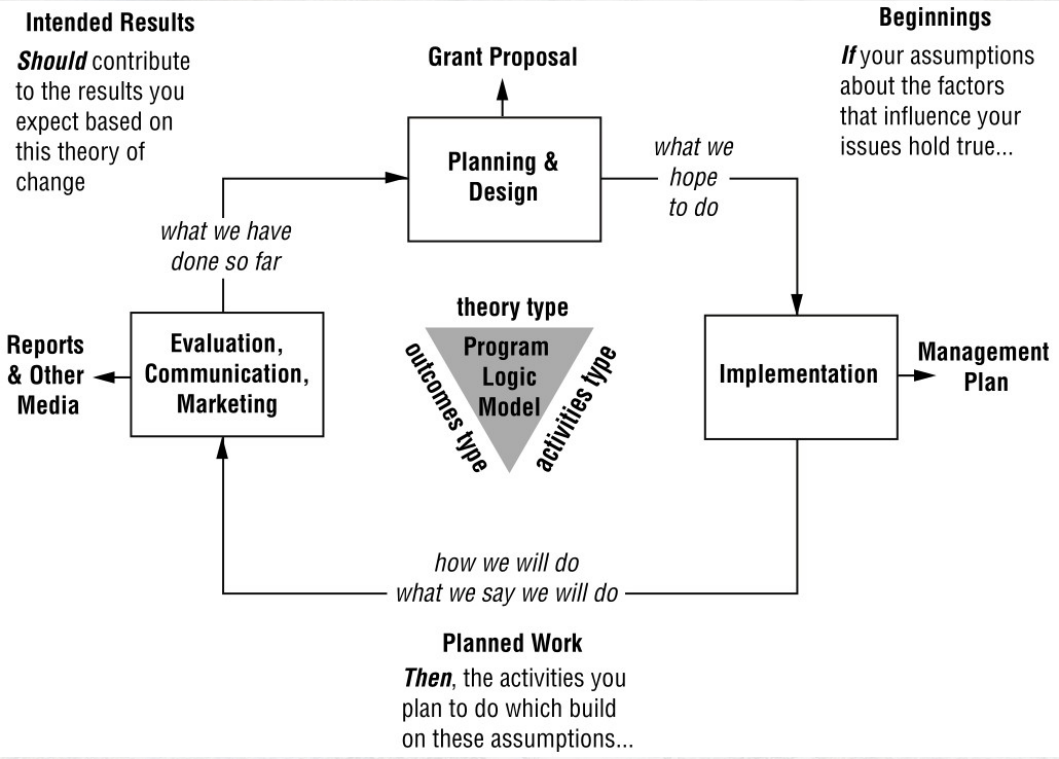
Shifting the arrangement of people, structures, etc from which undesired phenomena arise, to a different arrangement from which desired phenomena MAY arise.

The capacity, capability, and processes required to engage with the patterns and potential of nested living systems.

In this context, systems change is about the intentional design and implementation a change agenda that targets specific dynamics in a complex system to shift them in a way that accelerates a transition to a healthy system state (a long term goal determined by diverse stakeholders)

A program may have: (i) a *theory* (conceptual) approach model; (ii) an *outcome* approach model; (iii) an *activities* (applied) approach model; or a blend

Types of Logic Models: Emphasis and Strengths – **A program is a theory and an evaluation is its test.**



1. **Theory Approach Models** emphasize the theory of change that has influenced the design and plan for the program. [….] Models describing the beginnings of a program in detail are most useful during program planning and design.
2. **Outcomes Approach Models** focus on the early aspects of program planning and attempt to connect the resources and/or activities with the desired results in a workable program. [….]
   Models that outline the approach and expectations behind a program's intended results are most useful in designing effective evaluation and reporting strategies.
3. **Activities Approach Models** pay the most attention to the specifics of the implementation process. [….]
   Models that emphasize a program's planned work are most often used to inform management planning activities.

W, K. Kellogg Foundation. 1998. "Logic Model Development Guide: Using Logic Models to Bring Together Planning, Evaluation and Action." Battle Creek, Michigan. https://www.wkkf.org:443/resource-directory/resource/2006/02/wk-kellogg-foundation-logic-model-development-guide .

A program logic model explicates how an intervention proposes to achieve its end, via (i) theory of *leverage*; (ii) theory of *change*; + (iii) theory of *scale*

Theories of leverage are different from theories of change in that they focus not so much on the grand idea of how impact is best created, but rather on the mechanics of the process.

Leverage is something that allows donors to increase the effectiveness of their giving. It is a concept grounded in the physical principle, familiar to many, that a long lever may be more useful than a short one in dislodging or raising fixed objects.

A **theory of change** ...
commits the donor to a set or class of giving targets.

Theories of change can be very broad and define the level – ranging from the smallest societal units to the largest ones—at which the philanthropy will work. At one end of this spectrum are theories of change that focus on the training and development of individual leaders who might someday transform a field of practice. At the other end are theories that seek to bring change by shaping public policy at the national or even international level.

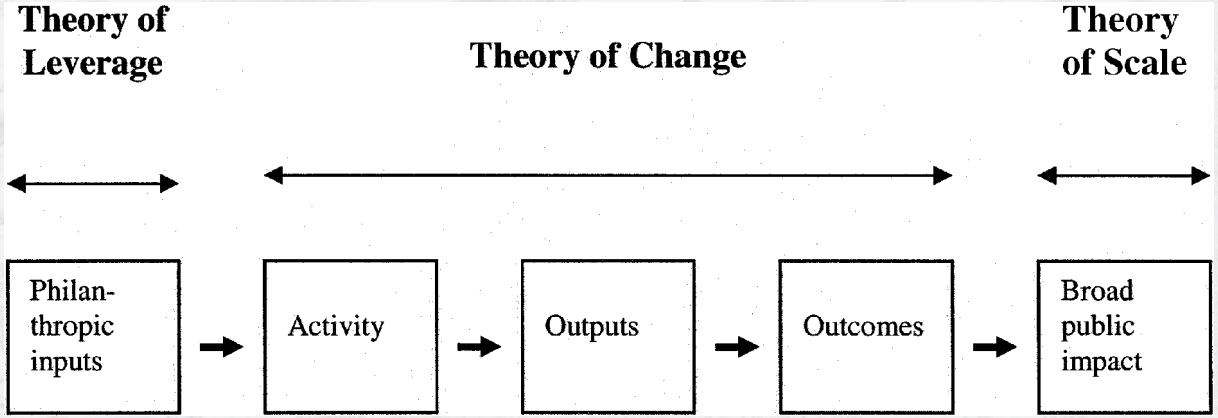


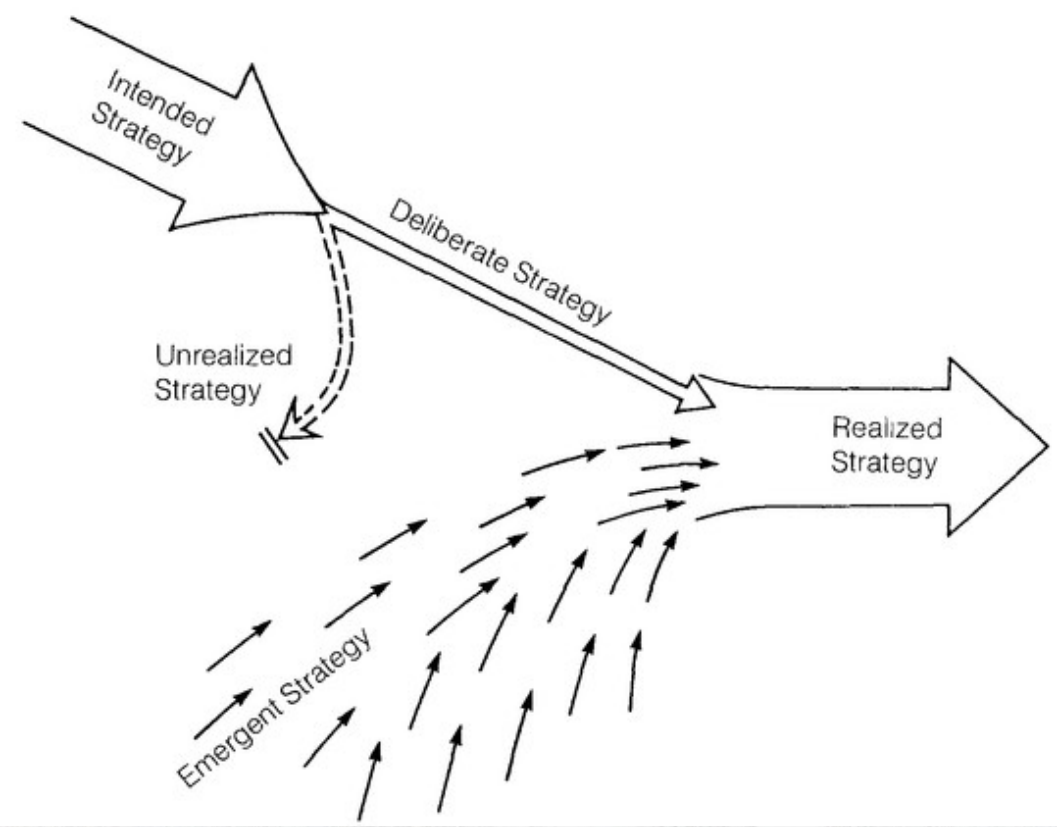
Figure 6.1 Elements of a logic model

… donors concerned with increasing the impact of their giving tend to focus on a third element: the **theory of scale** that will guide their philanthropic work. While some donors are content with making small, targeted gifts designed to meet episodic needs, many donors want to see their philanthropic work broadened. An intervention, when properly understood and documented, can be brought to scale through a variety of means so that the number of people who benefit increases.

One of the most common problems with logic models ... is the **mistaken belief** that they include all the relevant determinants in a **causal chain** leading from intervention to social outcome. In reality, the vast majority of social interventions have built within them a substantial amount of **noise outside the system** that affects the outcome.

Frumkin, P. 2006. “Logic Models: Theories of Change, Leverage, and Scale.” In *Strategic Giving: The Art and Science of Philanthropy*, 174–216. University of Chicago Press. http://doi.org/10.7208/chicago/9780226266282.001.0001 .

In contrast to strategy as *plan*, strategy as *pattern* in a stream of actions is defined by consistency in behavior, whether or not intended



To paraphrase Hume, strategies may result **from human actions**,
but **not human designs**.

If we label
the first definition ***intended* strategy**
and the second ***realized* strategy**,
as shown in Figure 1, then we can distinguish between
***deliberate* strategies**,
where intentions that exists previously were realized, from
***emergent* strategies**,
where patterns developed in the absence of intentions, or
despite them (which went ***unrealized***).

Mintzberg, Henry. 1987. “The Strategy Concept I: Five Ps For Strategy.” *California Management Review* 30 (1): 11–24. https://doi.org/10.2307/41165263 .

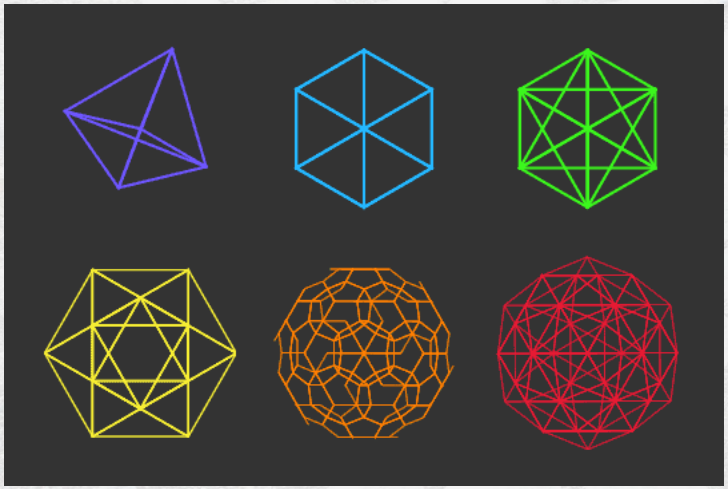
Two ways of seeing nature, since ~500 BCE, have set how humans beings negotiate with themselves and in their world(s)

Reality as a **changelessness state**

- Parmenides of Elea, Confucius
- Shift → stability → sustainable
- Analytic paradigm

Reality as a **state of change, not a change of state**

- Heraclitus of Ephesus, Laotse
- Beauty of dynamic (c.f. protection of static)
- Contextual appreciation



Hyper Platonic, by Nathan P. Seddig (natpbs.tumblr)

Walking, by Dominique Taswell (strawberrylicorice.tumblr)

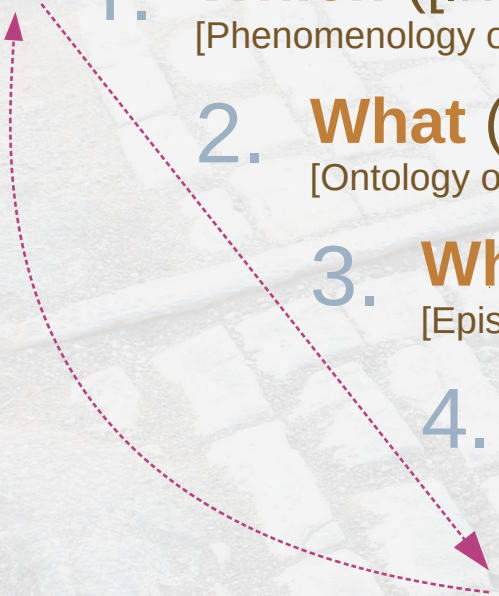
Hawk, David L. 1999. “Changelessness, and Other Impediments to Systems Performance.” In *Proceedings of the Conference to Celebrate Russell L. Ackoff, and the Advent of Systems Thinking*, edited by Matthew J. Liberatore and David N. Nawrocki. Villanova University. http://davidhawk.com/wp-content/uploads/2018/09/Ackoff-Birthday-Conference.pdf#page=59 .

Contrasting modes of thinking may be grounded in philosophy

Dualistic (Modern Western formal logic)		Contextual-dyadic (Classical Chinese implicit logic)
Abstract and permanent, is independent of context • Can extrapolate from propositions	**Truth - Falsity**	Application and meaning is relative to a particular context • Evaluate assertion as embedded
Oppositions Superior ↔ Inferior Superordinate ↔ Subordinate Intrinsic value ↔ Non-intrinsic value Human ↔ Nonhuman	**Pairings**	*Characteristics under context* A term presupposes it opposite • e.g. *cat* implies *non-cat*, not universe Context-dependence • e.g. men or women superior when/where?
Hierarchical Reductionist Entity- (thing-) ontology	**Frames**	Yin-Yang Harmonious whole Mutually engendering or constraining

Lee, Keekok. 2017. *The Philosophical Foundations of Classical Chinese Medicine: Philosophy, Methodology, Science*. Lexington Books. https://rowman.com/ISBN/9781498538886/The-Philosophical-Foundations-of-Classical-Chinese-Medicine-Philosophy-Methodology-Science.

A 5-Question Cycle for Systems Changes can guide modes of inquiry grounded on five philosophical traditions



1. **Which** ([living] wholes, containing wholes, parts)?
   [Phenomenology of joint attention on systems changes]
2. **What** (affordances, capacities, taskscapes-landscapes)?
   [Ontology of becoming with systems changes]
3. **Why** (causes)?
   [Episteme of systems changes]
4. **Whom**, **when**, **where** (impacts)?
   [Phronesis in systems changes]
5. **How** (collective action)?
   [Techne for systems changes]

Types of systems can be categorized by purposefulness

Systems and models	*Parts*	*Wholes*
Deterministic	Not purposeful	Not purposeful
Animated	Not purposeful	Purposeful
Social	Purposeful	Purposeful
Ecological	Purposeful	Not purposeful

Purposive == goal-seeking	*Goals*: those ends that we can expect to attain within the period covered by planning.
	Objectives: those ends that we do not expect to attain within the period planned for but which we hope to attain later, and toward which we believe progress is possible within the period planned for.
Purposeful == ideal-seeking	*Ideals*: those ends that are believed to be unattainable but towards which we believe progress is possible during and after the period planned for.

Ackoff, Russell L., and Jamshid Gharajedaghi. 1996. “Reflections on Systems and Their Models.” Systems Research 13 (1): 13–23. https://doi.org/10.1002/(SICI)1099-1735(199603)13:1<13::AID-SRES66>3.0.CO;2-O.

Let's think about systems changes through an illustration:

Edward Burtynsky (2012)
Marine Aquaculture,
Luoyuan Bay,
Fujian Province

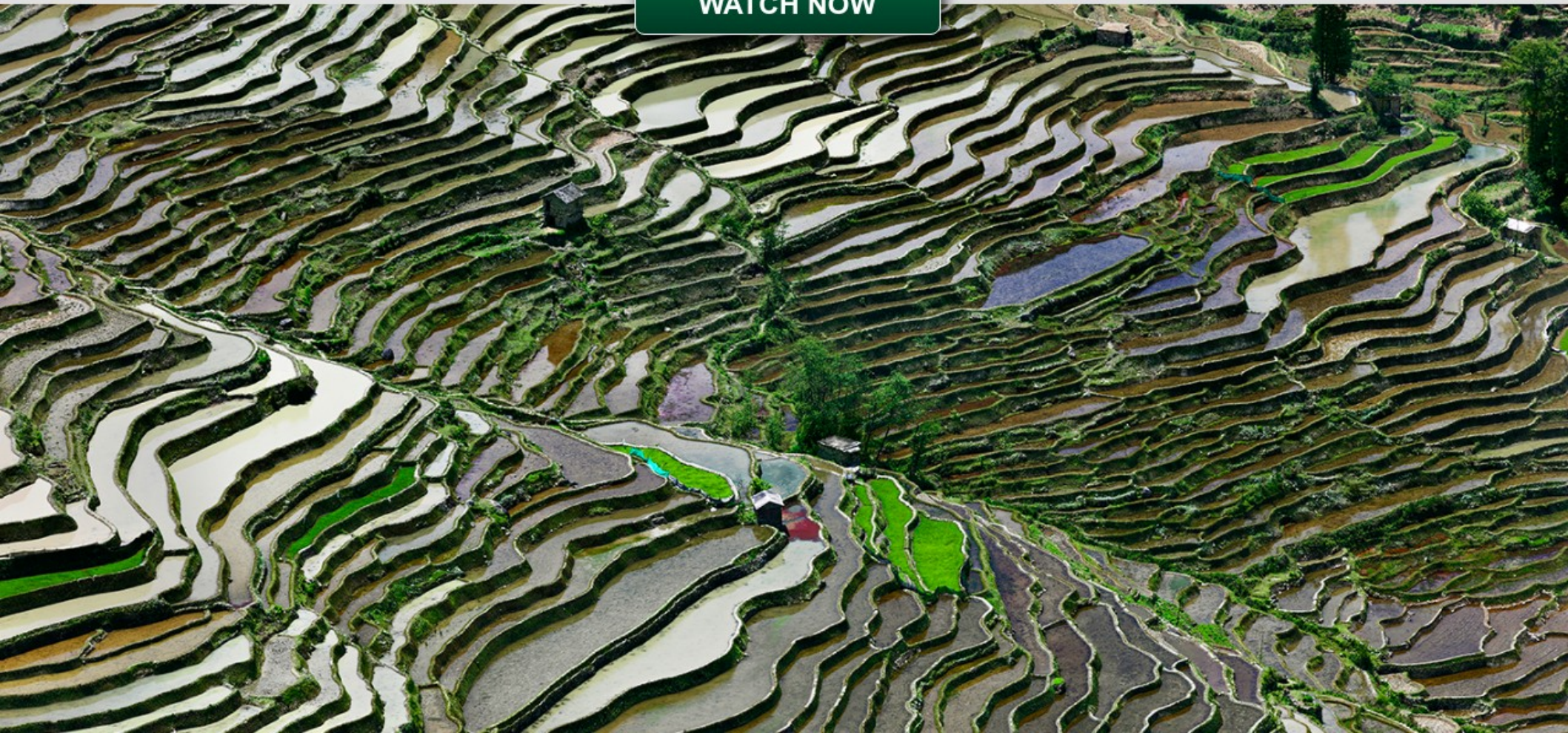
Aquaculture provides a glimpse into this quickly growing and increasingly important food source. Aquaculture looks as those places where land and sea is been shaped to serve the purposes of growing and harvesting water-based crops such as salt, fish, shrimp, seaweed and rice.

https://www.edwardburtynsky.com/projects/photographs/water

A FILM BY / UN FILM DE JENNIFER BAICHWAL & EDWARD BURTYNSKY

WATERMARK V.F.

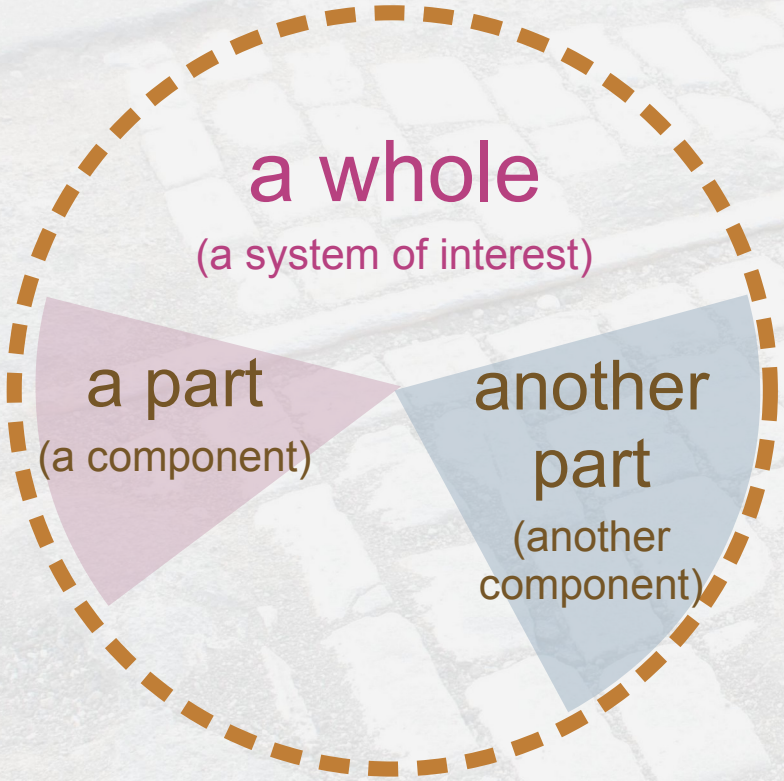
WATCH NOW



A 5-Question Cycle for Systems Changes can guide modes of inquiry grounded on five philosophical traditions

1. **Which** ([living] wholes, containing wholes, parts)?
   [Phenomenology of joint attention on systems changes]
2. **What** (affordances, capacities, taskscapes-landscapes)?
   [Ontology of becoming with systems changes]
3. **Why** (causes)?
   [Episteme of systems changes]
4. **Whom**, **when**, **where** (impacts)?
   [Phronesis in systems changes]
5. **How** (collective action)?
   [Techne for systems changes]

A system is a whole that cannot be divided into independent parts

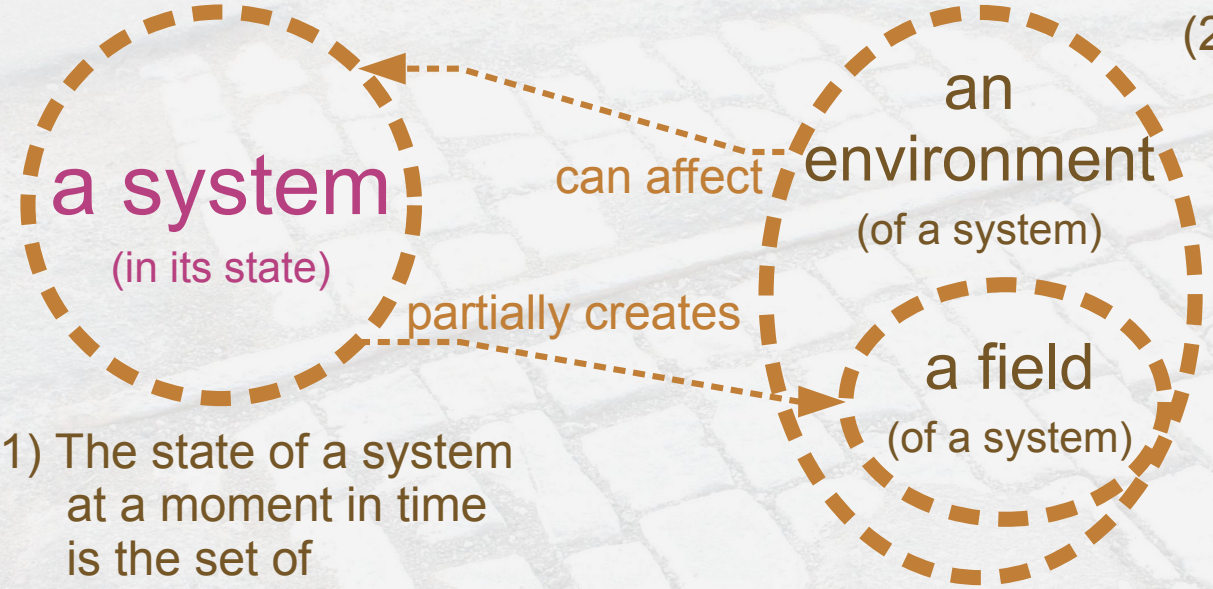


(1) Every part of a system has properties that it loses when separated from the system.

(2) Every system has some properties – its essential ones – that none of its parts do.

Ackoff, Russell L. 1981. *Creating the Corporate Future: Plan or Be Planned For*. New York: John Wiley and Sons, p. 15

An environment of a system consists of all variables which can affect the system's state



(1) The state of a system at a moment in time is the set of relevant properties which the system has at that time.

(2) An environment of a system is a set of elements and their relevant properties, which elements are not part of the system, but a change in any of which can produce a change in the state of the system.

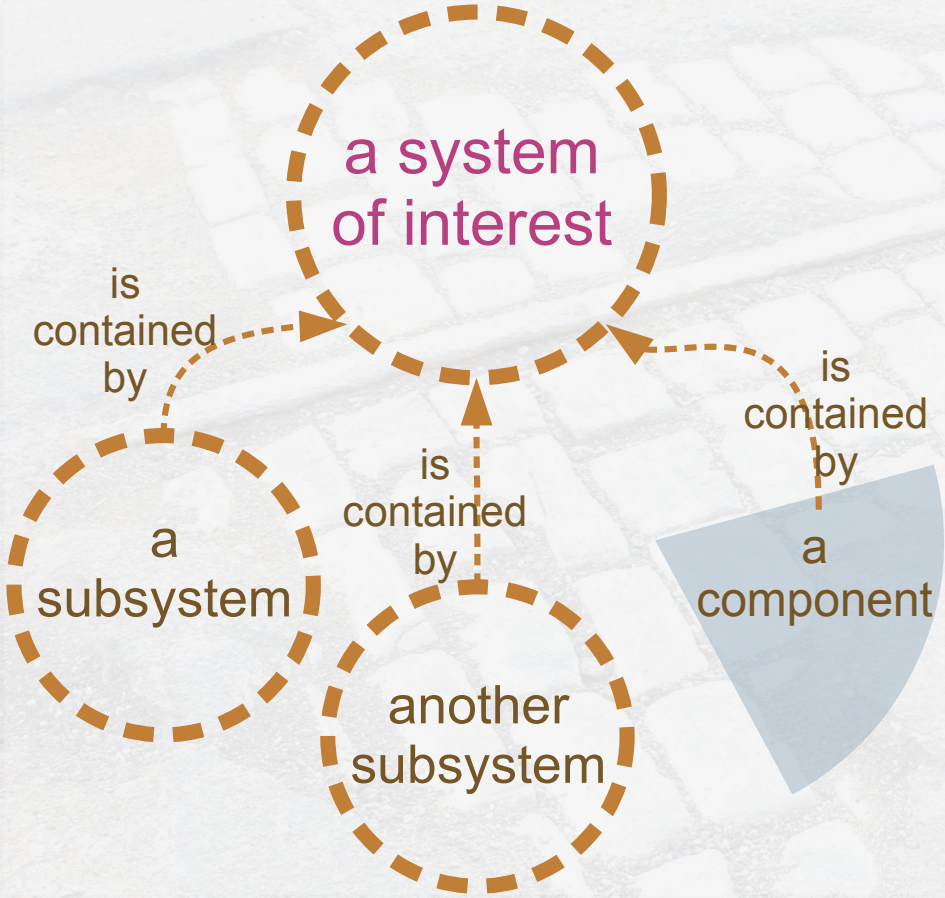
(3) External elements which affect irrelevant properties of a system are not part of its environment

(4) Field centers on the environment in which the subject organization is embedded and which is partially creates.

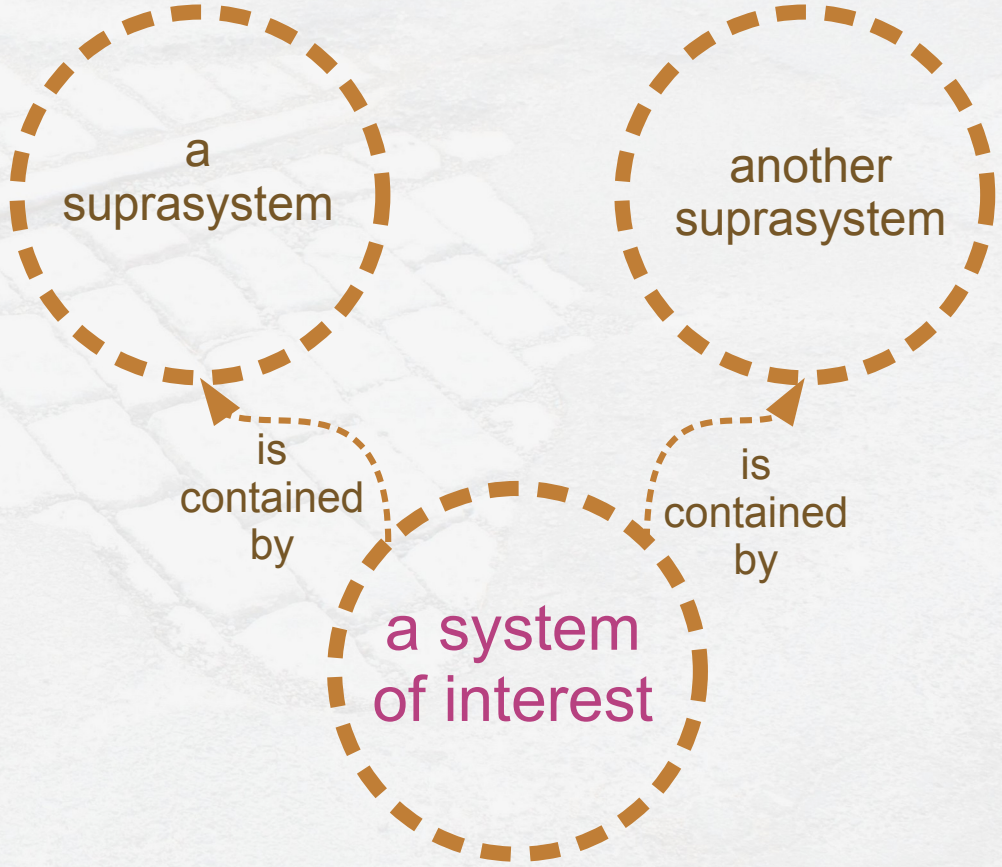
Ackoff, Russell L. 1971. "Towards a System of Systems Concepts." *Management Science* 17 (11): 661–671, (pp. 662-663)

Trist, Eric L. 1992. "Andras Angyal and Systems Thinking." In *Planning for Human Systems: Essays in Honor of Russell L. Ackoff*, edited by Jean-Marc Choukroun and Roberta M. Snow, 111–32. University of Pennsylvania Press. (p. 127)

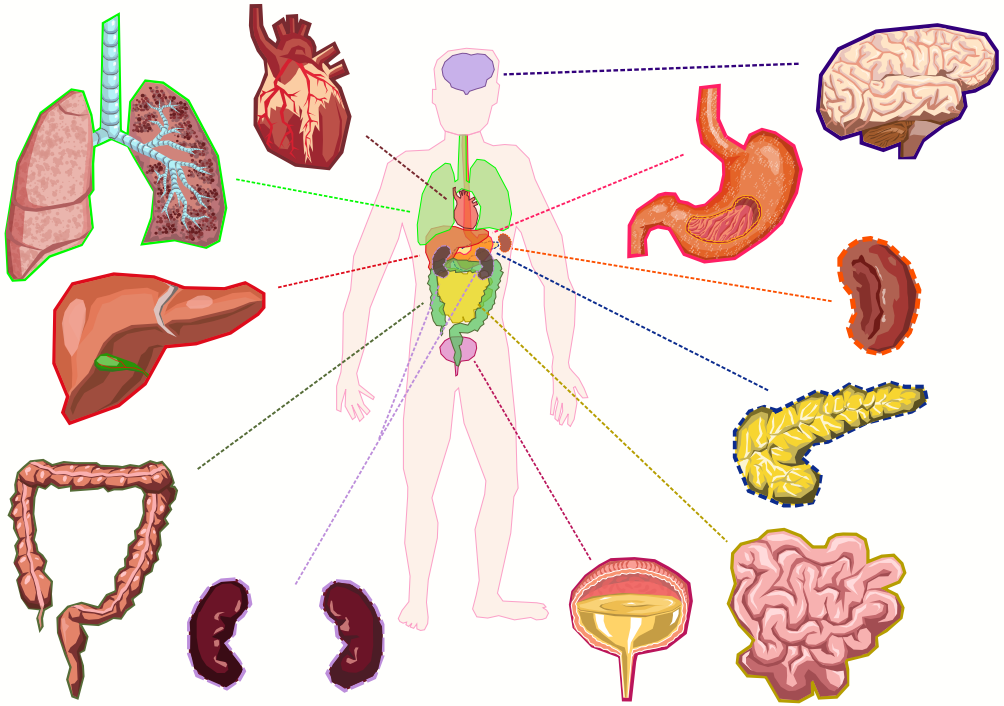
A system can contain subsystems or components

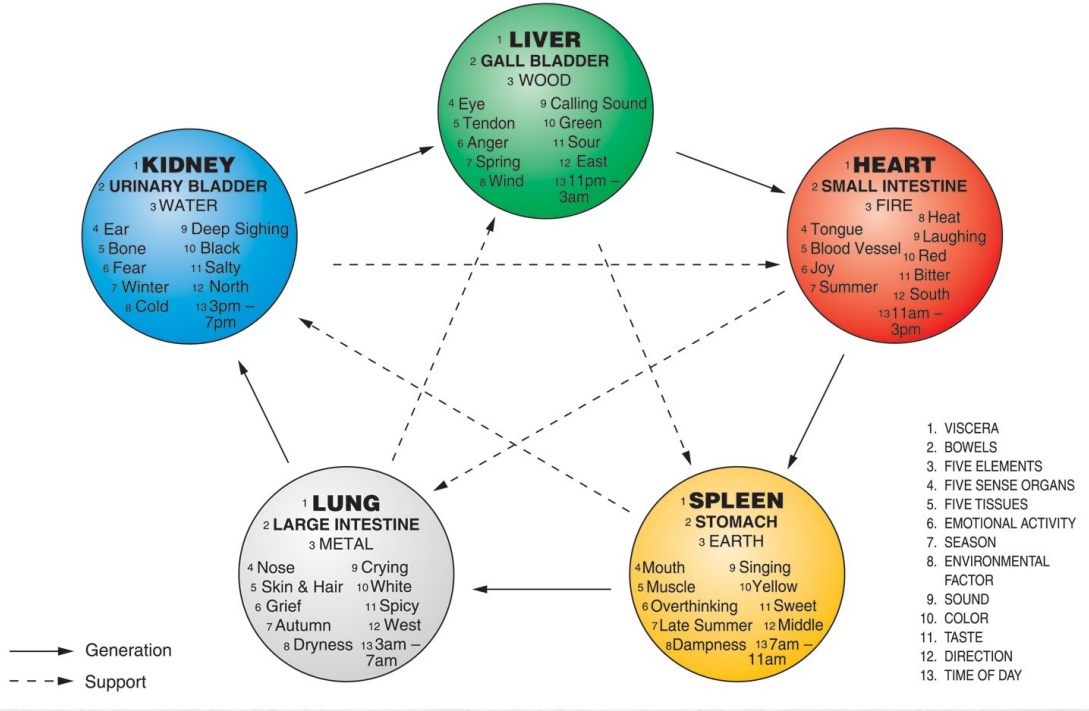


A system can be contained by multiple suprasystems



Human organs as *parts* by western physicians contrast to the *subsystems* of Traditional Chinese Medicine

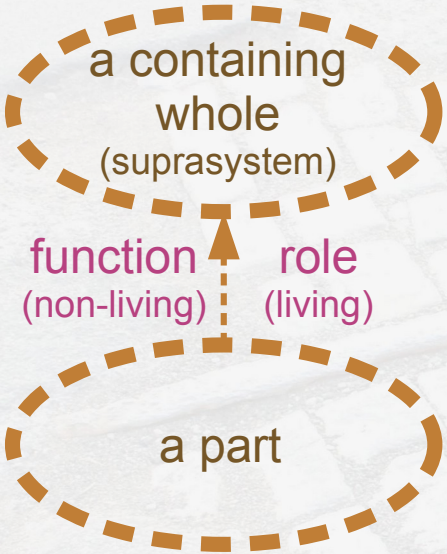




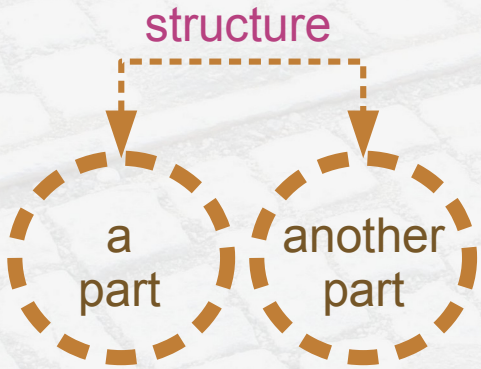
Mothsart, “Organs of the human body”, at https://openclipart.org/detail/280284/human-body

Traditional Chinese Medicine World Foundation, “Classification of things according to the theory of the five elements”, at https://www.tcmworld.org/what-is-tcm/the-five-major-organ-systems/

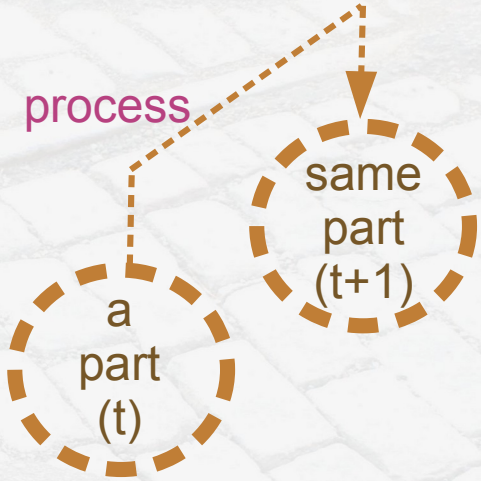
Systems thinking is a perspective on parts, wholes, and their relations



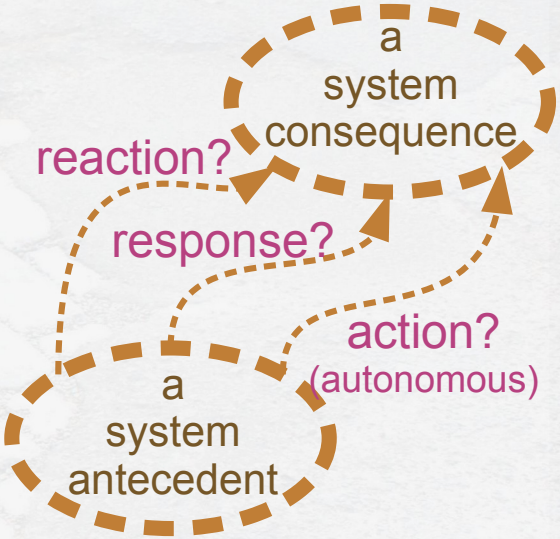
Function is a "contribution of the part to the whole"



Structure is an "arrangement in space"



Process is an "arrangement in time"



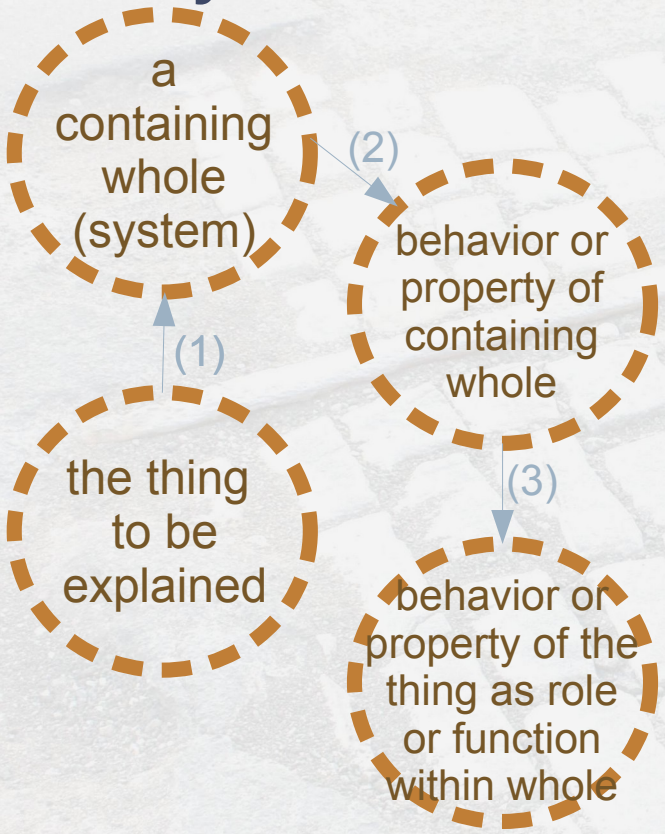
Behaviour is a "system change which initiates other events"

Ing, David. 2013. "Rethinking Systems Thinking: Learning and Coevolving with the World." *Systems Research and Behavioral Science* 30 (5): 527–47.

Gharajedaghi, Jamshid. 1999. *Systems Thinking: Managing Chaos and Complexity : A Platform for Designing Business Architecture*. Elsevier

Ackoff, Russell L. 1971. "Towards a System of Systems Concepts." *Management Science* 17 (11): 661–671.

In authentic systems thinking, synthesis precedes analysis and the containing whole is appreciated



Synthesis precedes analysis

1. Identify a **containing whole** (system) of which the **thing to be explained** is a part.
2. Explain the **behavior or properties** of the **containing whole**
3. Then explain the **behavior or properties** of the **thing to the explained** in terms of its **role(s) or function(s)** within its containing whole.

Ackoff, Russell L. 1981. *Creating the Corporate Future: Plan or Be Planned For*. New York: John Wiley and Sons, p. 16

Lacking history to study organizational learning circa 1995, videos and a book explored *How Buildings Learn*

1. How Buildings Learn - Stewart Brand - 1 of 6 -...
28,610 views • 2 years ago

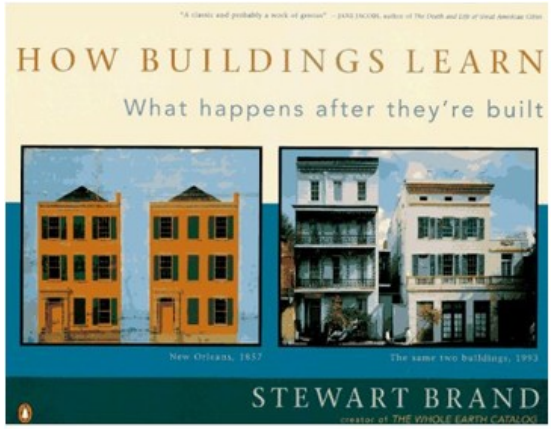
6. How Buildings Learn - Stewart Brand - 6 of 6 -...
10,888 views • 2 years ago

2. How Buildings Learn - Stewart Brand - 2 of 6 - "T...
8,386 views • 2 years ago

3. How Buildings Learn - Stewart Brand - 3 of 6 -...
7,432 views • 2 years ago

5. How Buildings Learn - Stewart Brand - 5 of 6 - "T...
4,345 views • 2 years ago

The Oak Beams of New College, Oxford
1,967 views • 2 years ago



Pacing layers emphasize coevolution and learning

SITE

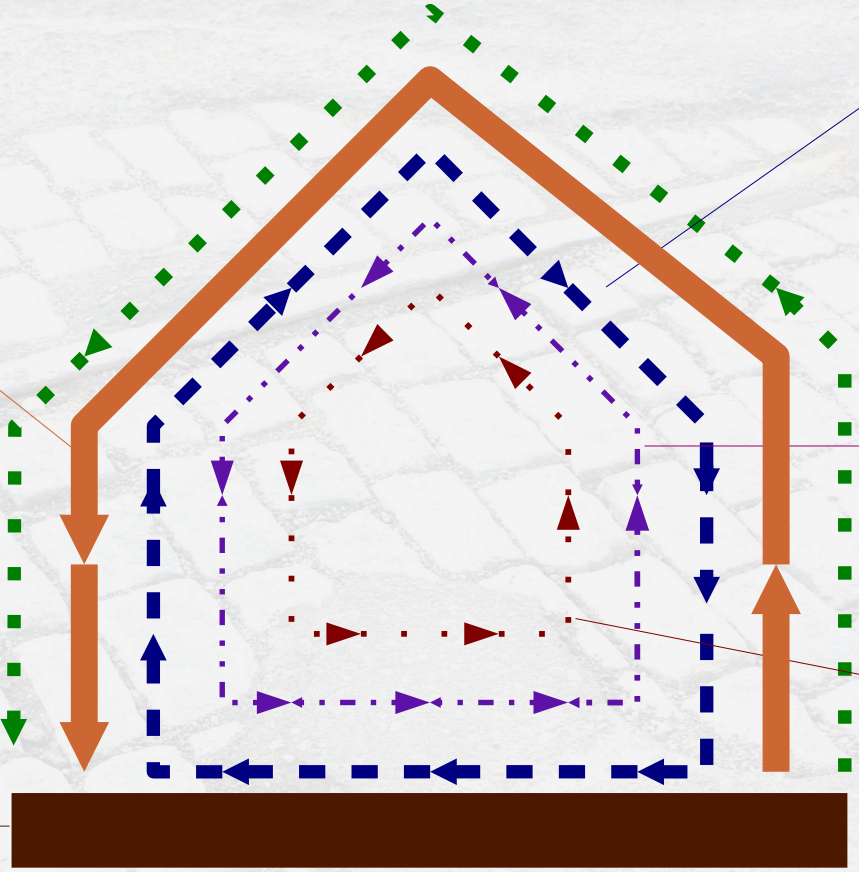
This is the geographical setting, the urban location, and the legally defined lot, whose boundaries outlast generations of ephemeral buildings. "Site is eternal", Duffy agrees.

STRUCTURE

The foundation and load-bearing elements are perilous and expensive to change, so people don't. These are the building. Structural life ranges from 30 to 300 years (but few buildings make it past 60, for other reasons).

SKIN

Exterior surfaces now change every 20 years or so, to keep up with fashion or technology, or for wholesale repair. Recent focus on energy costs has led to re-engineered Skins that are air-tight and better-insulated.



SERVICES

These are the working guts of a building: communications wiring, electrical wiring, plumbing, sprinkler system, HVAC (heating, ventilation, and air conditioning), and moving parts like elevators and escalators. They wear out or obsolesce every 7 to 15 years. Many buildings are demolished early if their outdated systems are too deeply embedded to replace easily.

SPACE PLAN

The interior layout, where walls, ceilings, floors, and doors go. Turbulent commercial space can change every 3 years; exceptionally quiet homes might wait 30 years.

STUFF

Chairs, desks, phones, pictures; kitchen appliances, lamps, hair brushes; all the things that twitch around daily to monthly. Furniture is called mobilia in Italian for good reason.

Source: Stewart Brand. 1994. *How Buildings Learn: What Happens after They're Built*. New York: Viking.

Trito-learning rolls with turbulent contexts by negotiating in worlds where proto-learning and deutero-learning break down

	Process discriminating context change over time	*Example / metaphor (groups learn to cook)*
Proto-learning (Learning 1)	Change in response correcting errors within a set of alternatives	Training on food service handling for consistency and safety (e.g. cafeteria kitchens)

Bateson, Gregory. 1972. “The Logical Categories of Learning and Communication.” In *Steps to an Ecology of Mind*, 279–308. Northvale, NJ: Jason Aronson

Trito-learning rolls with turbulent contexts by negotiating in worlds where proto-learning and deutero-learning break down

	Process discriminating context change over time	*Example / metaphor (groups learn to cook)*
Deutero-learning (Learning 2)	Change in response correcting the set of alternatives	Mastering a range of food prep traditions (e.g. Culinary Institute of America)
Proto-learning (Learning 1)	Change in response correcting errors within a set of alternatives	Training on food service handling for consistency and safety (e.g. cafeteria kitchens)

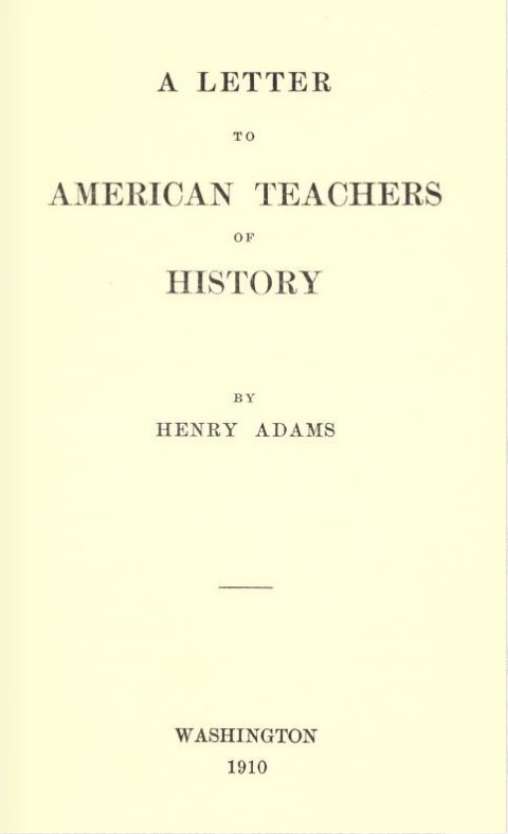
Bateson, Gregory. 1972. “The Logical Categories of Learning and Communication.” In *Steps to an Ecology of Mind*, 279–308. Northvale, NJ: Jason Aronson

Trito-learning rolls with turbulent contexts by negotiating in worlds where proto-learning and deutero-learning break down

	Process discriminating context change over time	*Example / metaphor (groups learn to cook)*
Trito-learning (Learning 3)	Change in response correcting for contexts (i.e. systems of sets of alternatives)	Competing on tv cooking challenges as teams and individuals (e.g. Hell's Kitchen)
Deutero-learning (Learning 2)	Change in response correcting the set of alternatives	Mastering a range of food prep traditions (e.g. Culinary Institute of America)
Proto-learning (Learning 1)	Change in response correcting errors within a set of alternatives	Training on food service handling for consistency and safety (e.g. cafeteria kitchens)

Bateson, Gregory. 1972. “The Logical Categories of Learning and Communication.” In *Steps to an Ecology of Mind*, 279–308. Northvale, NJ: Jason Aronson

“Stable equilibrium is death”


A LETTER

TO

AMERICAN TEACHERS

OF

HISTORY

BY

HENRY ADAMS

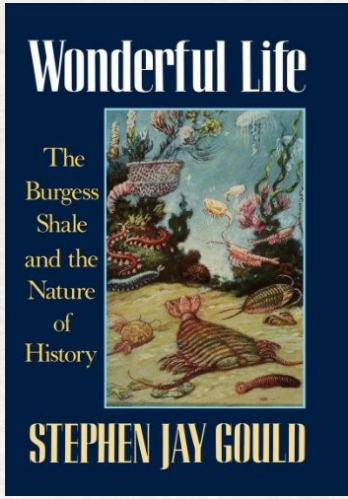
WASHINGTON

1910

… if one physical law exists more absolute than another, it is the law that **stable equilibrium is death**.

A society in stable equilibrium is — by definition, — one that has history, and wants not historians. [Adams, p. 186]

… Gould has shown that evolution has been by catastrophes, like the one that caused the demise of the dinosaurs and more serious ones that extinguished up to percent of all species nearly six hundred million.
Gould has concluded that such catastrophes have been more instrumental in shaping the course of evolution than competition and natural selection.
If so, then no necessary direction can be imputed to evolution, and **the current state of nature may not be inevitable and predictable**. [Burich p. 645]



Adams, Henry. 1910. A Letter to American Teachers of History. Washington [Press of J.H. Furst]. http://archive.org/details/alettertoamerica00adamuoft.

Burich, Keith R. 1992. “‘Stable Equilibrium Is Death’: Henry Adams, Sir Charles Lyell, and the Paradox of Progress.” The New England Quarterly 65 (4): 631–47. doi:10.2307/365825.

“Stable equilibrium is death” at https://stream.syscoi.com/2017/09/24/stable-equilibrium-is-death/

Are your changes systematic, or systemic?

Systematic	*Systemic*
Somatic (adaptive, cellular) change	Genotypic (generational) change
Non-living, effect-producing (allopoietic)	Living, systems-generating (autopoietic)
Reactive	Co-responsive

Exercise:
Systems changes for marine aquaculture in Luoyang Bay?

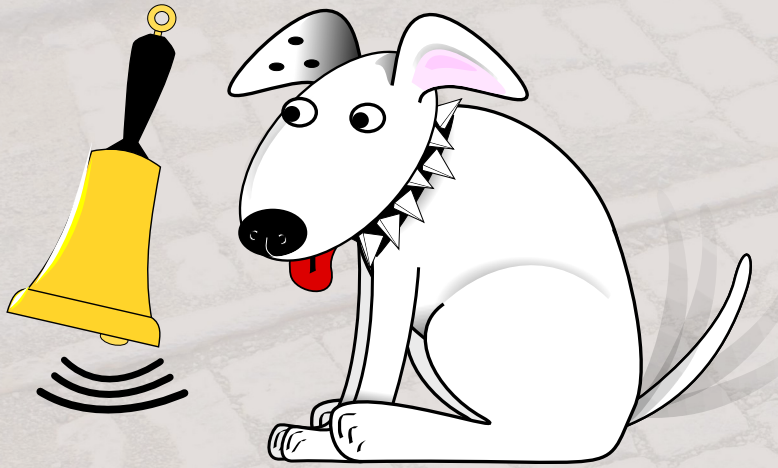
1. **Which** ([living] wholes, containing wholes, parts)?
   [Phenomenology of joint attention on systems changes]
2. **What** (affordances, capacities, taskscapes-landscapes)?
   [Ontology of becoming with systems changes]
3. **Why** (causes)?
   [Episteme of systems changes]
4. **Whom**, **when**, **where** (impacts)?
   [Phronesis in systems changes]
5. **How** (collective action)?
   [Techne for systems changes]

A 5-Question Cycle for Systems Changes can guide modes of inquiry grounded on five philosophical traditions

1. **Which** ([living] wholes, containing wholes, parts)?
   [Phenomenology of joint attention on systems changes]
2. **What** (affordances, capacities, taskscapes-landscapes)?
   [Ontology of becoming with systems changes]
3. **Why** (causes)?
   [Episteme of systems changes]
4. **Whom**, **when**, **where** (impacts)?
   [Phronesis in systems changes]
5. **How** (collective action)?
   [Techne for systems changes]

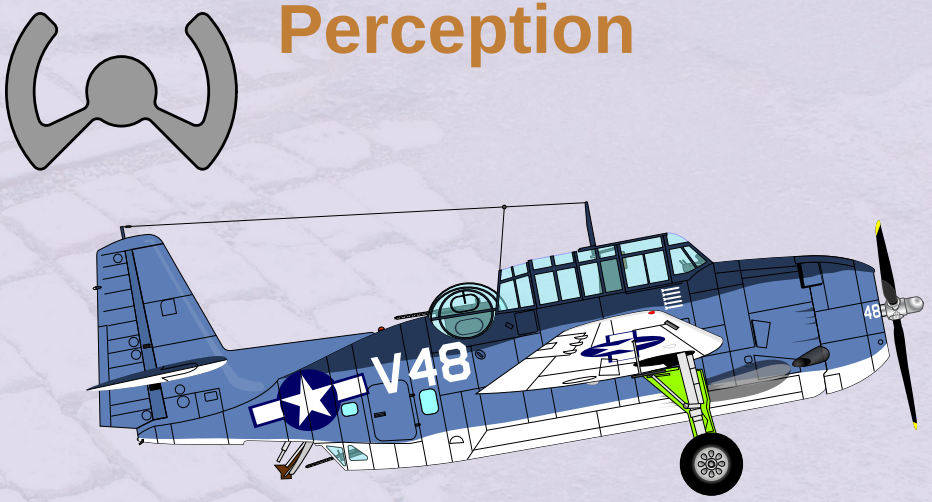
Ask Not What's Inside Your Head, but What Your Head's Inside of

Stimulus – Response
(Behavioral Psychology)



[In the 1950] psychophysics of perception … "givens" in the light to the eye could not support perceptual phenomena, but only elementary experiences such as sensations. [….] Succinctly put, the psycho-physical program was … traditional in considering perception to be a set of responses to presented stimuli (albeit "higher order" stimuli).

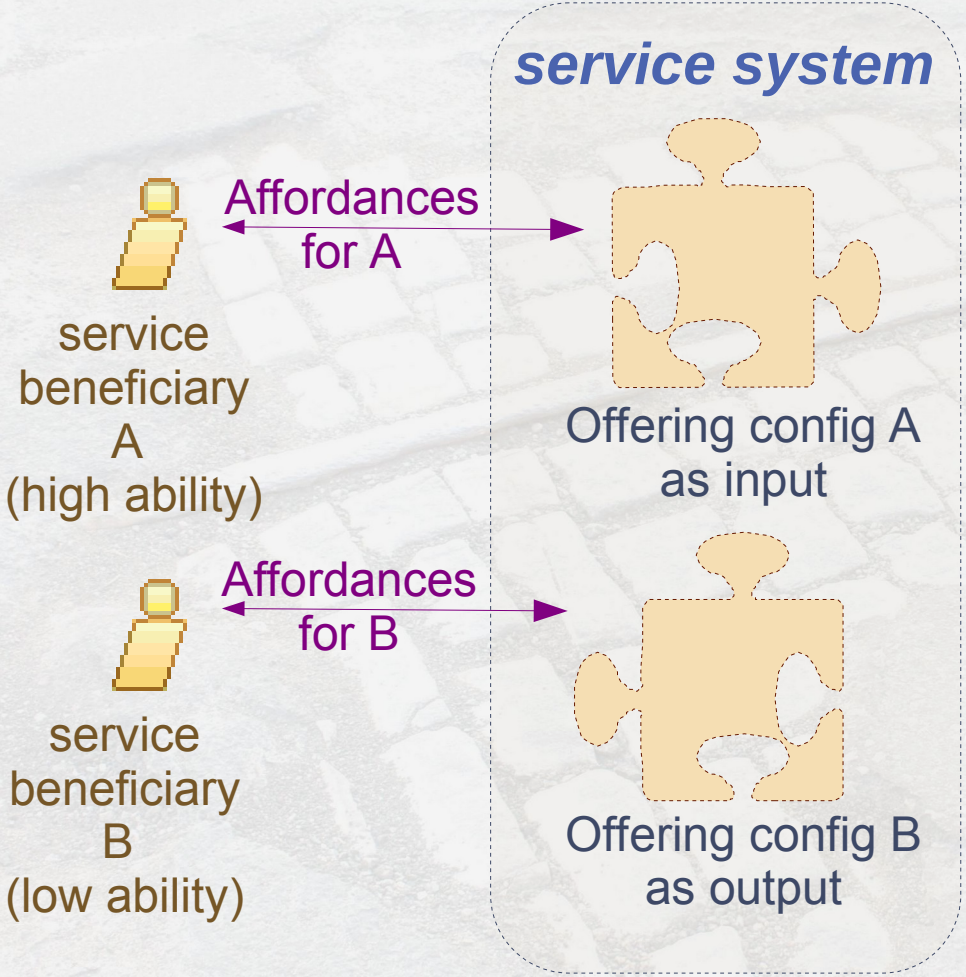
Ecological Approach to Perception



Over the last 10-15 years [James J. Gibson] has tried to develop enough theory … to demonstrate that direct perception is indeed plausible even if hordes of difficult details remain to be worked out. The … analysis of the optic array, stimulus organization, and the functional organization of perceptual systems are what Gibson oftens points to as radical features ….

William M. Mace 1977. "James J. Gibson's Strategy for Perceiving: Ask Not What's inside Your Head, but What Your Head's inside of." In *Perceiving, Acting, and Knowing: Toward an Ecological Psychology*, edited by Robert Shaw and John Bransford, 43–65.

Affordances are relational in an ecological perception



The term ***affordance*** refers to whatever it is about **the environment** that **contributes** to the kind of **interaction** that occurs. [….]

An affordance relates attributes of something in the environment to an interactive activity by an agent who has some ability, and an ability relates attributes of an agent to an interactive activity with something in the environment that has some affordance.

The relativity of affordances and abilities is fundamental. Neither an affordance nor an ability is specifiable in the absence of specifying the other.

James G. Greeno 1994. "Gibson's Affordances." *Psychological Review* 101 (2): 336–342.

Metabolism involves anabolism (building up) and catabolism (breaking down)

Overview of metabolism

Cells are constantly carrying out thousands of chemical reactions needed to keep the cell, and your body as a whole, alive and healthy. These chemical reactions are often linked together in chains, or pathways. All of the chemical reactions that take place inside of a cell are collectively called the cell's **metabolism**.

Anabolic and catabolic pathways

The processes of making and breaking down glucose molecules are both examples of metabolic pathways. A **metabolic pathway** is a series of connected chemical reactions that feed one another. The pathway takes in one or more starting molecules and, through a series of intermediates, converts them into products.

Metabolic pathways can be broadly divided into two categories based on their effects. Photosynthesis, which builds sugars out of smaller molecules, is a "building up," or **anabolic**, pathway. In contrast, cellular respiration breaks sugar down into smaller molecules and is a "breaking down," or **catabolic**, pathway.

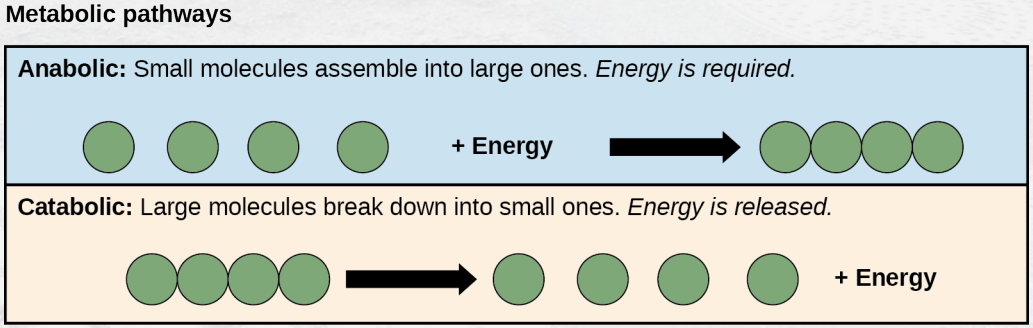


Figure 6.5 Anabolic pathways are those that require energy to synthesize larger molecules. Catabolic pathways are those that generate energy by breaking down larger molecules. Both types of pathways are required for maintaining the cell's energy balance.

Reference: Clark, Mary Ann, Matthew Douglas, and June Choi. 2018. "Energy and Metabolism." In *Biology* 2e. Houston, TX: OpenStax. https://openstax.org/books/biology-2e/pages/6-1-energy-and-metabolism .

Anabolic pathways build complex molecules from simpler ones and typically need an input of energy. Building glucose from carbon dioxide is one example. Other examples include the synthesis of proteins from amino acids, or of DNA strands from nucleic acid building blocks (nucleotides). These biosynthetic processes are critical to the life of the cell, take place constantly, and use energy carried by ATP and other short-term energy storage molecules.

Catabolic pathways involve the breakdown of complex molecules into simpler ones and typically release energy. Energy stored in the bonds of complex molecules, such as glucose and fats, is released in catabolic pathways. It's then harvested in forms that can power the work of the cell (for instance, through the synthesis of ATP).

Khan Academy. 2020. "Overview of Metabolism". In *High School Biology*. https://www.khanacademy.org/science/high-school-biology/hs-energy-and-transport/hs-introduction-to-metabolism/a/overview-of-metabolism

In the human body, it is possible to establish a relation between the metabolic pattern at the level of the parts, and the level of the whole

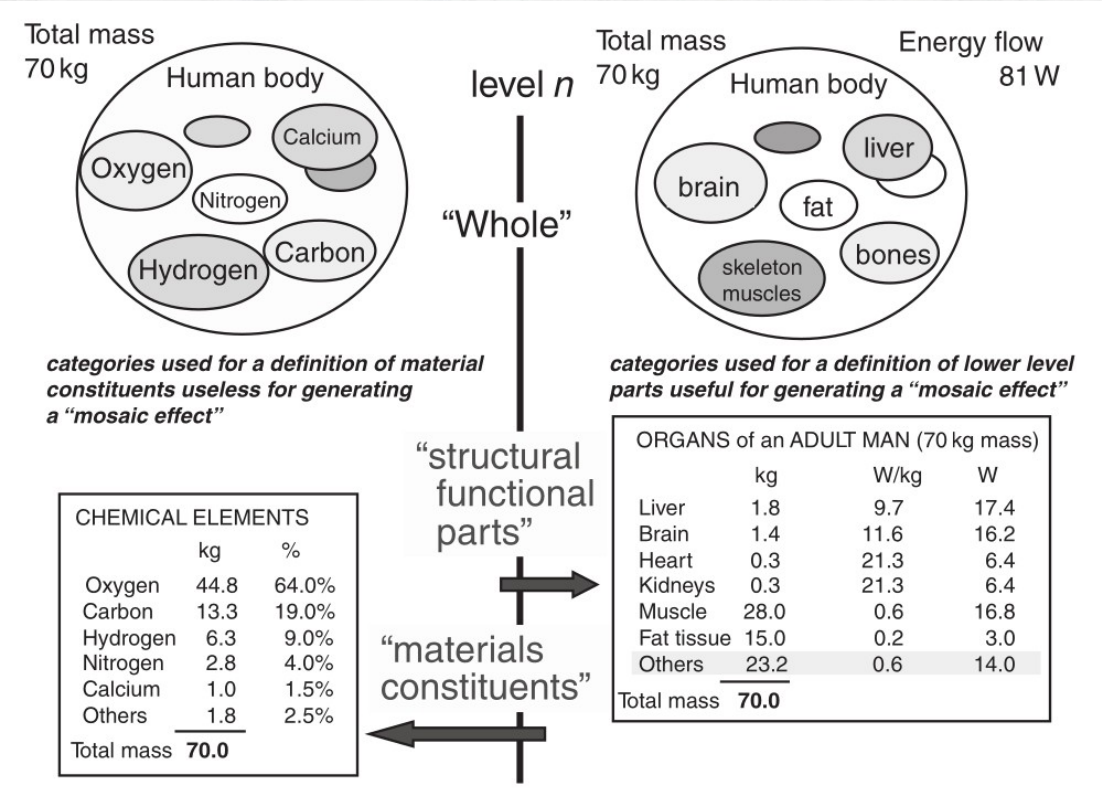


Figure 6.8 Mosaic effect over the metabolic rate of the human body and its organs.

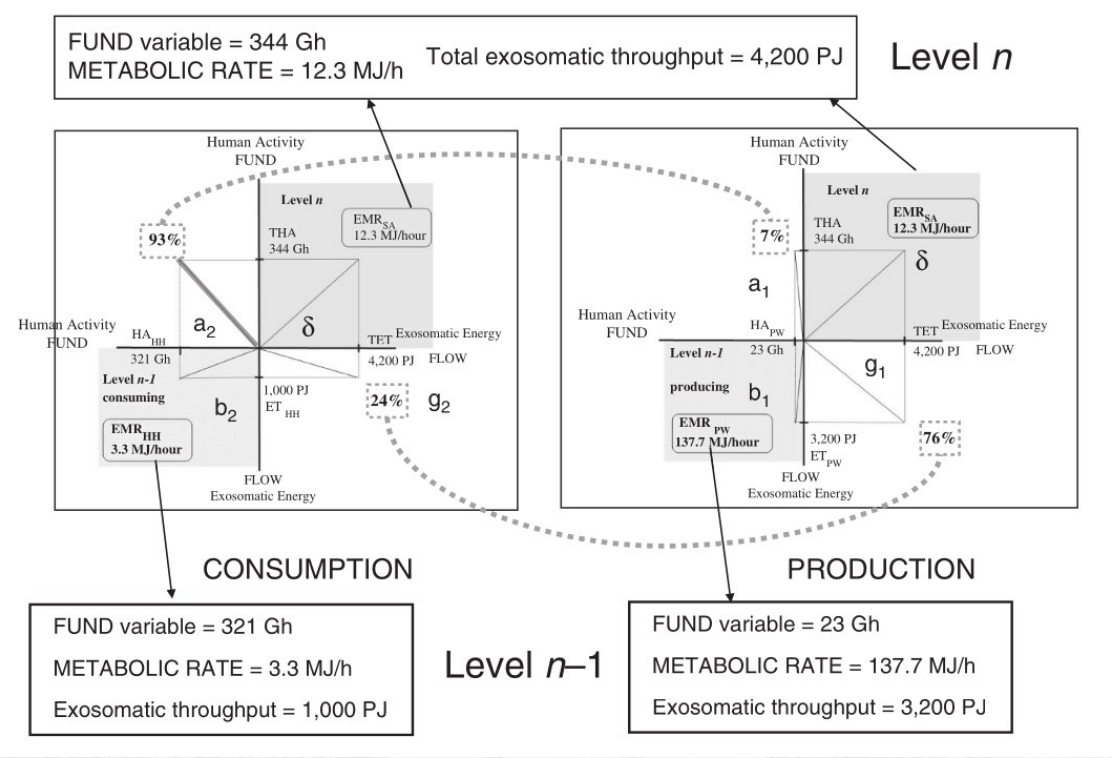
... we characterize the metabolism of a human body using three variables:

- the fund element "body mass" (expressed in kg),
- the flow element "energy expenditure" (expressed in W) and
- the resulting metabolic rate (i.e. energy expenditure per unit of body mass in W/kg).

This quantitative representation can be applied across hierarchical levels and can be used to describe the metabolism of the whole body at level *n*.
The same system of accounting can be applied to the representation of individual organs at a lower hierarchical level.
[pp. 164-165]

Giampietro, Mario, Kozo Mayumi, Alevgül H. Sorman. 2011. *The Metabolic Pattern of Societies : Where Economists Fall Short*. Routledge. https://doi.org/10.4324/9780203635926 .

A metabolic pattern of socio-economic components operating across continguous levels has potential for establishing a relation



... we carry out the same type of analysis illustrated above for the human body, but applied to the metabolic pattern of society. The only difference in the system of accounting is a different definition of the size of the fund element: we adopt a definition of size based on “hours of human activity per year” rather than kilograms of body mass.

Our example is based on an analysis of the metabolic pattern of Spain, referring to 1999 (Giampietro and Mayumi, 2009), and is illustrated in Figure 6.9.
[pp. 165-166]

Figure 6.9 Mosaic effect over the metabolic pattern of energy at levels *n* and *n – 1* (source: Giampietro and Mayumi, 2009)

Giampietro, Mario, Kozo Mayumi, and Alevgül H. Sorman. 2011. *The Metabolic Pattern of Societies : Where Economists Fall Short*. Routledge. https://doi.org/10.4324/9780203635926 .

Taskscape and landscape via Pieter Bruegel the Elder (1565) *The Harvesters*

Rather than treating the world as its own painting I should like you, the reader, to regard this painting by Bruegel as though it were its own world, into which you have been magically transported. Imagine yourself, then, set down in the very landscape depicted, on a sultry August day in 1565. Standing a little way off to the right of the group beneath the tree, you are a witness to the scene unfolding about you. And of course you hear it too, for the scene does not unfold in silence.

So used are we to thinking of the landscape as a picture that we can look at, like a plate in a book or an image on a screen, that it is perhaps necessary to remind you that exchanging the painting for 'real life' is not simply a matter of increasing the scale.

What is involved is a fundamental difference of orientation. In the landscape of our dwelling, we look around (Gibson 1979: 203).

Ingold, Tim. 2000. "The Temporality of the Landscape." In *The Perception of the Environment: Essays on Livelihood, Dwelling and Skill*, 189–208. Routledge.

A *dwelling* perspective is beyond a naturalistic view of landscape as neutral backdrop, and culturalistic view as cognitive or symbolic ordering of space

Landscape

Let me be begin by explaining what the landscape is not. It is not 'land', it is not 'nature', and it is not 'space'. [….]

In short, **the landscape is the world as it is known to those who dwell therein, who inhabit its places and journey along the paths connecting them**.

Is it not, then, identical to what we might otherwise call the environment? […]

The environment is no more 'nature' than is the landscape a symbolic construct. […]

As Lewontin succinctly puts it (1982:160), the environment is 'nature organised by an organism'.

Temporality

Let me begin, once again, by stating what temporality is not. It is not chronology (as opposed to history), and it is not history (as opposed to chronology). [….]

One of the great mistakes of recent anthropology ... has been to insist upon a separation between the domains of technical and social activity ….

It is to **the entire ensemble of tasks, in their mutual interlocking, that I refer by the concept of *taskscape***. Just as the landscape is an array of related features, so – by analogy – the taskscape is an array of related activities. [….]

In short, the taskscape is to labour what the landscape is to land, and indeed what an ensemble of use-values is to value in general.

Temporalizing the Landscape

My conclusion that the landscape is the congealed form of the taskscape does enable us to explain why, intuitively, **the landscape seems to be what we *see* around us, whereas the taskscape is what we *hear***. […]

In short, what I hear is *activity*, even when its source cannot be seen.

Ingold, Tim. 2000. "The Temporality of the Landscape." In *The Perception of the Environment: Essays on Livelihood, Dwelling and Skill*, 189–208. Routledge.

Lifelines co-respond with habit, agencing, and attentionality

Habit, rather than volition:

I become my walking, and that my walking walks me. I am there, inside of it, animated by its rhythm. And with every step I am not so much changed as modified, in the sense not of transition from one state to another but of perpetual renewal. [p. 16]

Agencing, rather than agency:

Interaction goes back and forth as agents, facing each other on opposite banks of the river, trade messages, missiles, and merchandise. But to *correspond*, in my terms, is to join with the swimmer in the midstream. It is a matter not of taking sides but of going along. [p. 18]

Attentionality, rather than intentionality:

Walking calls for the pedestrian's continual responsiveness to the terrain, the path, and the elements. To respond, he must attend to these things as he goes along, joining or participating with them in his own movements. [p. 19]

Ingold, Tim. 2017. "On Human Correspondence." *Journal of the Royal Anthropological Institute* 23 (1):9–27. https://doi.org/10.1111/1467-9655.12541.

Develop systems thinking

Israel X | TECHNION Israel Institute of Technology

Professional Certificate in

Model-Based Systems Engineering - MBSE

I'm interested

What you will learn

- Identifying and defining objects, processes, and states in a system and the structural and procedural relations among them
- Modeling the system's top-level diagram with its function, beneficiary, benefit, stakeholders, and enables - agents and instruments
- Modeling various kinds of systems, including technological, natural, and complex socio-technical systems
- Managing system complexity by using refinement-abstraction mechanisms of in-zooming - out-zooming, unfolding - folding, and state expression - suppression

Expert instruction
2 skill-building courses

Instructor-led
Assignments and exams have specific due dates

3 months
5 - 6 hours per week

Program Overview

youtube.com/channel/UCMJTbOJq-3RCM7E1mfHCF5Q/videos

YouTube CA

object process methodology (opm)

MBSE OPM

107 subscribers

SUBSCRIBED

HOME | VIDEOS | PLAYLISTS | CHANNELS | DISCUSSION | ABOUT

Uploads PLAY ALL

SORT BY

Rea Lavi Interviews Dov Dori on OPM Part 2 17 11 19

88 views • 2 weeks ago

Rea Lavi Interviews Dov Dori on OPM Part 1 17 11 19

78 views • 2 weeks ago

1006 (962 22 12) - Goodbye and good luck!

108 views • 2 weeks ago

CC

931 hopcat - Alternative solution concept

118 views • 3 weeks ago

941 1912v3 - Software Development

116 views • 3 weeks ago

CC

931 19 12 Alternative solution concepts

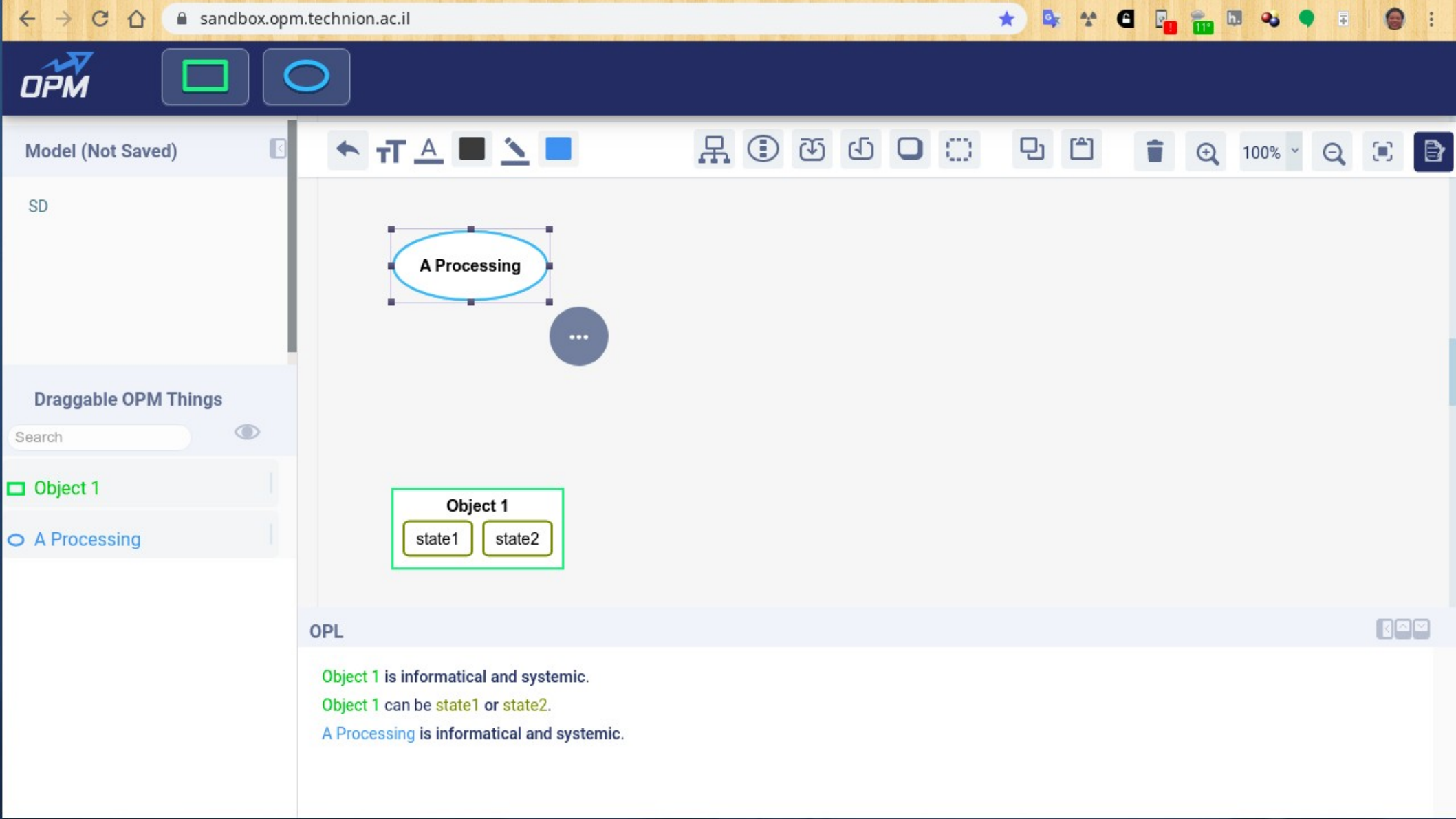
943 19 12 - Hardware Development

942 19 12 - Virtual integration

932 19 12 - Solution design

122 views • 3 weeks ago

911 19 12 - MBSE: System architecting overview


sandbox.opm.technion.ac.il
OPM
Model (Not Saved)
SD
A Processing
Draggable OPM Things
Search
Object 1
A Processing
Object 1
state1
state2
100%
OPL
Object 1 is informatical and systemic.
Object 1 can be state1 or state2.
A Processing is informatical and systemic.

OPM Entities

Symbol	Name: Definition	OPL	Comments
Things: A	Object **A**: A thing that exists	**A** is physical (and environmental).	**A** is informatical and systemic by default.
Things: B	Process **B**: A thing that transforms (generates, consumes, or changes the state of an object).	**B** is physical (and environmental).	**B** is informatical and systemic by default.
A (s1, s2)	State: A situation of an object.	**A** is s1. **A** can be s1 or s2. **A** can be s1, s2, or s3.	Always within an object.

OPM Procedural Links

Name	Symbol	OPL	Semantics
Consumption Link	A → B	**B** consumes **A**.	Process B consumes Object A.
State-Specified Consumption Link	A (s1) → B	**B** consumes **s1 A**.	Process B consumes Object A when it is at State s1.
Result Link	A ← B	**B** yields **A**.	Process B creates Object A.
State-Specified Result Link	A (s1) ← B	**B** yields **s1 A**.	Process B creates Object A at State s1.
Input-Output Link Pair	A (s1, s2) ↔ B	**B** changes **A** from **s1** to **s2**.	Process B changes the state of Object A from State s1 to State s2.
Effect Link	A ↔ B	**B** affects **A**.	Process B changes the state of Object A;

Object Process Methodology ISO/PAS 19450

Enterprise Systems Modeling Laboratory, led by Dov Dori, http://esml.iem.technion.ac.il/introduction-to-opm/

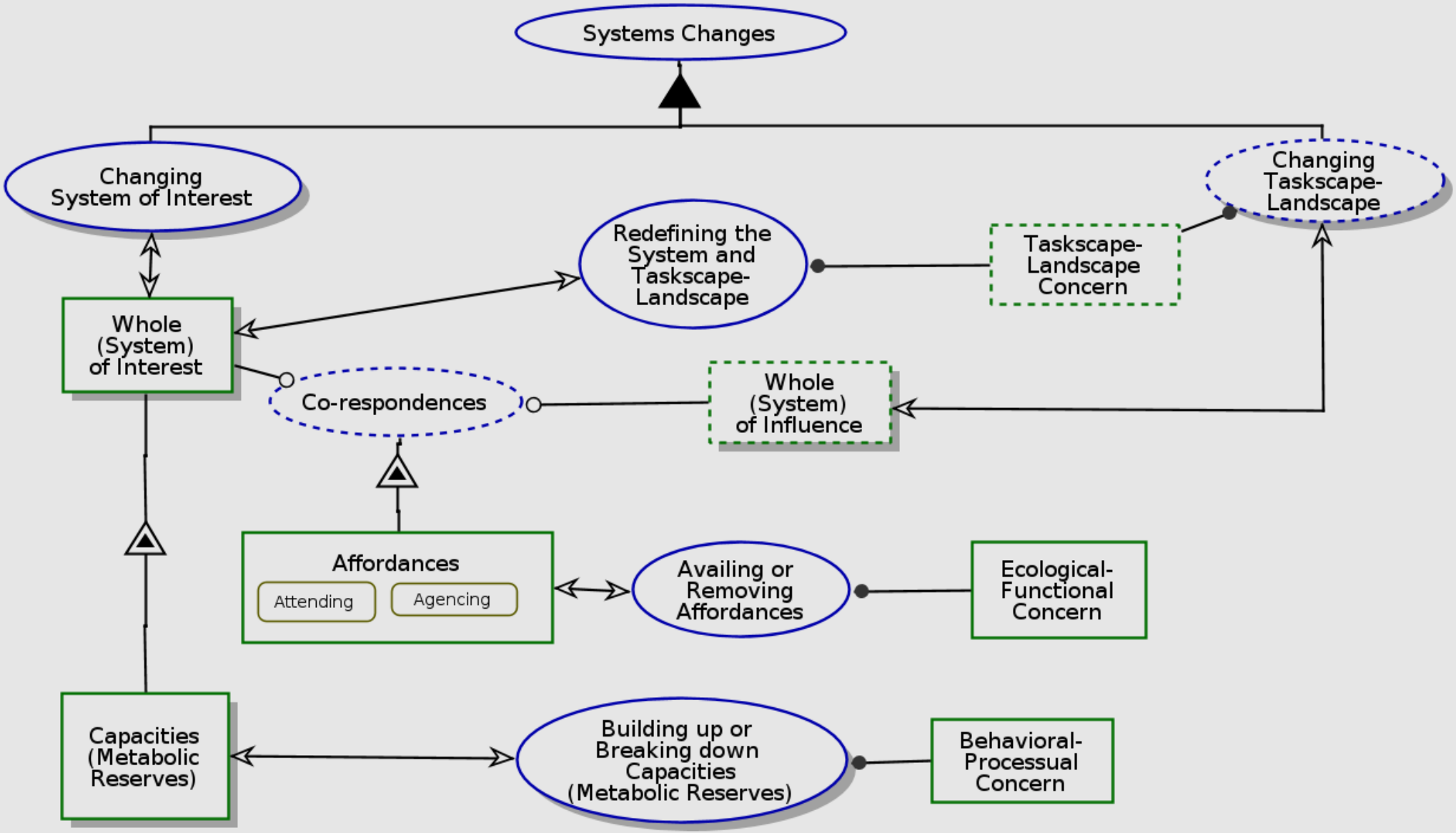
OPM Structural Links

Symbol	Name	OPL	Allowed Source-to-Destination connections	Semantics/ Effect on the system flow/ Comments
▲	Aggregation-Participation	**A** consist of **B**.	Object-Object Process- Process	Whole -Part
◬	Exhibition-Characterization	**A** exhibits **B**.	Object-Object Object-Process Process-Object Process- Process	
△	Generalization-Specialization	**B** is an **A**. (objects) **B** is **A**. (processes)	Object-Object Process- Process	
◭	Classification-Instantiation	**B** is an instance of **A**.	Object-Object Process- Process	
↔	Tagged structural links: Unidirectional Bidirectional	According to text added by user	Object-Object Process- Process	Describes structural information.

OPM tables by CC BY-SA 4.0 Snhot, https://en.wikipedia.org/wiki/Object_Process_Methodology

Three principal concerns of systems changes relate to three perspectives, and logical categories of learning

Concern	*Perspectives*			Learning
Taskscape-Landscape Concern			**Redefining** the System and Taskscape-Landscape	Trito-learning
Ecological-Functional Concern		Availing or Removing **Affordances**		Deutero-learning
Behavioral-Processual Concern	Building up or Breaking down **Capacities** (Metabolic Reserves)			Proto-learning


Systems Changes
Changing System of Interest
Changing Taskscape-Landscape
Redefining the System and Taskscape-Landscape
Taskscape-Landscape Concern
Whole (System) of Interest
Co-respondences
Whole (System) of Influence
Affordances
Attending
Agencing
Availing or Removing Affordances
Ecological-Functional Concern
Capacities (Metabolic Reserves)
Building up or Breaking down Capacities (Metabolic Reserves)
Behavioral-Processual Concern

Ecological- Functional Concern handles Availing or Removing Affordances.
Behavioral- Processual Concern handles Building up or Breaking down Capacities (Metabolic Reserves).
Taskscape- Landscape Concern is environmental.
Taskscape- Landscape Concern handles Redefining the System and Taskscape- Landscape and Changing Taskscape- Landscape.
Whole (System) of Interest is physical.
Whole (System) of Interest exhibits Capacities (Metabolic Reserves).
    Capacities (Metabolic Reserves) is physical.
Whole (System) of Influence is environmental and physical.
Systems Changes consists of Changing System of Interest and Changing Taskscape- Landscape.
    Changing System of Interest is physical.
    Changing System of Interest affects Whole (System) of Interest.
    Changing Taskscape- Landscape is environmental and physical.
    Changing Taskscape- Landscape affects Whole (System) of Influence.
Availing or Removing Affordances affects Affordances.
Building up or Breaking down Capacities (Metabolic Reserves) is physical.
Building up or Breaking down Capacities (Metabolic Reserves) affects Capacities (Metabolic Reserves).
Co-respondences is environmental.
Co-respondences exhibits Affordances.
    Affordances can be Attending or Agencing.
Co-respondences requires Whole (System) of Interest and Whole (System) of Influence.
Redefining the System and Taskscape- Landscape affects Whole (System) of Interest.

Exercise:
Systems changes for marine aquaculture in Luoyang Bay?

1. **Which** ([living] wholes, containing wholes, parts)?
   [Phenomenology of joint attention on systems changes]
2. **What** (affordances, capacities, taskscapes-landscapes)?
   [Ontology of becoming with systems changes]
3. **Why** (causes)?
   [Episteme of systems changes]
4. **Whom**, **when**, **where** (impacts)?
   [Phronesis in systems changes]
5. **How** (collective action)?
   [Techne for systems changes]

A 5-Question Cycle for Systems Changes can guide modes of inquiry grounded on five philosophical traditions

1. **Which** ([living] wholes, containing wholes, parts)?
   [Phenomenology of joint attention on systems changes]
2. **What** (affordances, capacities, taskscapes-landscapes)?
   [Ontology of becoming with systems changes]
3. **Why** (causes)?
   [Episteme of systems changes]
4. **Whom**, **when**, **where** (impacts)?
   [Phronesis in systems changes]
5. **How** (collective action)?
   [Techne for systems changes]

With known knowns in science eroding by systemic world changes, collective learning on why, how + when-where-whom gains value

Colloquial description:	**Learning why**	**Learning how**	**Learning when, learning where, learning whom**
Pursuits:	Uncovering universal truths	Instrumental rationality towards a conscious goal	Values in practice based on judgement and experience
Primary intellectual virtue:	**Episteme**	**Techne**	**Phronesis**
Translation / interpretation:	Science (viz. epistemology)	Craft (viz. technique)	Prudence, common sense
Type of virtue:	Analytic scientific knowledge	Technical knowledge	Practical ethics
Orientation:	Research	Production	Action
Nature:	Universal	Pragmatic	Pragmatic
	Invariable (in time and space)	Variable (in time and space)	Variable (in time and space)
	Context-independent	Context-dependent	Context-dependent

[1] Ing, David, Minna Takala, and Ian Simmonds. 2003. "Anticipating Organizational Competences for Development through the Disclosing of Ignorance." In Proceedings of the 47th Annual Meeting of the International Society for the System Sciences. Hersonissos, Crete. http://systemicbusiness.org/pubs/2003_ISSS_47th_Ing_Takala_Simmonds.html

[2] Ing, David. 2013. "Rethinking Systems Thinking: Learning and Coevolving with the World." *Systems Research and Behavioral Science* 30 (5): 527–47. doi:10.1002/sres.2229.

Image CC-BY Mike Cassano (2009) *Most Interesting Pothole*