Service Systems, Natural Systems: Systems Approaches to Urban Issues

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What's new in the systems sciences?

1. Challenges:
(post-industrial) service economy; planetary boundaries

2a. Service systems:
Theory of the offering

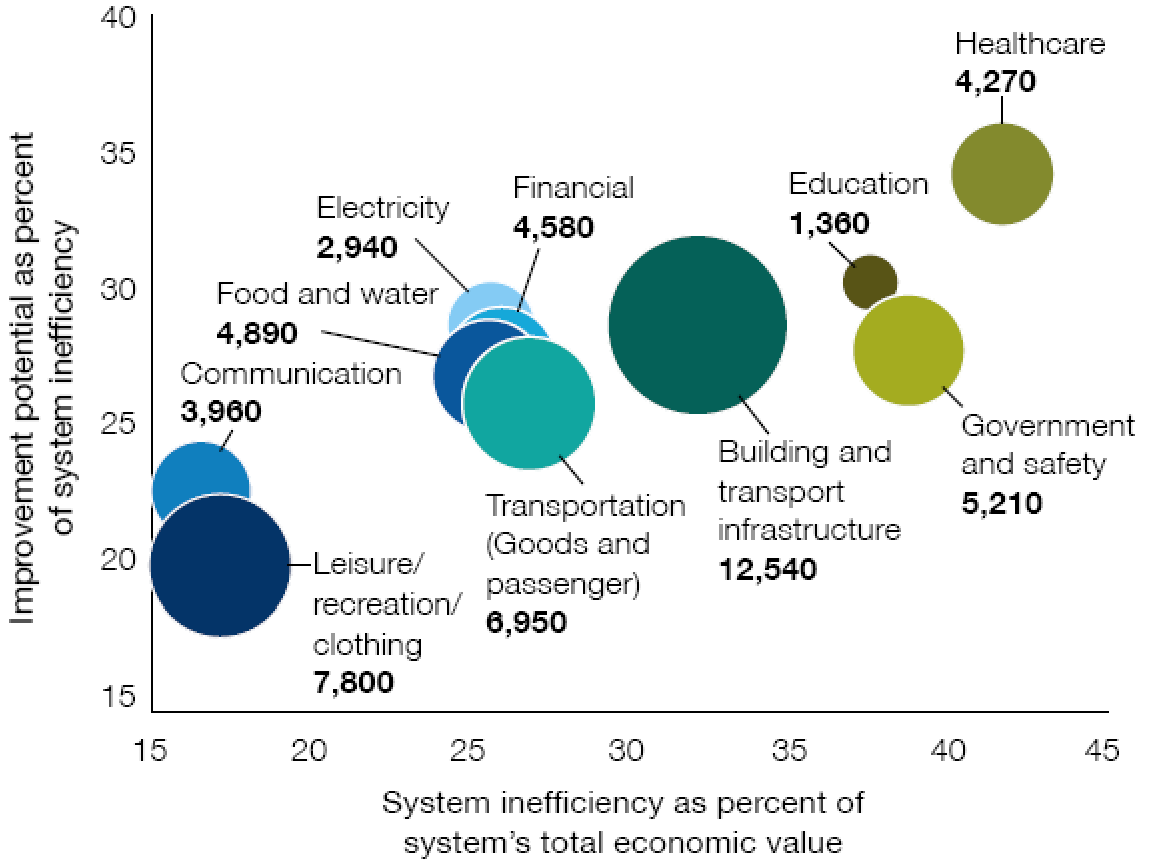
2b. Natural systems:
Regime shifts, ecological resilience, panarchy

3. Language action perspective:
produce a deliverable; provide a capability; follow a process; contribute to a relationship

4. Supply side sustainability:
elaboration of structure as an increase in complicatedness; elaboration of organization as an increase in complexity

5. Systems sciences and systems engineering:
Episteme, techne and phronesis

The world's $4 billion challenge -- IBM



Note: Size of the bubble indicates absolute value of the system in US$ billions
Source: IBM Institute for Business Value analysis based on inefficiency and improvement potential estimates reported during 2009 survey of 518 economists.

http://www-935.ibm.com/services/us/gbs/bus/html/ibv-smarter-planet-system-of-systems.html.

Figure 2: Of the US$15 trillion in inefficiencies within our global system, approximately US$4 trillion could be eliminated.

Human civilization is served by systems in technical, organizational and socio-political form

Systems that move, store, harvest, process	•Transportation	K
	•Water and waste management	1
	•Food and global supply chain	2
	•Energy and energy grid	3
	•Information and communications (ICT) infrastructure	4
Systems that enable healthy, wealthy and wise people	•Building and construction	5
	•Banking and finance	6
	•Retail and hospitality	7
	•Healthcare	8
	•Education (including universities)	9
Systems that govern	•Government (cities)	10
	•Government (regions / states)	11
	•Government (nations)	12

[Spohrer and Maglio 2010]

Planetary Boundaries

Earth-system process	Parameters	Proposed boundary	Current status	Pre-industrial value
Climate change	(I) Atmospheric carbon dioxide concentration (parts per million by volume) (ii) Change in radiative forcing (watts per metre squared)	350 1	387 1.5	280 0
Rate of biodiversity loss	Extinction rate (number of species per million species per year)	10	>100	0.1-1
Nitrogen cycle (part of a boundary with the phosphorus cycle)	Amount of N_2 removed from the atmosphere for human use (millions of tonnes per year)	35	121	0
Phosphorus cycle (part of a boundary with the nitrogen cycle)	Quantity of P flowing into the ocean (millions of tonnes per year)	11	8.5 - 9.5	-1
Stratospheric ozone depletion	Concentration of ozone (Dobson unit)	276	283	290
Ocean acidification	Global mean saturation state of aragonite in surface sea water	2.75	2.90	3.44
Global freshwater use	Consumption of freshwater by humans (km^3 per year)	4,000	2,600	415
Change in land use	Percentage of global land cover converted to cropland	15	11.7	Low
Atmospheric aerosol loading	Overall particulate concentration in the atmosphere, on a regional basis	To be determined		
Chemical pollution	For example, amount emitted to, or concentration of persistent organic pollutants, plastics, endocrine disrupters, heavy metals and nuclear waste, in the global environment, or the effects on ecosystem and functioning of Earth system thereof	To be determined		

Boundaries for processes in red have been crossed.

Table 1, Rockström, J., W. Steffen, K. Noone et al. 2009. “Planetary Boundaries: Exploring the Safe Operating Space for Humanity.” *Ecology and Society* 14 (2): 32. http://www.ecologyandsociety.org/vol14/iss2/art32/.

Beyond the boundaries

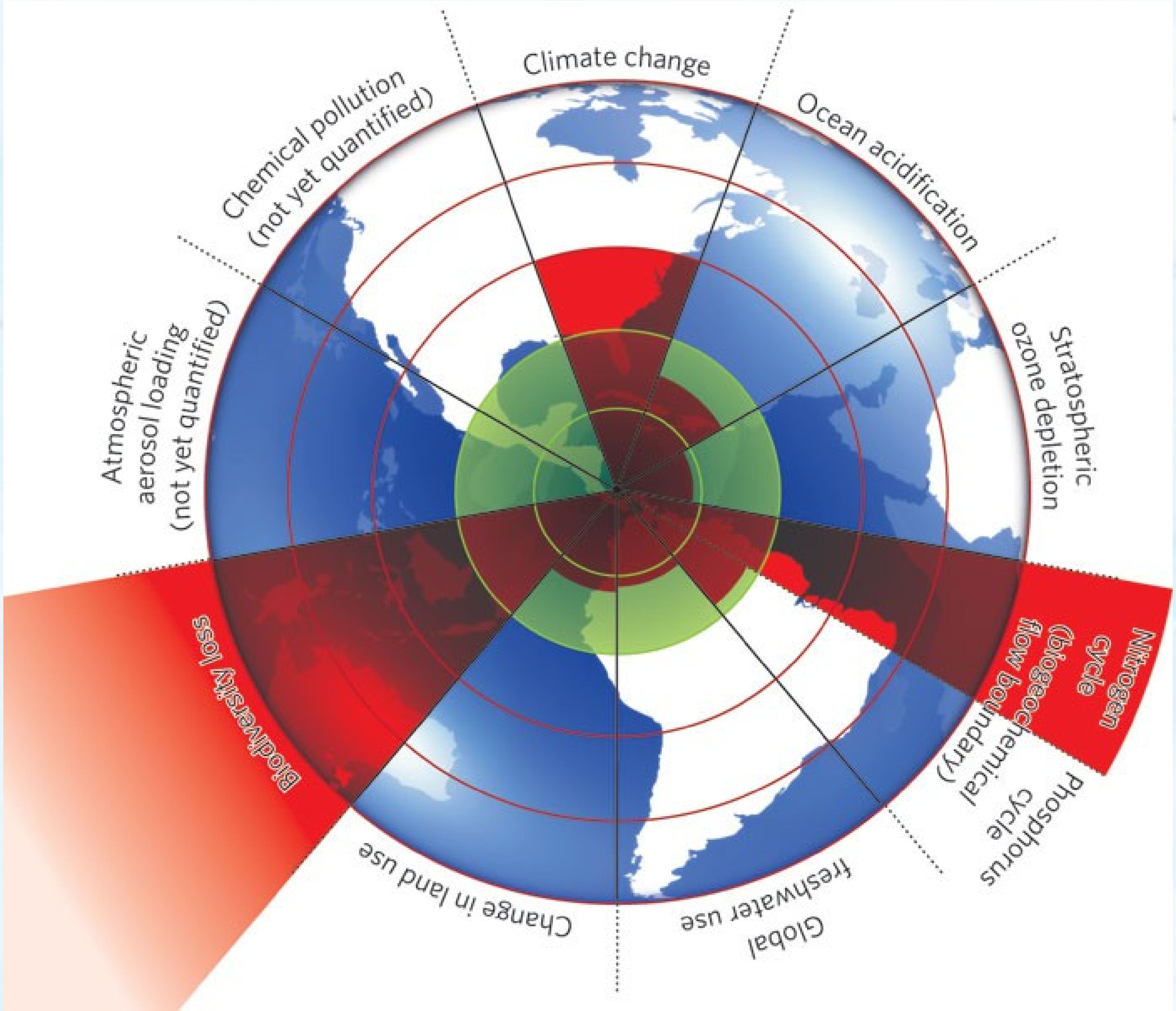


Figure 1.

The inner green shading represents the proposed safe operating space for nine planetary systems.

The red wedges represent an estimate of the current position for each variable.

The boundaries in three areas (rate of biodiversity loss, climate change and human interference with the nitrogen cycle), have already been exceeded.

Rockström, Johan, Will Steffen, Kevin Noone, et al. 2009. “A Safe Operating Space for Humanity.” *Nature* 461 (7263): 472–475. doi:10.1038/461472a. http://dx.doi.org/10.1038/461472a..

What's new in the systems sciences?

2a. Service systems:
Theory of
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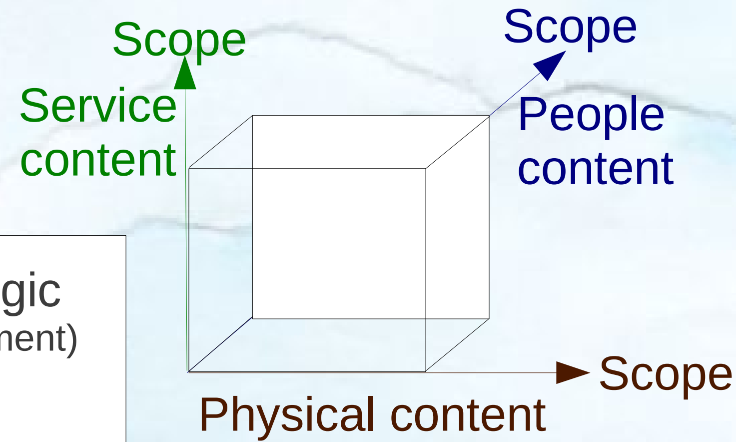
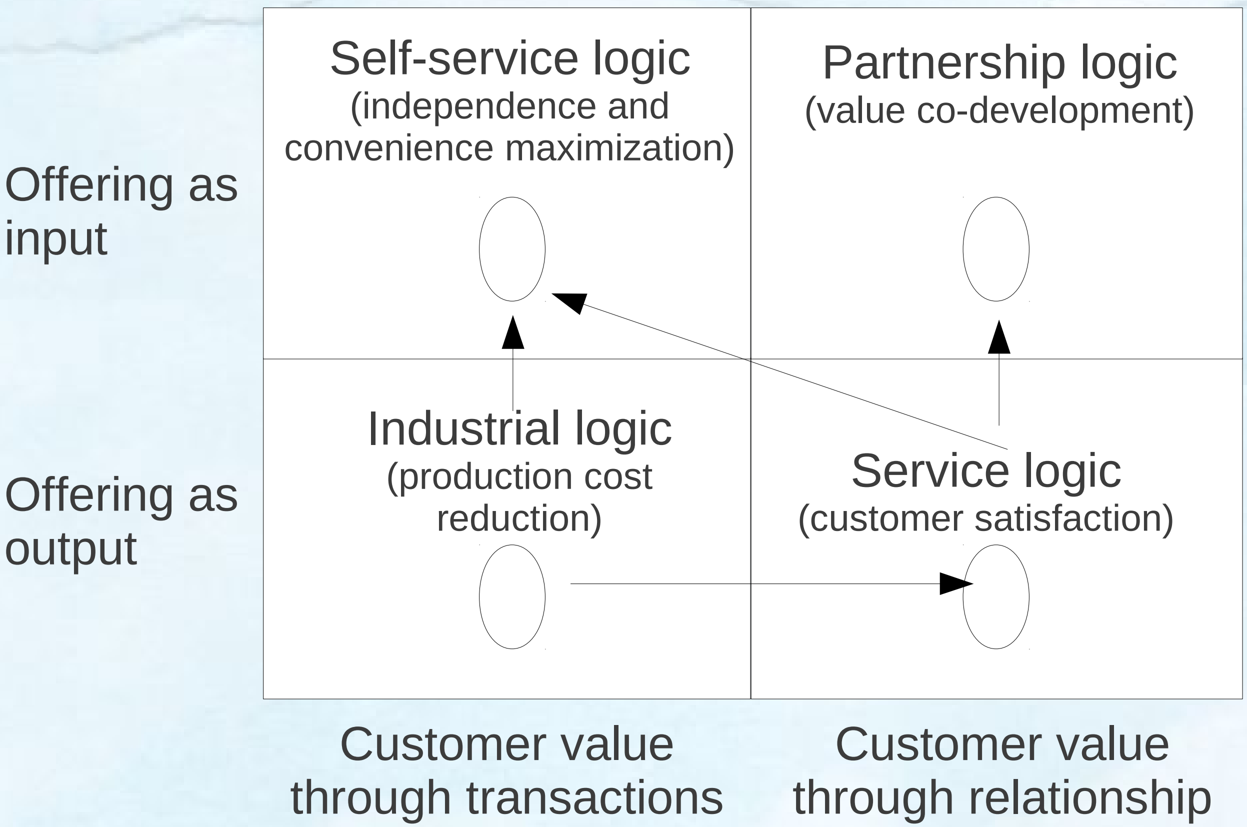
2b. Natural systems:
Regime shifts,
ecological resilience, panarchy

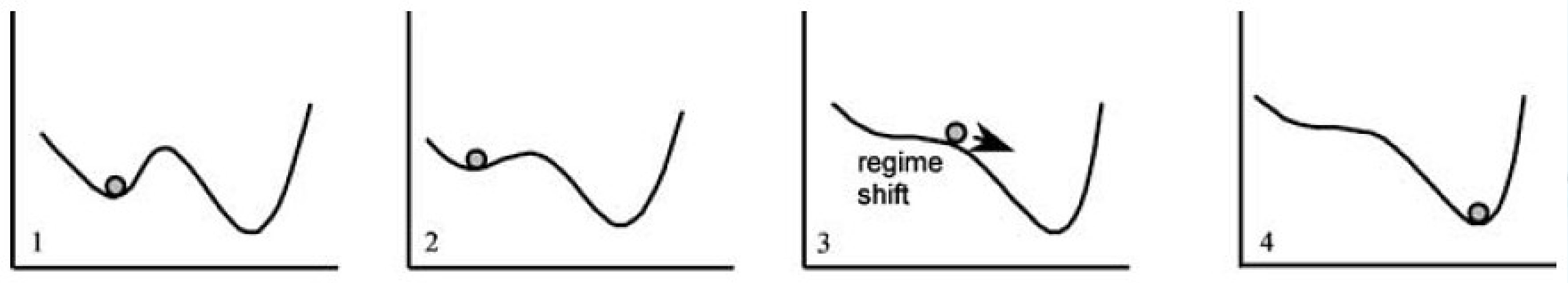
A high- or low-ability client may prefer an offering as an *input*, or *output, of coproduction*





Rafael Ramirez and Johan Wallin. *Prime Movers: Define Your Business or Have Someone Define It Against You*, 2000, p. 141.

Regime shifts and thresholds



clear-water lakes	phosphorous accumulation in agricultural soil and lake mud	flooding, warming, overexploitation of predators	turbid-water lakes
coral-dominated reefs	overfishing, coastal eutrophication	disease, bleaching hurricane	algae-dominated reefs
grasslands	fire prevention	good rains, continuous heavy grazing	shrub-bushland
grassland	hunting of herbivores	disease	woodland
...	...	...	...

Figure 2 Alternate states in a diversity of ecosystems (1, 4) and the causes (2) and triggers (3) behind loss of resilience and regime shifts.

[Folke, Carpenter, Walker, Scheffer, Elmqvist, Gunderson and Holling 2004]

Low ecosystem resilience → opportunity to transform

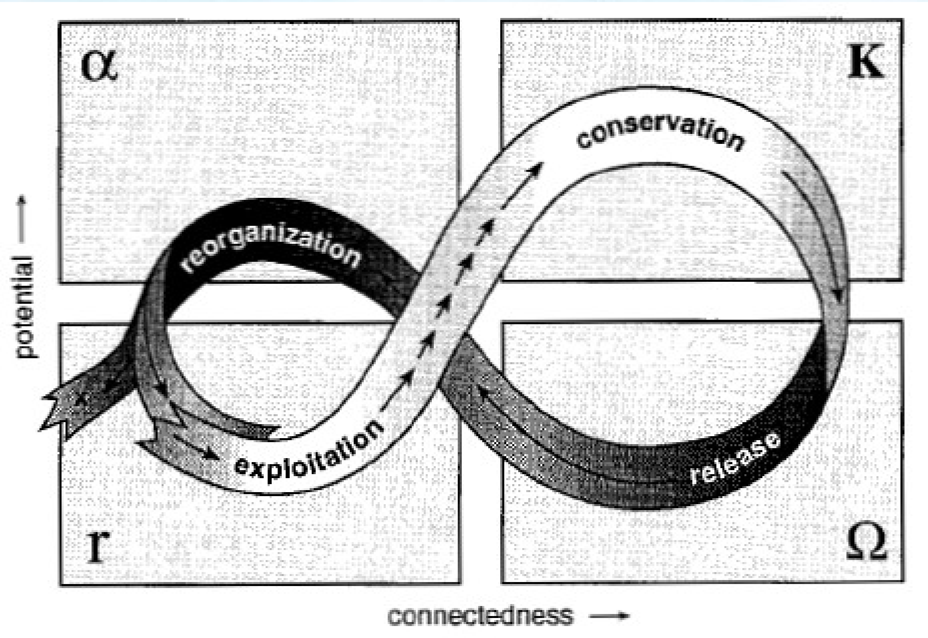


Figure 4. A stylized representation of the four ecosystem functions (r, K, Ω, α) and the flow of events among them.

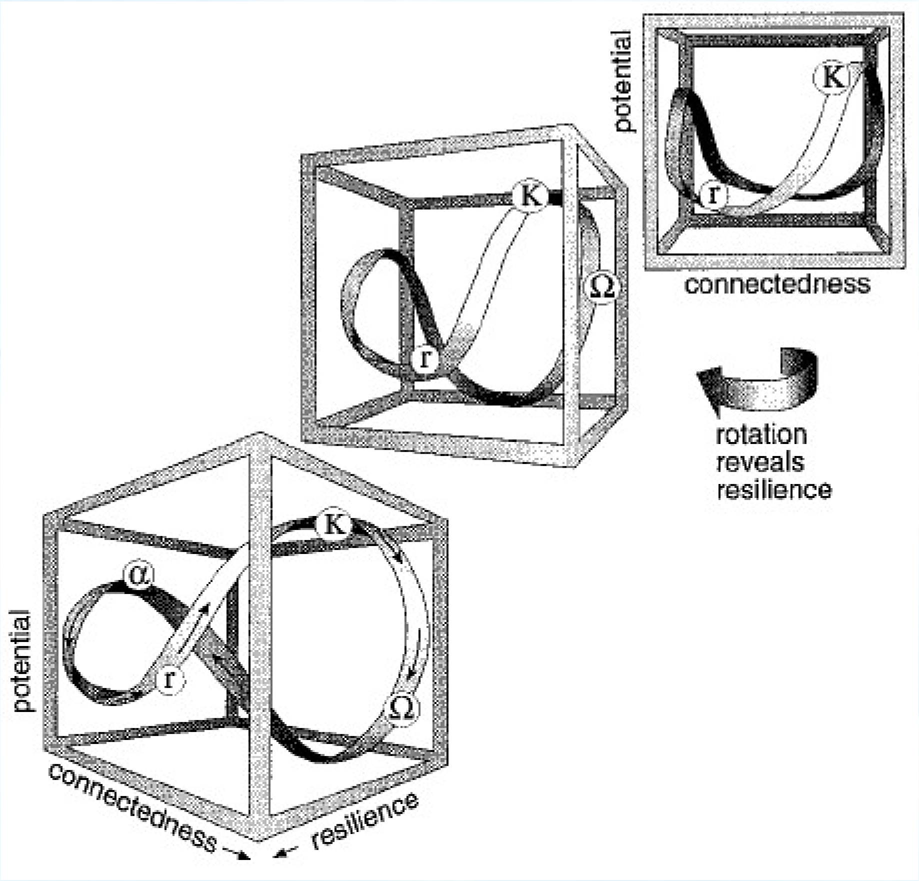


Figure 5. Resilience is another dimension of the adaptive cycle.

[Holling 2001]

Cross-scale adaptive cycles, panarchical connections

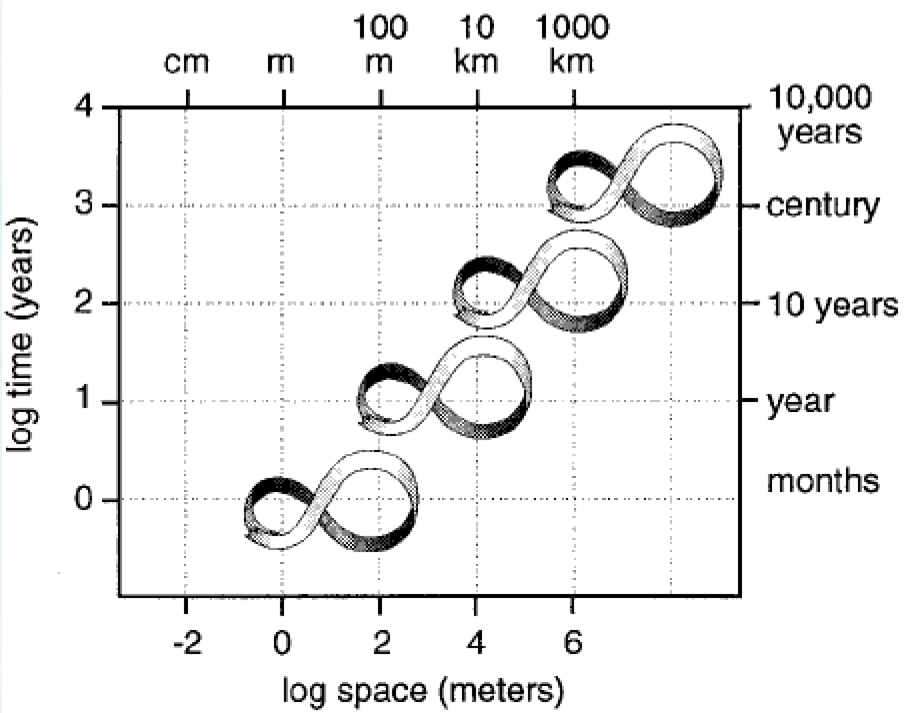


Figure 6. A stylized panarchy. A panarchy is a cross scale, nested set of adaptive cycles that indicates the dynamic nature of structures depicted in the previous plots.

[Holling 2001]

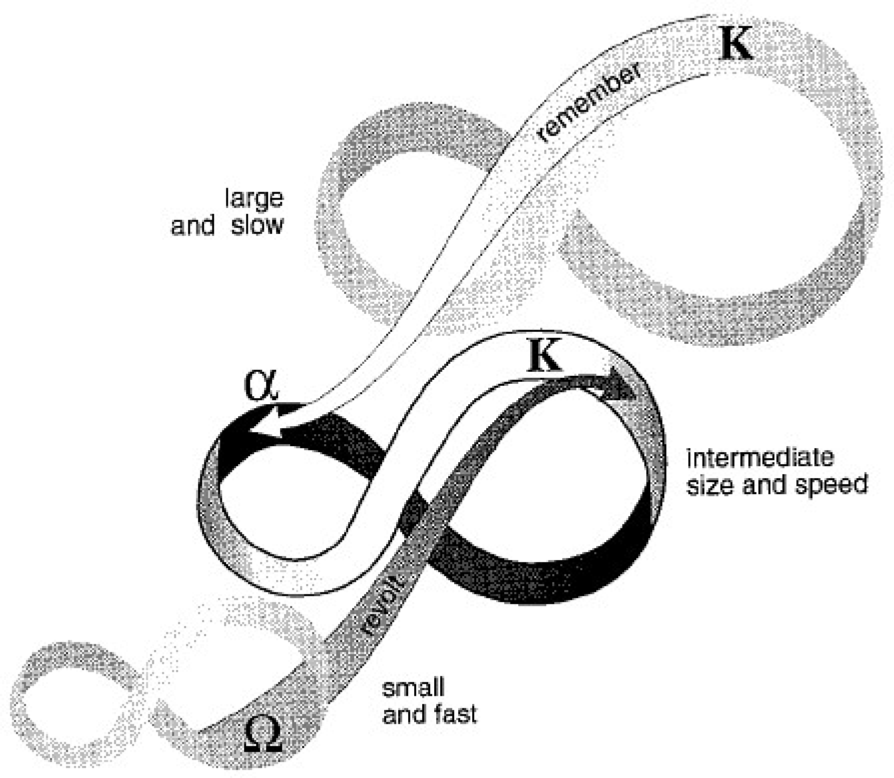


Figure 7. Panarchical connections. [....] the "revolt" connection ...can cause a critical change in one cycle to cascade up to a vulnerable stage in a larger and slower one. The ... "remember" connection ... facilitates renewal by drawing on the potential that has been accumulated and stored in a larger, slower cycle.

What's new in the systems sciences?

3. Language action perspective:
produce a deliverable; provide a capability;
follow a process; contribute to a relationship

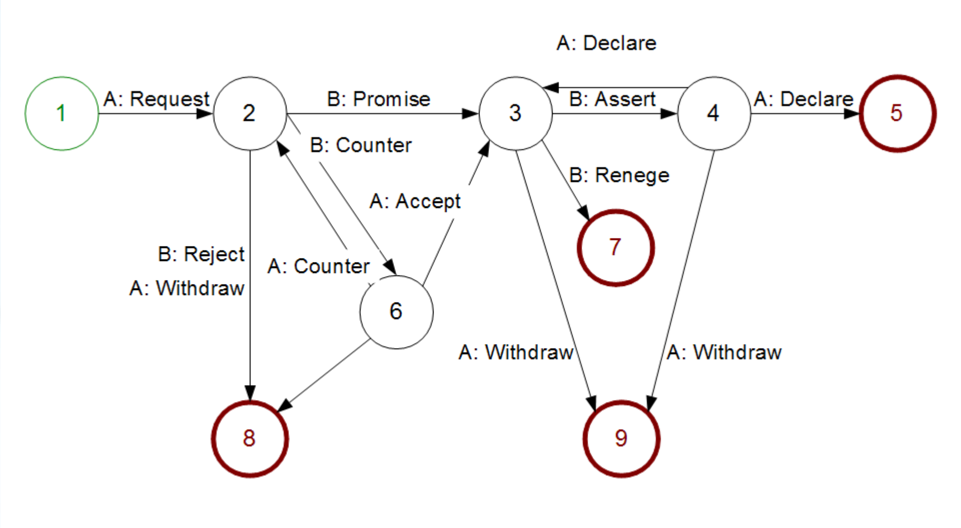
Dialogue, language-action, conversation

Dialogue

The type of dialogue discuss heretofore is often called "generative," meaning that it generates a collective worldview.

... ... strategic dialogue focuses on specific issues and tasks and is applied in finding specific solutions in organizational and social systems settings.

[Banathy 1996, p. 28]



The basic conversation for action
[Winograd and Flores, 1986]

We distinguish several additional kinds of conversation that go along with conversations for action (CfA):

•conversation for clarification,

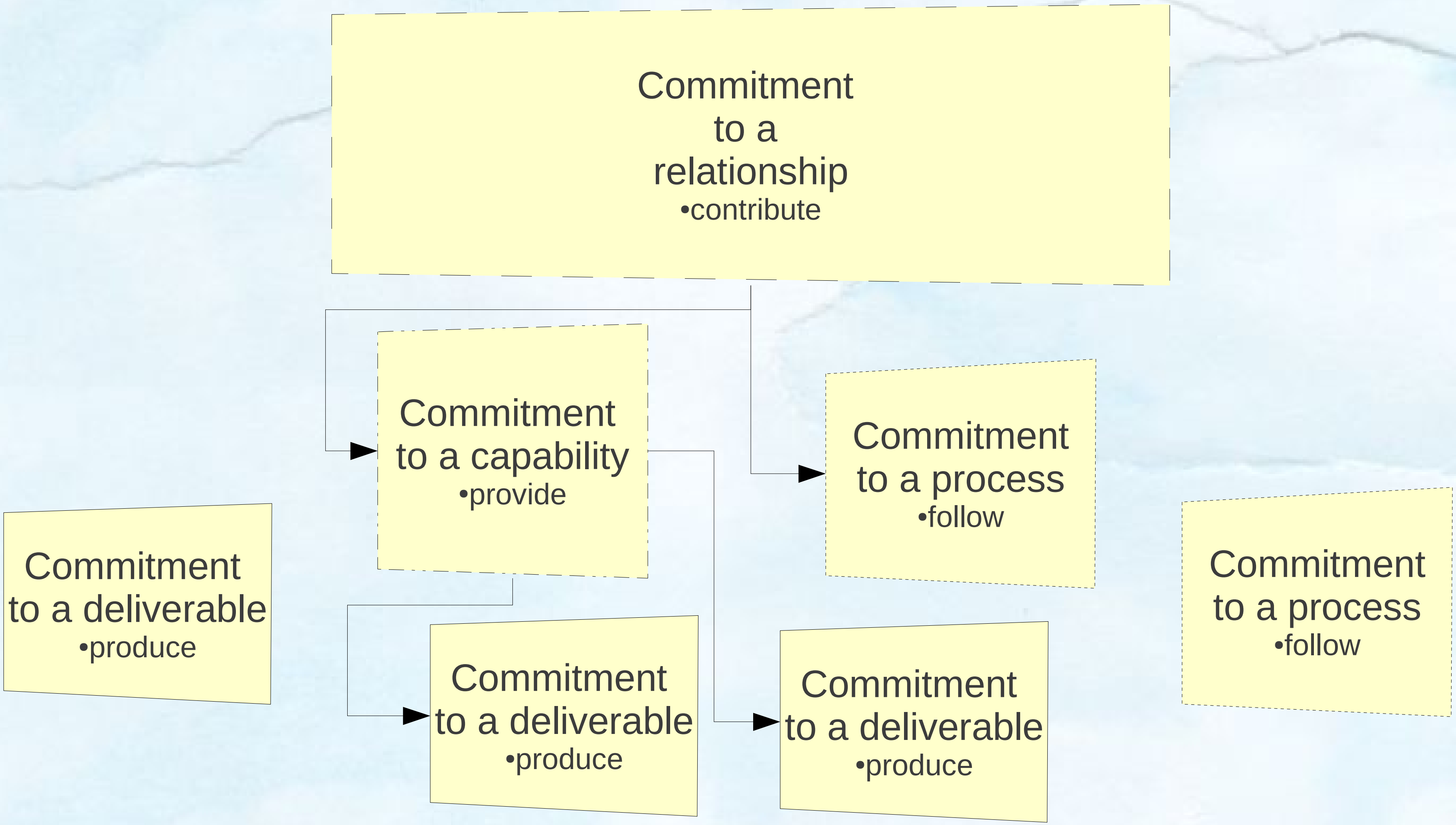
•conversation for possibilities, and

•conversation for orientation. [Winograd 1986]

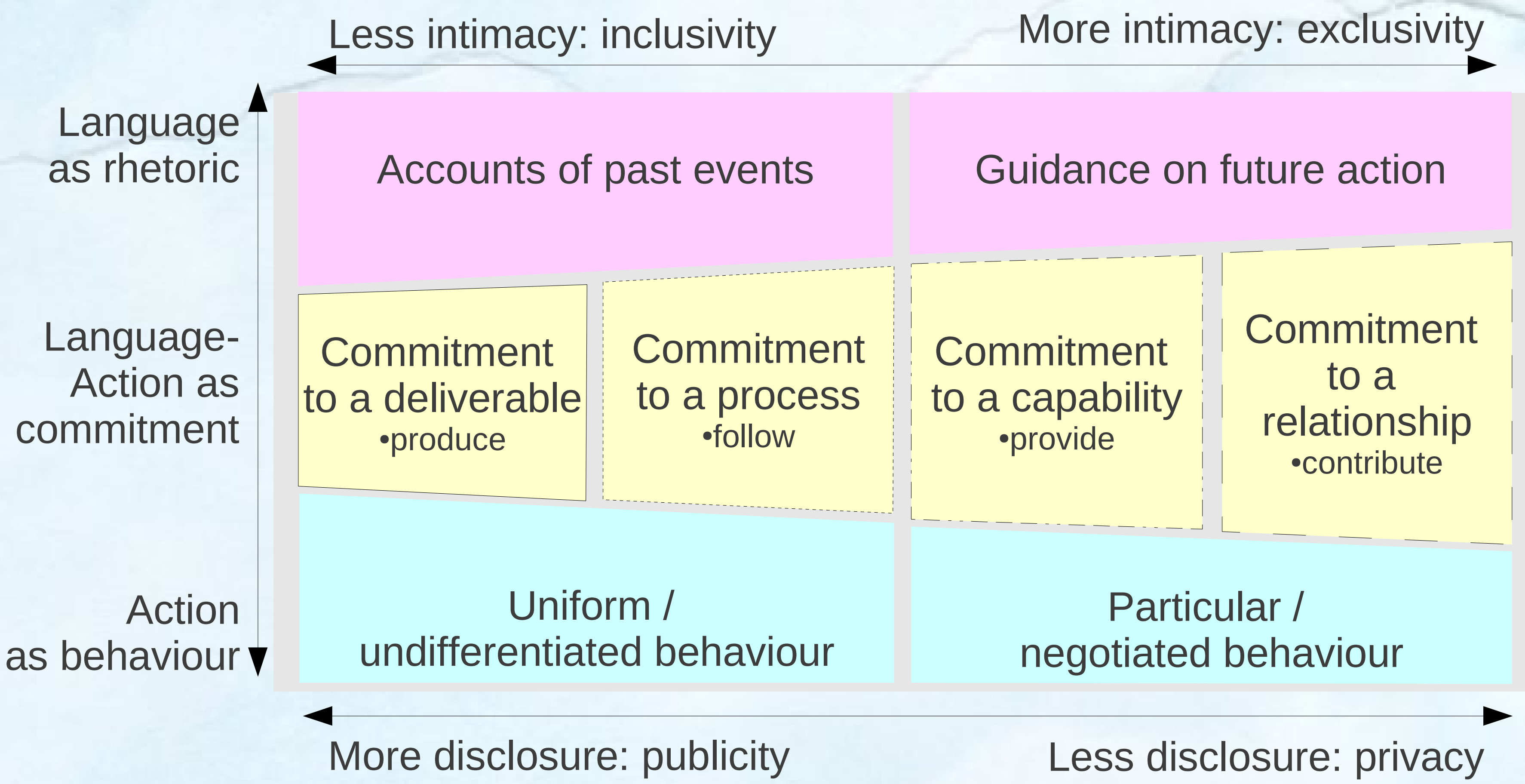
Obligations can be formalized as commitments to deliverables, process and/or relationships (at least)

- Commitment to a deliverable
  - produce
- Commitment to a process
  - follow
- Commitment to a capability
  - provide
- Commitment to a relationship
  - contribute

Commitments can be explicitly linked upstream or downstream, and can be impacted by the unanticipated



Commitments occur in contexts of language decoupled from action, and action decoupled from language



What's new in the systems sciences?

4. Supply side sustainability:
elaboration of structure as an increase in complicatedness;
elaboration of organization as an increase in complexity

Collapse, resilience, sustainability, regeneration

Collapse

A society has collapsed when it displays a rapid, significant loss of an established level of sociopolitical complexity. [....]

Losses that are less severe, or take longer to occur, are to be considered cases of weakness and decline.

[Tainter 1990]

Resilience

[Engineering resilience means] stability near an equilibrium steady state, ... resistance to disturbance and speed of return to the equilibrium are used to measure the property. [...]

[Ecological resilience means] conditions far from any equilibrium steady state, ... instabilities can flip a system into another regime of behavior ... to another stability domain

[Holling 1996]

Sustainability

"Of what, for whom, for how long, and at what cost?" ... sustainability as maintaining, or fostering the development of systemic contexts that produce the goods, services and amenities that people need or value, at an acceptable cost, for as long as they are needed or valued.

[Allen, Tainter and Hoekstra 2003]

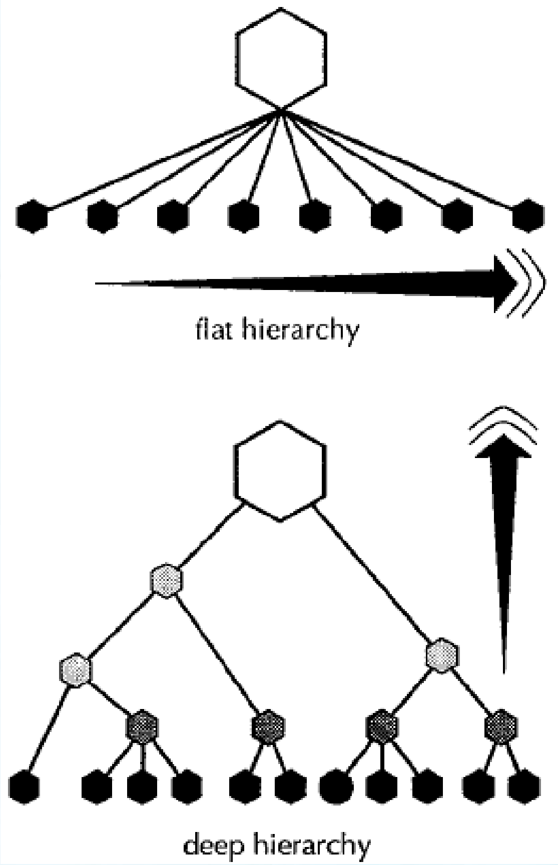
Regeneration

... regenerative systems tend to follow a strategy of dispersal, or spreading out over the landscape, combined with some degree of augmentation. [....]

Whatever the means used, sustainability requires that the basic processes not be exploited beyond their capacity for renewal.

[Lyle 1996]

Complexify for high efficiency with low variety, or decomplexify for high variety as sustainable



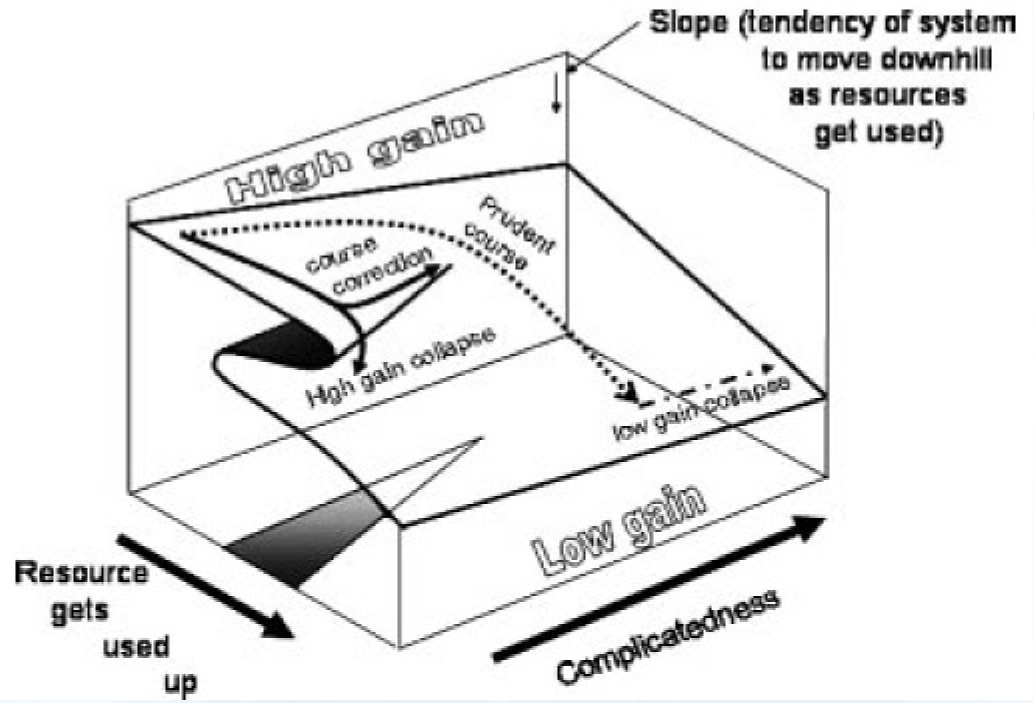


Figure 7. A representation of the tracks that lead from high to low to super low gain patterns. [Allen, Allen, Malek 2006]

Figure 3. The top hierarchy shows increases in complicatedness by increasing the structural elaboration. Structural elaboration is portrayed as widening the span in horizontal differentiation. The bottom hierarchy shows increasing complexity, by an elaboration of organization. New levels appear as new constraints emerge as limits to the positive feedbacks of the emergent process. Elaboration of organization increases hierarchical depth. [Allen, Tainter, Hoekstra 1999]

What's new in the systems sciences?

5. Systems sciences and systems engineering:
Episteme, techne and phronesis

Defining systems science(s) → science?

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
Pursuits:	Uncovering universal truths	Instrumental rationality towards a conscious goal	Values in practice based on judgement and experience
Colloquial description:	**Know why**	**Know how**	**Know when, know where, know whom**

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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
Pursuits:	Uncovering universal truths	Instrumental rationality towards a conscious goal	Values in practice based on judgement and experience
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Domains of systems thinking

Categories of systems thinking:	**Systems theory**	**Systems methods**	**Systems practice**
Primary intellectual virtue:	Episteme	Techne	Phronesis
Colloquial description:	Know why	Know how	Know when, know where, know whom
Systems thinking domains:	•Living systems theory •Hierarchy theory •Open Systems Theory •Viable System Model •Inquiring Systems •Critical Systems Theory •Panachy and ecological resilience	•System dynamics •Soft Systems Methodology •Interactive Planning •Action Research •Structured Dialogic Design •Strategic Assumption Surfacing and Testing •Search Conference •Deep Dialog	•Language Action Perspective •Appreciative Systems •Evolutionary Development •Systems Intelligence

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