AS-74.4192 Elementary Cybernetics

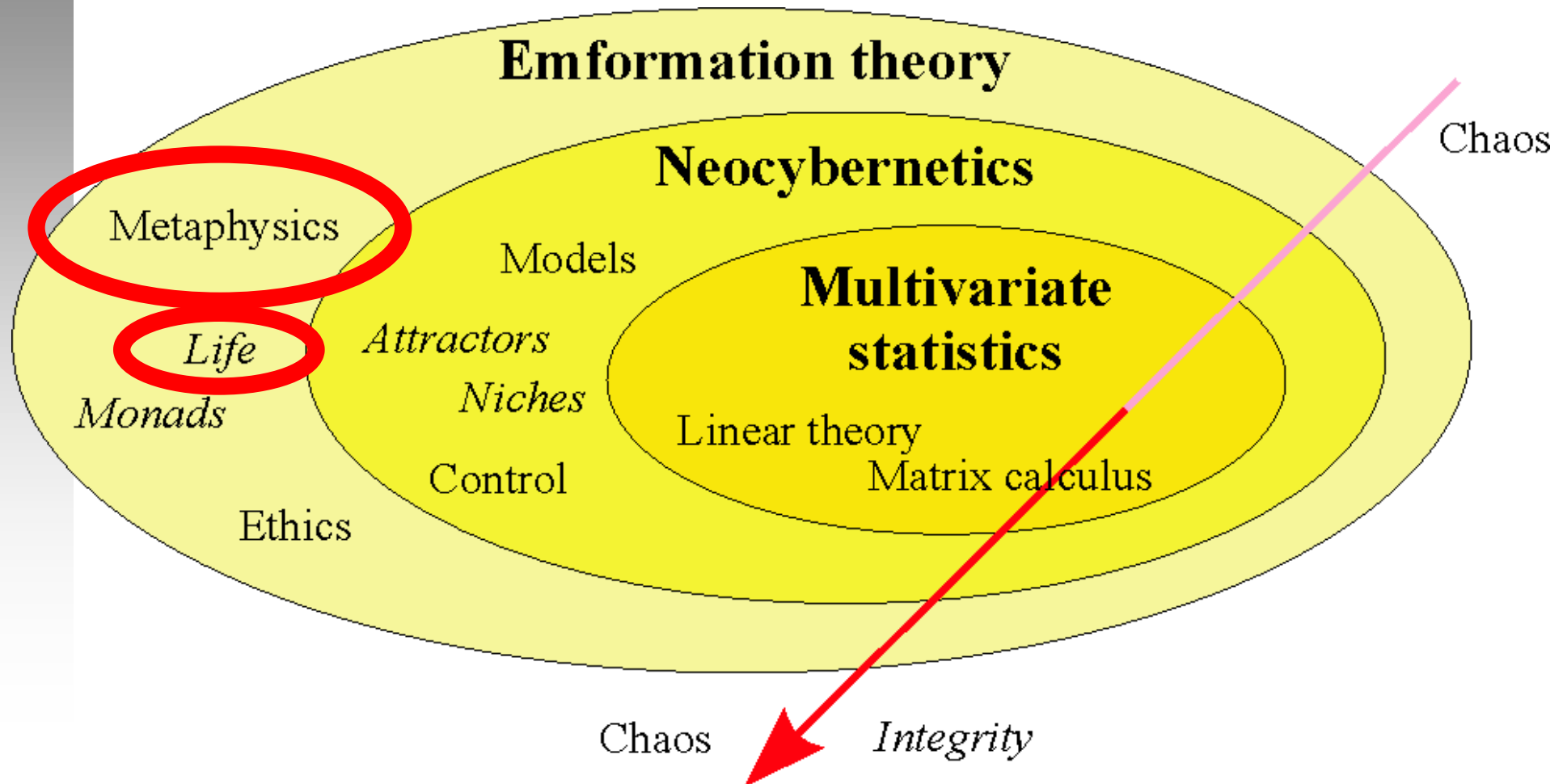# Bonus Lecture

Some Glimpses
and the Big Picture

The Big Picture

Starting points 😊

- (**Intuition:**) Understanding complex systems is understanding *life*
- Today, science cannot say what life is – there are only formal characterizations of carbon-based life forms, given "from above"
- (**Intuition:**) To attack the essence of life, key concept is *life force*
- Today, the idea of life force is (more or less) taboo, as it seems to address scientifically questionable (finalistic) approaches
- (**Intuition:**) The life phenomena are fragile – tools must be *life-like*
- Today, the science searches ruthlessly for absolute truths, while the approach should now be gentle and somehow *holistic*

Intuition is a form of *mental life force*, or *flow of consciousness*, and in the desired methodology it must be the guiding principle!

We are not alone

- *Henri Bergson* (1859–1941): There is *instinct / insight* and *intellect* in the mental world, just as there are these *life force* and *liveless matter*

- Once, Bergson was a *best-seller* and a *Nobelist*

- *Albert Einstein* must also have been a *vitalist*:

  - Imagination is more important than knowledge.
  - The search for truth is more precious than its possession.
  - The most beautiful thing we can experience is the mysterious. It is the source of all true art and science.
  - There are two ways to live your life. One is as though nothing is a miracle. The other is as though everything is a miracle.
  - These thoughts did not come in any verbal formulation. I rarely think in words at all. A thought comes, and I may try to express it in words afterward.

More about alien life forms

- Can we even recognize life when we see it?
- Compare to the *search for extra-terrestrial intelligence / life* (SETI): One can only try and find interesting *correlation structures* in signals
- But they are not very intelligent if they do not code their signals, or eliminate redundancy!
- Nature must not optimize its behavior (here) …
- One just has to believe in *Antero Vipunen* – or, quoting *Einstein* again:

    - God is subtle, but he is not malicious.
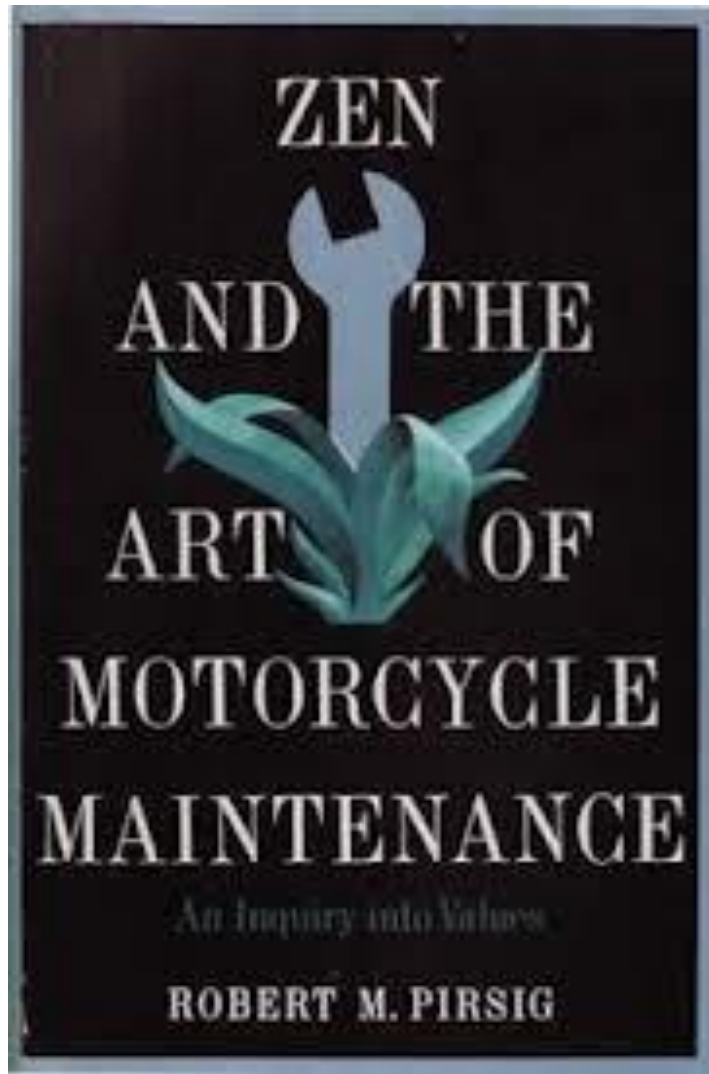   - Nature hides her secret because of her essential loftiness, but not by means of ruse.

Collecting evidence

- Eastern tradition is full of examples of vitalistic thinking
  - In Taoism, the life force *qi* is a central concept; the continuous change, harmony, *yin* and *yang* are also "resonating" concepts
  - In Zen-Buddhism, intuition instead of intellect is emphasized, etc.

- In the West, the success of *cartesianism* has promoted mechanistic approaches

- Famous vitalists are, for example, Leibniz, Schopenhauer, Bergson, and also Wittgenstein in his later writings – and also Freud!

- Later, *analytical philosophy* concentrated on word-level world, assuming that "world is as it is"

- Modern science ignores vitalism altogether – perhaps it is as it was with Plato: *Change* has proven slippery, it is better forget it!
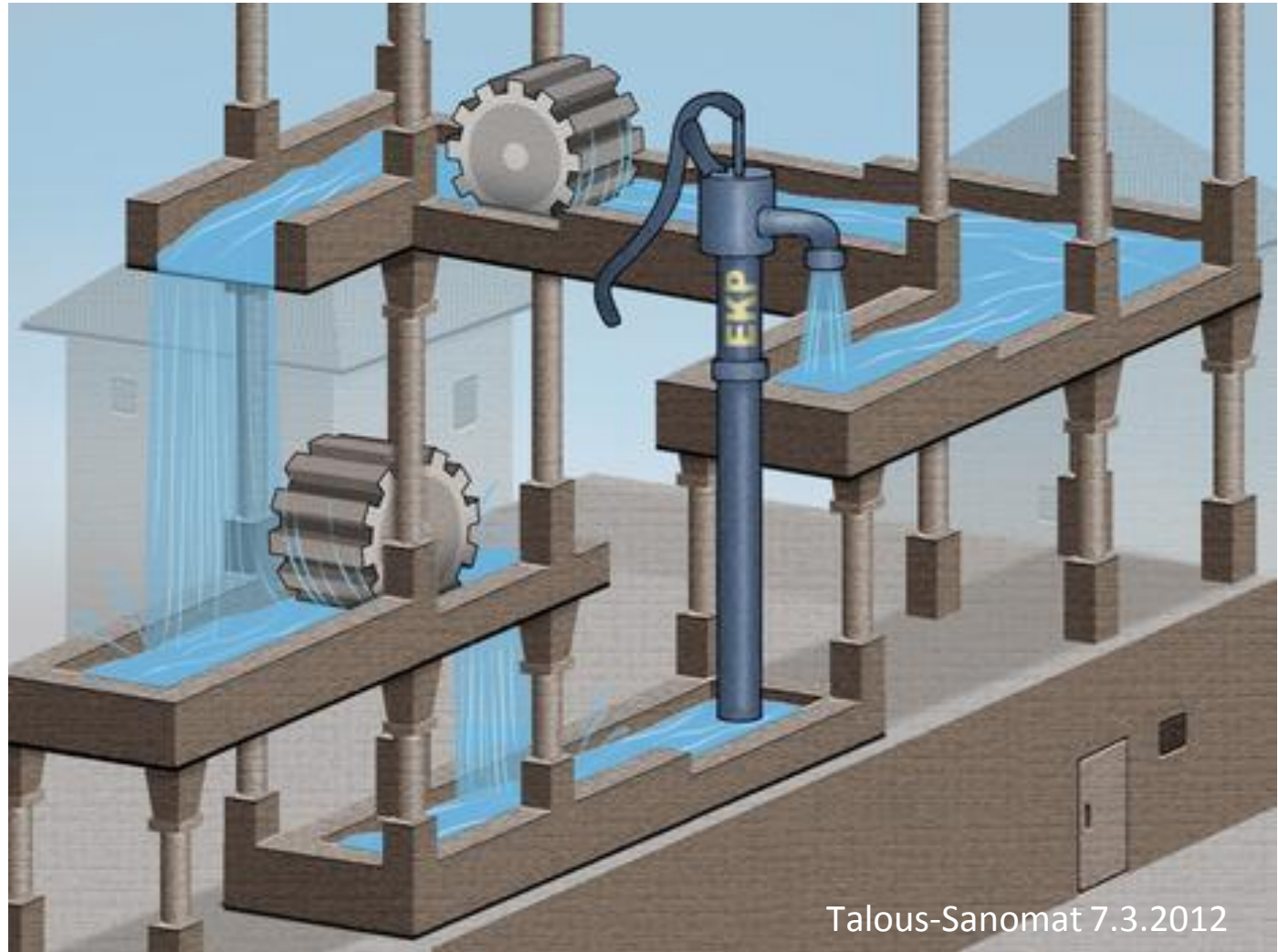
Engineering ethos

ZEN AND THE ART OF MOTORCYCLE MAINTENANCE
An Inquiry into Values
ROBERT M. PIRSIG

- Find the way to redirect the force from the fuel to the main shaft
- Polish all constraints to maximally reach freedom of movement
- Detect and tune fractal controls, evolving the system forever
- Good workmanship starts from bottom, with no shortcuts
- *Quality is value in itself*

- Pirsig's *quality* = emphasis on the technical vital force?

There is lousy technocracy, on the other hand…

- Dynamics is forced from above here

Talous-Sanomat 7.3.2012

"Alle Menschen werden Brüder" ... But *HOW?*

Freude, schöner Götterfunken
tochter aus Elysium
wir betreten feuertrunken
himmlische dein Heiligtum!
...
Freude heisst die starke Feder
in der ewigen Natur
Freude, Freude treibt die Räder
In der grossen Weltenuhr.
Blumen lockt sie aus den Keimen
Sonnen aus dem Firmament
Sphären rollt sie in den Räumen
die des Sehers Rohr nicht kennt.
...
Freude trinken alle Wesen
an der Brüsten der Natur
alle Guten, alle Bösen
folgen ihrer Rosenspur.
Küsse gab sie uns und Reben
einen Freund, geprüft im Tod
Wollust ward dem Wurm gegeben
und der Cherub steht vor Gott.

Ilo, jumaluuden kipinä
sinä pyhien tytär
Humaltuneina astumme
taivaalliseen valtakuntaasi!
...
Ilo on se vahva voima
luonnon ikuisessa kierrossa
joka pyörittää rattaita
suuressa kellokoneistossa
Houkuttelee kukat iduistaan
auringot kaaoksesta
Pyörittää avaruuksia
joita ei edes osaa etsiä.
...
Iloa juovat kaikki
luontoäidin rinnoilta
Niin hyvät kuin pahatkin
seuraavat hänen polkuaan
Suukkoja ja halauksia
antaa mukaan seikkailuun
- Madollekin viettinsä
vaan ihmiselle enemmän.

Birth of taboos

- There was a long history of German philosophy in the vitalistic spirit of national romanticism (starting from that Schiller, etc.):

    - *Hegel* saw that national state is the climax of the *Weltgeist*
    - *Nietzsche* saw how the spirit must be implemented by the *Übermensch*
    - *Spengler* saw how this all can only culminate in ever repeating *Untergang*
    - *Hitler* was just a consistent corollary of all this to complete the cycle?!

- As a consequence, post-war (EC/EU) politics has been characterized by "systemic abnegation": *No more wars in Europe*!

- The anti-nationalism is reflected as exaggerated internationalism and multiculturalism – *tolerance* is the a totalitaristic dogma!

- Stiff optimum society is being explicitly constructed to avoid uncontrolled "life" – like *hate speech*

But what if the Germans were *right*?

Frank(furt)enstein monster

- However, natural dynamics does not follow the declarations, and the system is vulnerable to disturbances
- And when instinct is missing, one cannot recognize the "becoming", however clever "experts" are employed for control
- It turned out that the celebrated "European Freedom" was just freedom for money – as the balancing idealism had collapsed
- A *new form* of life force emerged – with its crooked values and strange dynamics, being bound to a fixed growth (interest rate)
- A freedom to some is a constraint to others – *debt is the new constitution* for former independent nations

… It seems that the essence of life force cannot be understood from above, looking at examples; *a general approach is needed*
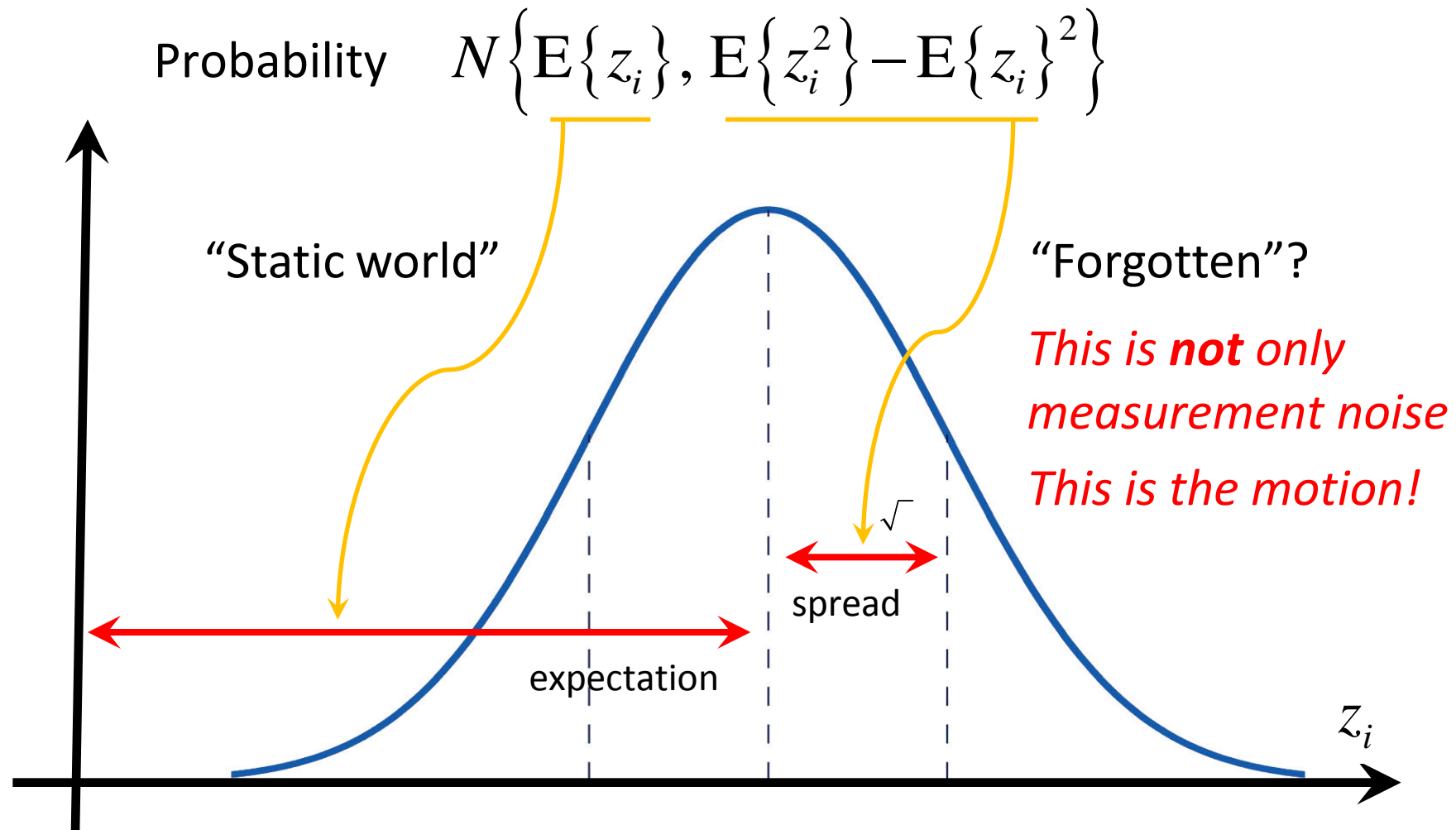
Life force – *what is it*

- Start from the beginning!

In the beginning ... there is *motion*

- *Process philosophy* emphasizes the dynamic essence of the world – *becoming* is more important than *being*

- Assumption now: Everything that is relevant is *dynamics*, in its simplest form only some kind of *vibration*

- Later ... it turns out that correlating vibrations constitute *flows* and *dynamic attractors* therein

- So, *process* and *dynamics* are more relevant than *structures* or *mechanisms*

- To simplify things to the extreme, assume that there is *no structure whatsoever* to begin with

- Start from the "birth", from complete chaos, and study what kind of *information* (data distributions) there is available

"VITALISM" without FINALISM

No structure – *normal* (*Gaussian*) *distribution*

Probability $N\left\{ \mathrm{E}\{z_i\},\ \mathrm{E}\{z_i^2\} - \mathrm{E}\{z_i\}^2 \right\}$

"Static world"

"Forgotten"?

*This is **not** only measurement noise*

This is the motion!

$\sqrt{}$

spread

expectation

z_i

Becomes interesting in higher dimensions, in the case of *multivariate distributions*

Characterizing distributions – *interpretations*

- *"Matter"* – observed reality; averaging, *coarsening*

$$\mathrm{E}\{z_i\}$$

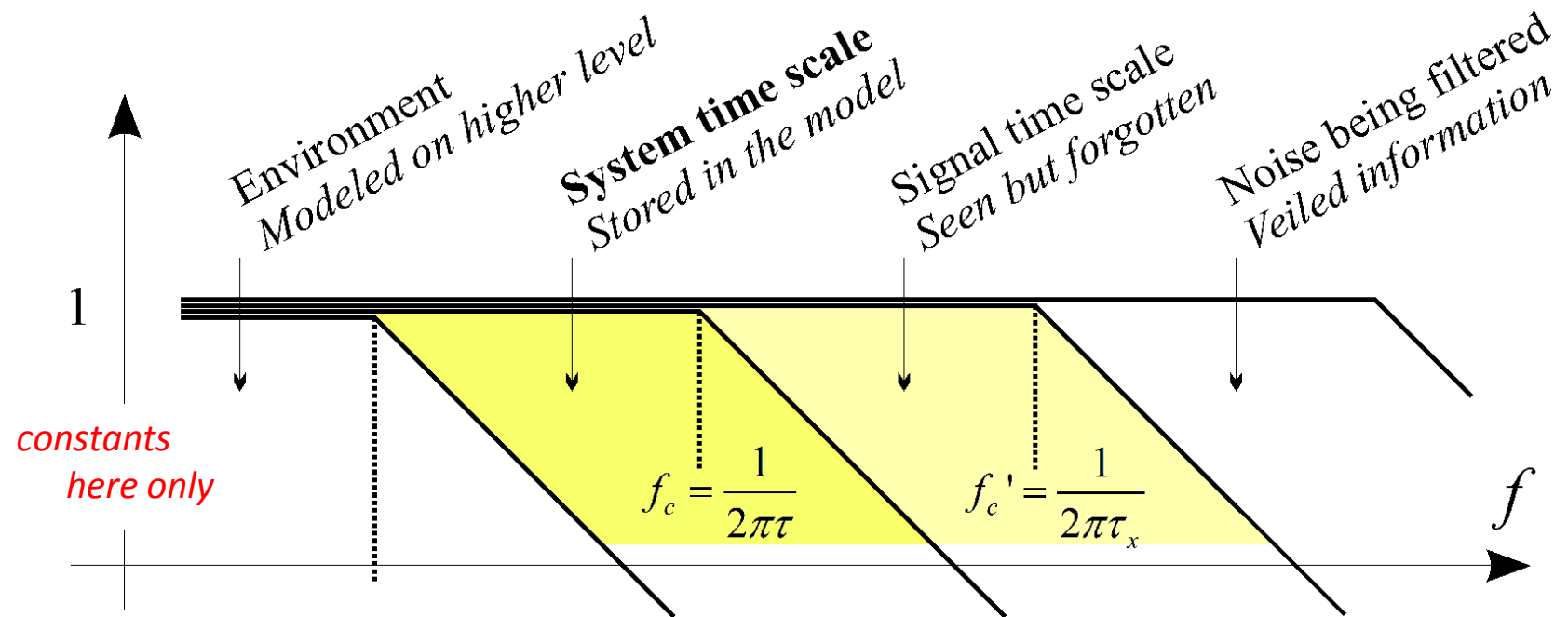- Enformation – variation, nature of change, *dynamics*

$$\mathrm{E}\{z_i^2\} - \mathrm{E}\{z_i\}^2 \qquad \text{variance} \qquad correlations - covariances$$

- "If everything is *springs* and the state of a spring (deviation from balance / amplitude) is z_i , then its *energy* is proportional to z_i^2 "
- "Energetic information" – capacity to change the world = basis for *natural semantics*
- It turns out that this enformation can be interpreted as vital force

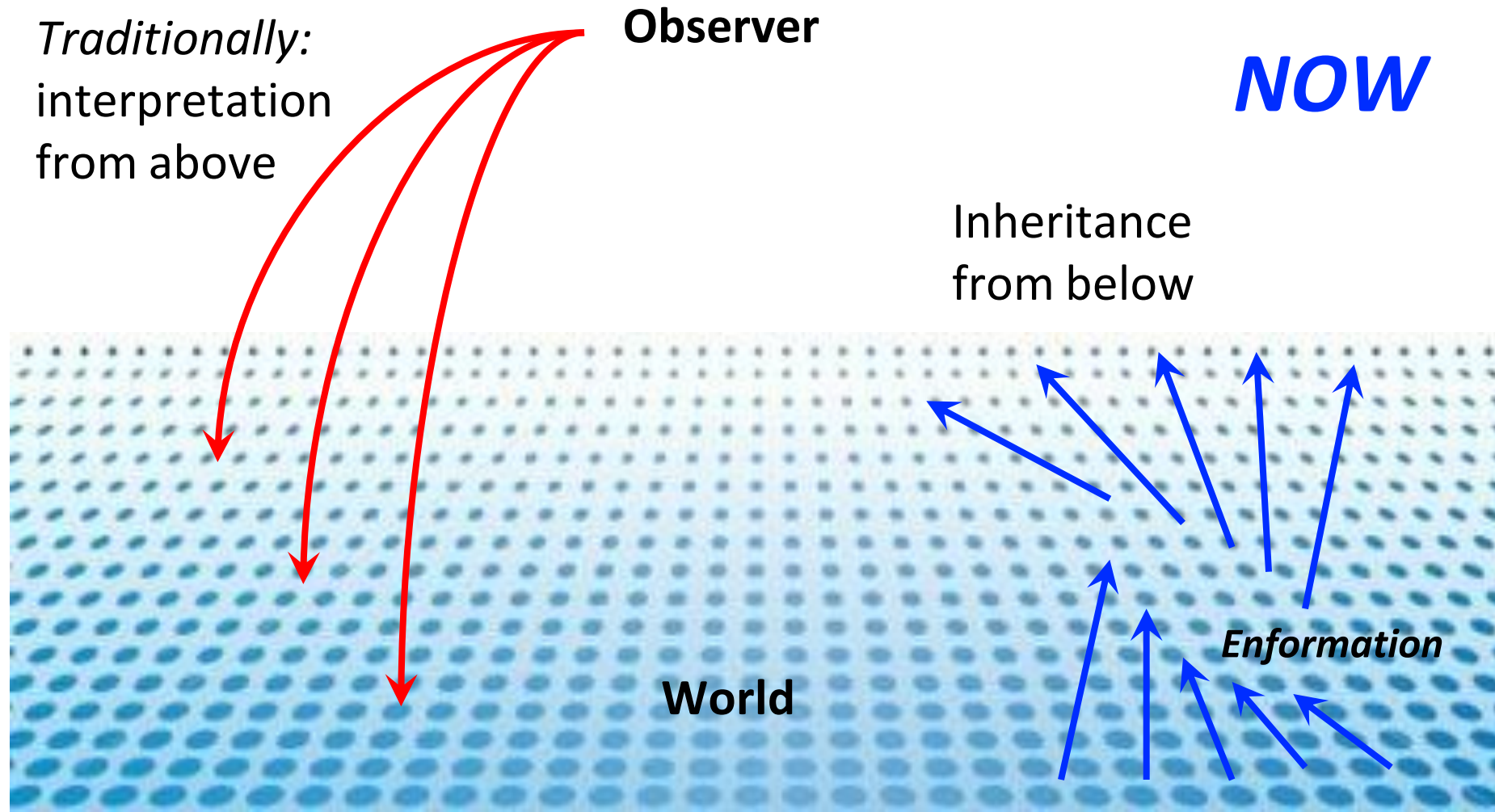"HOW" $\longrightarrow$ **"WHY"**

Practical enformation

- If the observer has "finite horizon", instead of $E\{\;\}$ one uses

$$\frac{d\mathcal{E}\{z_\iota^2\}}{dt/\tau}(t) = z_\iota^2(t) - \mathcal{E}\{z_\iota^2\}$$

*Lesson: observing real world nonidealities gives rise to emerging structures (here **hierarchies**)*

Semantics – "origin of meaning"

Observer

NOW

Traditionally: interpretation from above

Inheritance from below

World

Enformation

More general views

- Natural semantics = Cybernetic "Gregory Bateson semantics": everything is based on "differences making difference"
- Bishop Berkeley said that *to exist is to become observed*
- Extending this, one can say that to exist is to *apply* enformation in one's environment ("make one's mark")
- On the other hand, the goal is to *acquire* enformation to be able to exploit it
- Altogether, the goal is *interaction* with the environment
- "Measurement" is the basic functionality in nature: everything measures each other, *man is not needed*
- Optimization: "winner" is the one capturing most enformation; looks goal-directed but this is just an illusion as seen from above

Model of interaction

- Assumption: "Reactions" are a result of "collisions", being proportional to "activities" being related to "concentrations"

$$\frac{d\,\zeta_i}{dt} = \dot{\zeta}_i = \alpha_i\, z_1^{a_{i1}} \cdots z_m^{a_{im}}$$

- Taking logarithms

$$\log \dot{\zeta}_i = \log \alpha_i + a_{i1} \log z_1 + \cdots + a_{im} \log z_m$$

and differentiating around the nominal point one gets

$$\frac{\Delta \dot{\zeta}_i}{\langle \dot{\zeta}_i \rangle} = a_{i1}\frac{\Delta z_1}{\langle z_1 \rangle} + \cdots + a_{im}\frac{\Delta z_m}{\langle z_m \rangle}$$

Enformation theoretic *system*

- The model becomes linear:

$$\bar{x}_i = a_{i1}\bar{u}_1 + \cdots + a_{im}\bar{u}_m$$

- This can also be interpreted as a model for (truly linear) "generalized diffusion"

- Now there are *inputs* (*resources*, or some kind of *pressures*) and *states* (*activities*, or some kind of *rates of change* or *flows*)

$$\bar{u}_j = \Delta z_j / \langle z_j \rangle$$
$$\bar{x}_i = \Delta \dot{\zeta}_i / \langle \dot{\zeta}_i \rangle$$

Local balance values = "observables"

- A *system* is a set of states sharing the same view of the world

Coordinated micro-level vibration is flow and change on macro-level

Survival strategy of systems

- The acquired internal enformation reveals the evolutionary "fitness" of a systemic mode:

$$\mathcal{E}\{\bar{x}_i^2\} = a_{i1}\mathcal{E}\{\bar{x}_i\bar{u}_1\} + \cdots + a_{im}\mathcal{E}\{\bar{x}_i\bar{u}_m\}$$

- The maximum strategy can be found applying Lagrangian technique for the constrained problem ($|a_i| = const$), giving
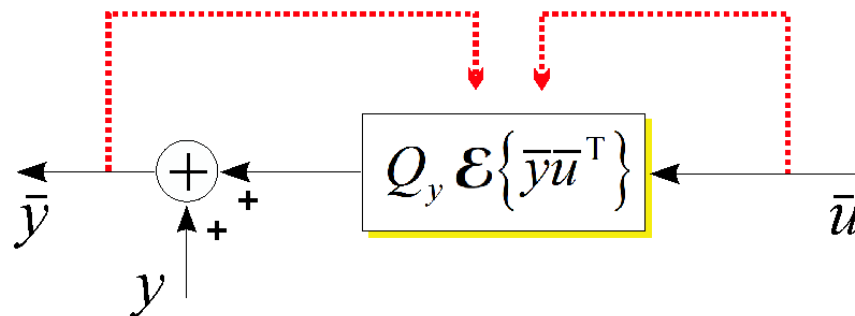
$$a_{ij} = q_i\,\mathcal{E}\{\bar{x}_i\bar{u}_j\}$$

- Also – for all i and j in a system the "surviving" interactions can be formally written as

$$\bar{x} = Q\,\mathcal{E}\{\bar{x}\bar{u}^{\mathrm{T}}\}\,\bar{u}$$
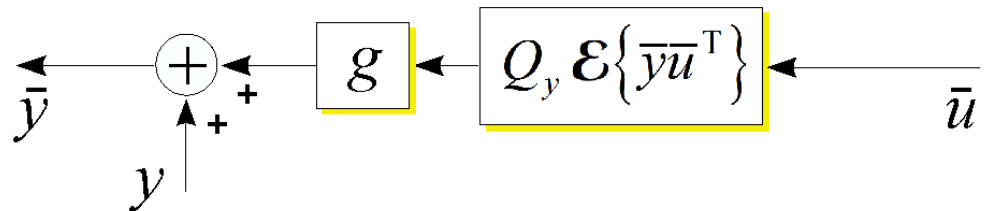
Towards general-purpose *modules*

- The above scheme can be extended: An additional signal can be added, and it still converges towards maximum enfo transfer

- Such a module contains internal positive feedback, and it can be used only as a part of a network system with stabilizing feedbacks!

Maximization

$$\bar{y} \quad \oplus \leftarrow \quad Q_y \, \mathcal{E}\{\overline{yu}^{\mathrm{T}}\} \leftarrow \quad \bar{u}$$

y

Nonlinear maximization

$$\bar{y} \quad \oplus \leftarrow \quad g \leftarrow \quad Q_y \, \mathcal{E}\{\overline{yu}^{\mathrm{T}}\} \leftarrow \quad \bar{u}$$

y

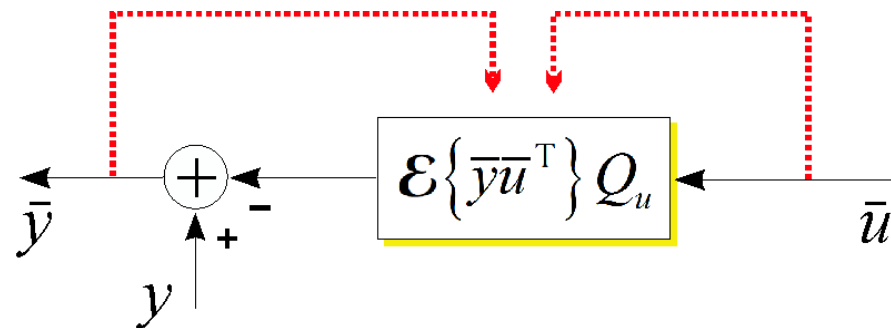- Another function module can be found through *subtraction*:

$$\bar{y} = y - \mathcal{E}\{\bar{y}\bar{u}^{\mathrm{T}}\} Q \, \bar{u}$$

so that after some manipulations

$$\mathcal{E}\{\bar{y}\bar{u}^{\mathrm{T}}\} Q = \mathcal{E}\{y\bar{u}^{\mathrm{T}}\} \left(Q^{-1} + \mathcal{E}\{\bar{u}\bar{u}^{\mathrm{T}}\}\right)^{-1}$$
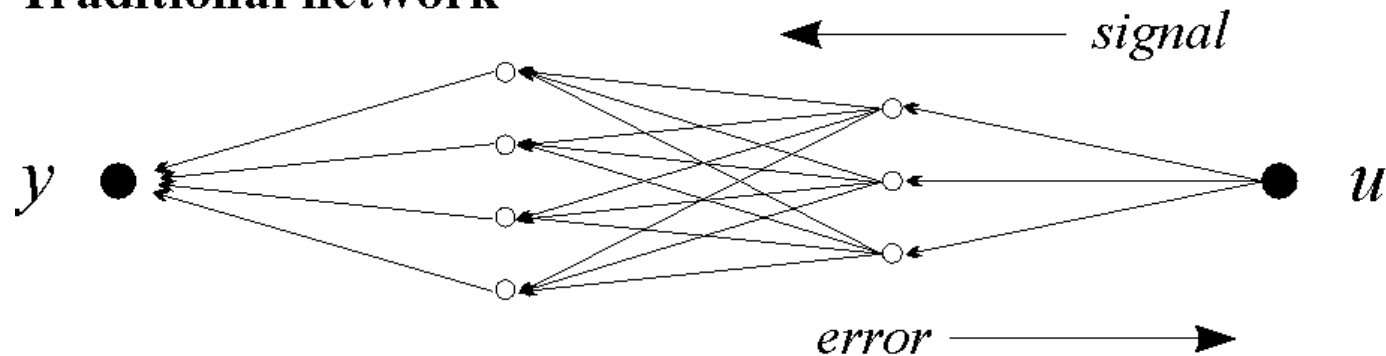
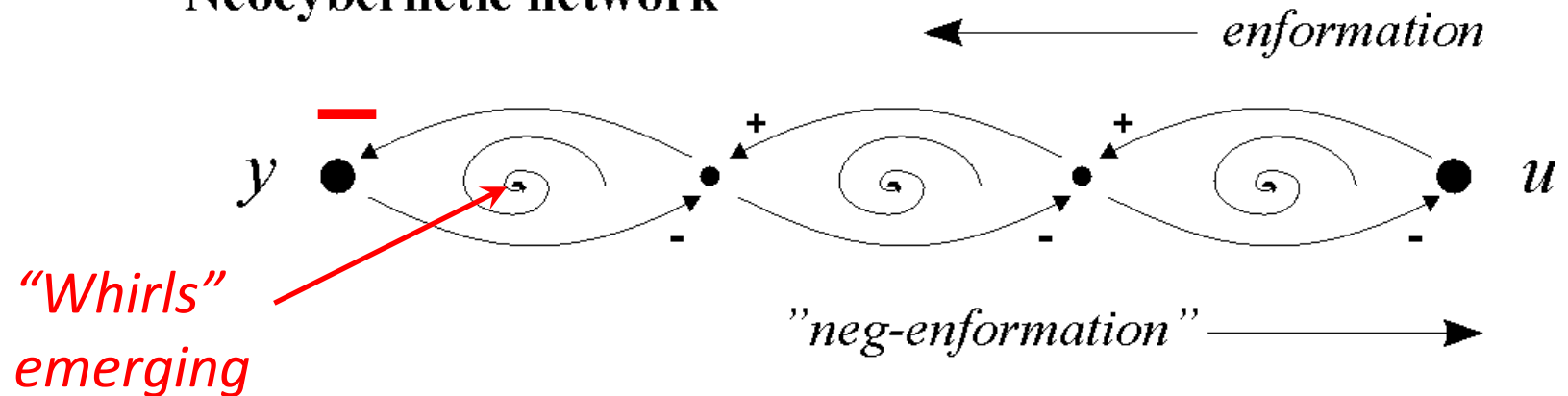meaning that the module implements *ridge regression*.

Minimization

From "laminar" to "turbulent" flow

Traditional network

signal

y u

error

Neocybernetic network

enformation

y u

"neg-enformation"

"Whirls" emerging

From easy signal propagation and hard adaptation to complicated signal transfer and easy adaptation

- Sciences have made magnificent breakthroughs – but that is not only a good thing
- If there is no counterforce, systems seem to end in *narcissism* – and it can be claimed that this is happening to sciences, too

  "If sciences cannot attack something, it cannot be interesting"

  "And science is self-correcting – there is never need to shame"

- The tragedy there is that the success of sciences has dazzled all cultivated people – there is just one route to follow
- Contemporary philosophy has reduced to "filling the holes" between the specialized sciences
- No "big stories" are searched for, *coherence* is forever lost?

… But paradigm shifts are discontinuous phenomena …

Panta rhei!

- The natural philosophers in Antiquity tried to find holistic understanding, integrity in the world view; is this forever lost?

- Let us look at the Greek thinking closer – they had the four basic elements (and, additionally, *quintessence* and *apeiron*, etc.):

  - Heraclitus: The driving force is *fire*
  - Thales: All things are based on *water*
  - Anaximenes: Everything is explained by compressed *air*
  - Leucippus, Democritus: atoms – it is all *earth*

- Oh we know so much better!   – But do we really?

  - Vital force can very well be characterized as *fire*
  - The flowing enformation with its whirls is like *water*
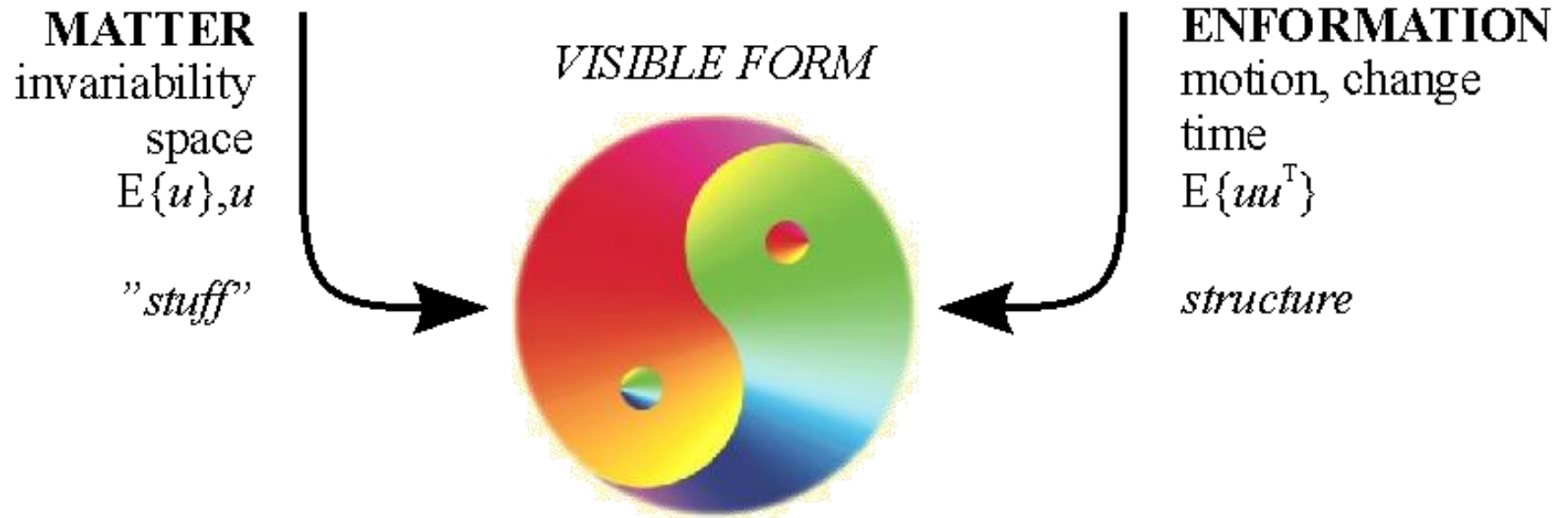 - The only element that completely misses *dynamics* is *earth*!

Atoms are NOT solid particles: rather, they are illusions, reflections of the underlying dynamics

Fire and Water: New metaphysics of what exists

- New kind of dualism: it is not *mind* and *matter*, but *enformation* and matter that together constitute everything (?) that exists

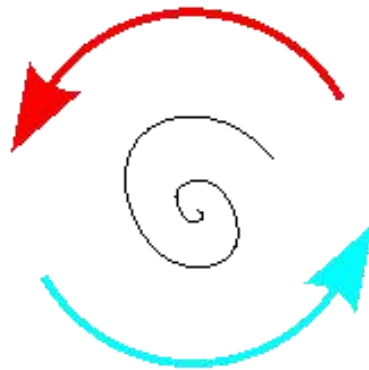- What general functionality is that experienced *form*? ⟶

MATTER	*VISIBLE FORM*	**ENFORMATION**
invariability		motion, change
space		time
$E\{u\},u$		$E\{uu^T\}$
"stuff"		*structure*

Model-based control in the core

- The system gets coupled to its environment; both change essentially, and they constitute an atomic whole

- What do these assumed universal cycles look like? ⟶

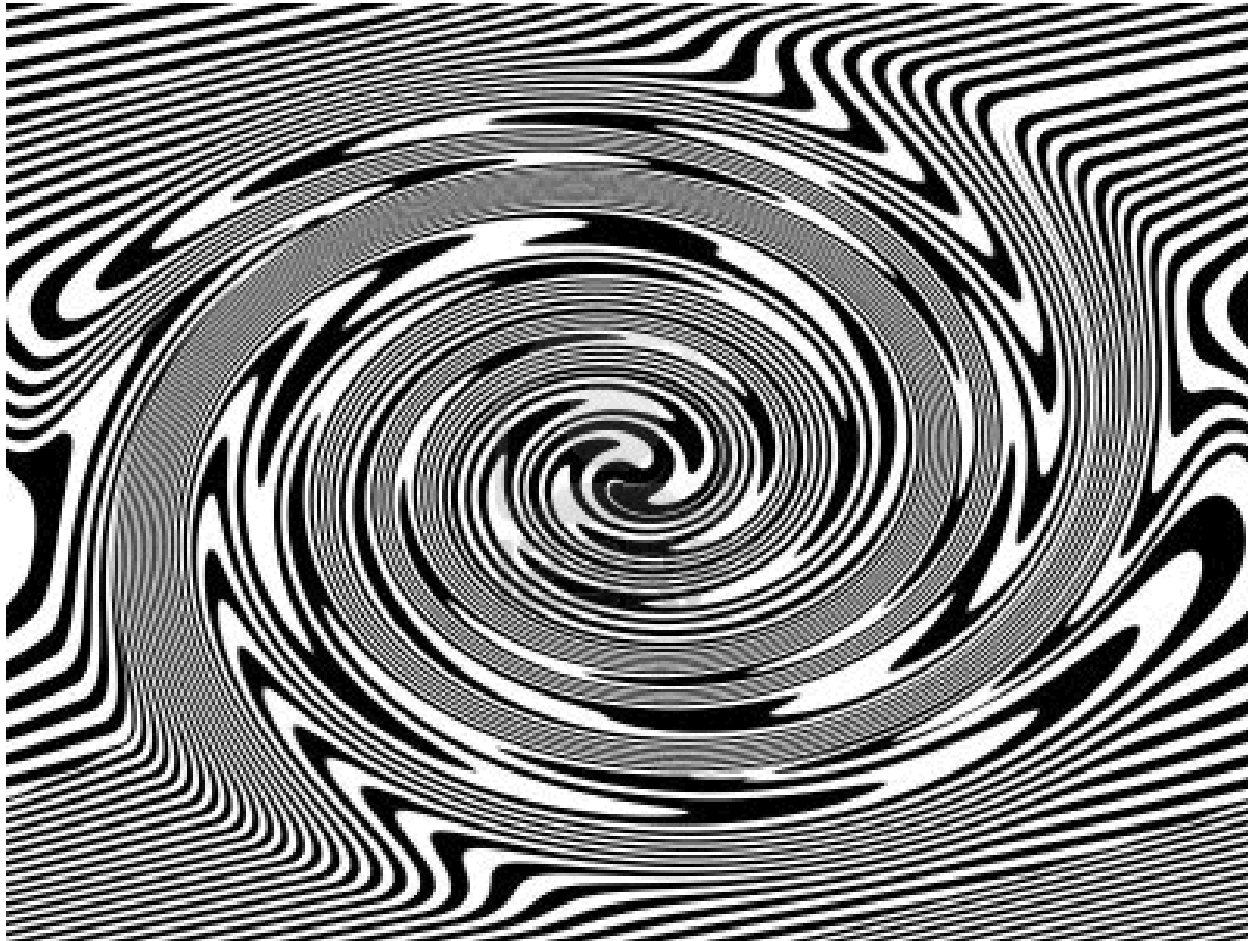**MODEL**
compressed
feature-based

CONTROL

PATTERN
complex
high-dimensional

Monad – atom of *life*
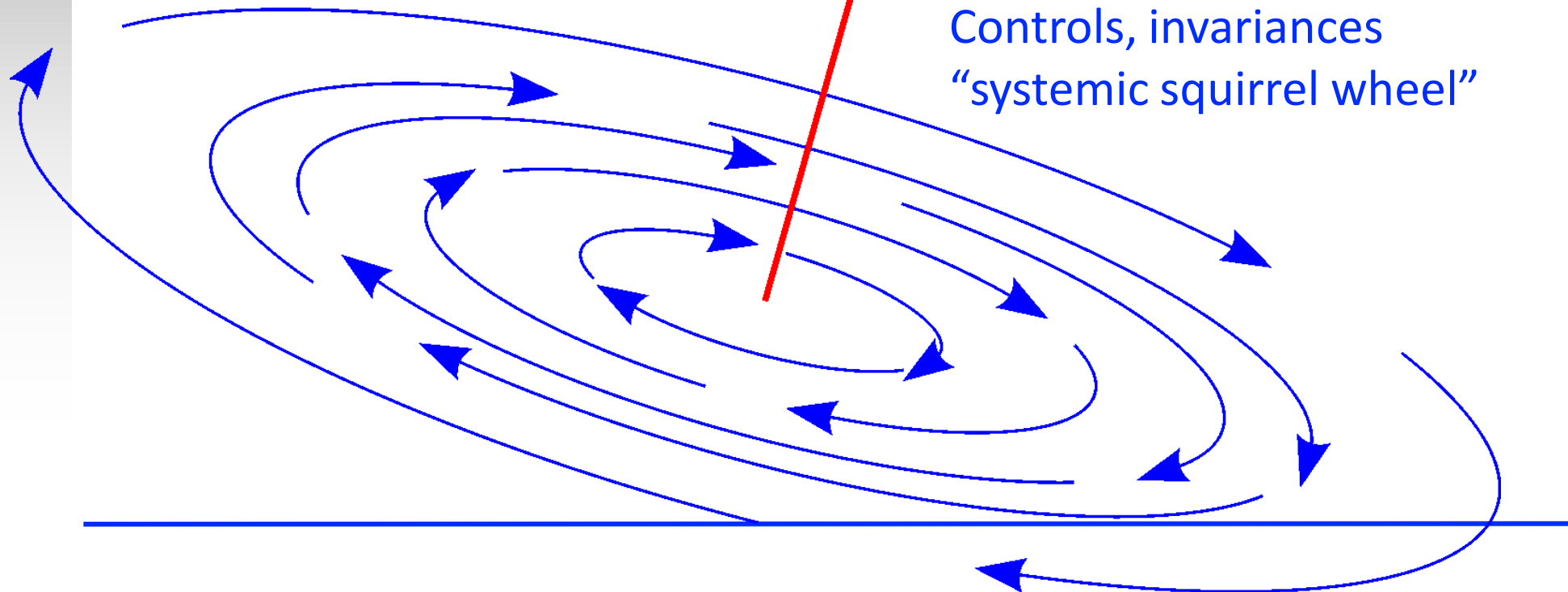

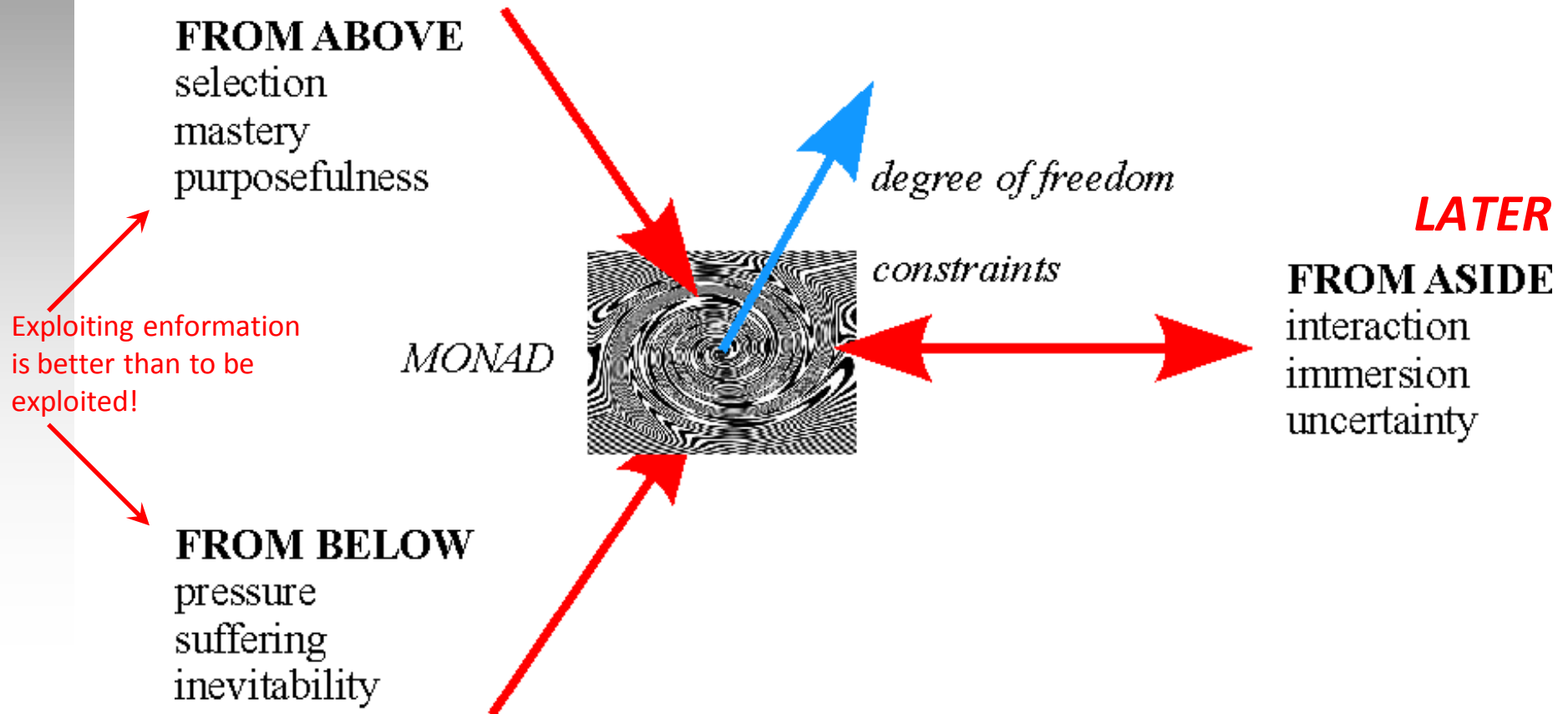Whirl in enformation flow = enformation pump

Direction of enformation

- When there are plenty of constraints, it is clever to model only the remaining DOF's (Ockham)
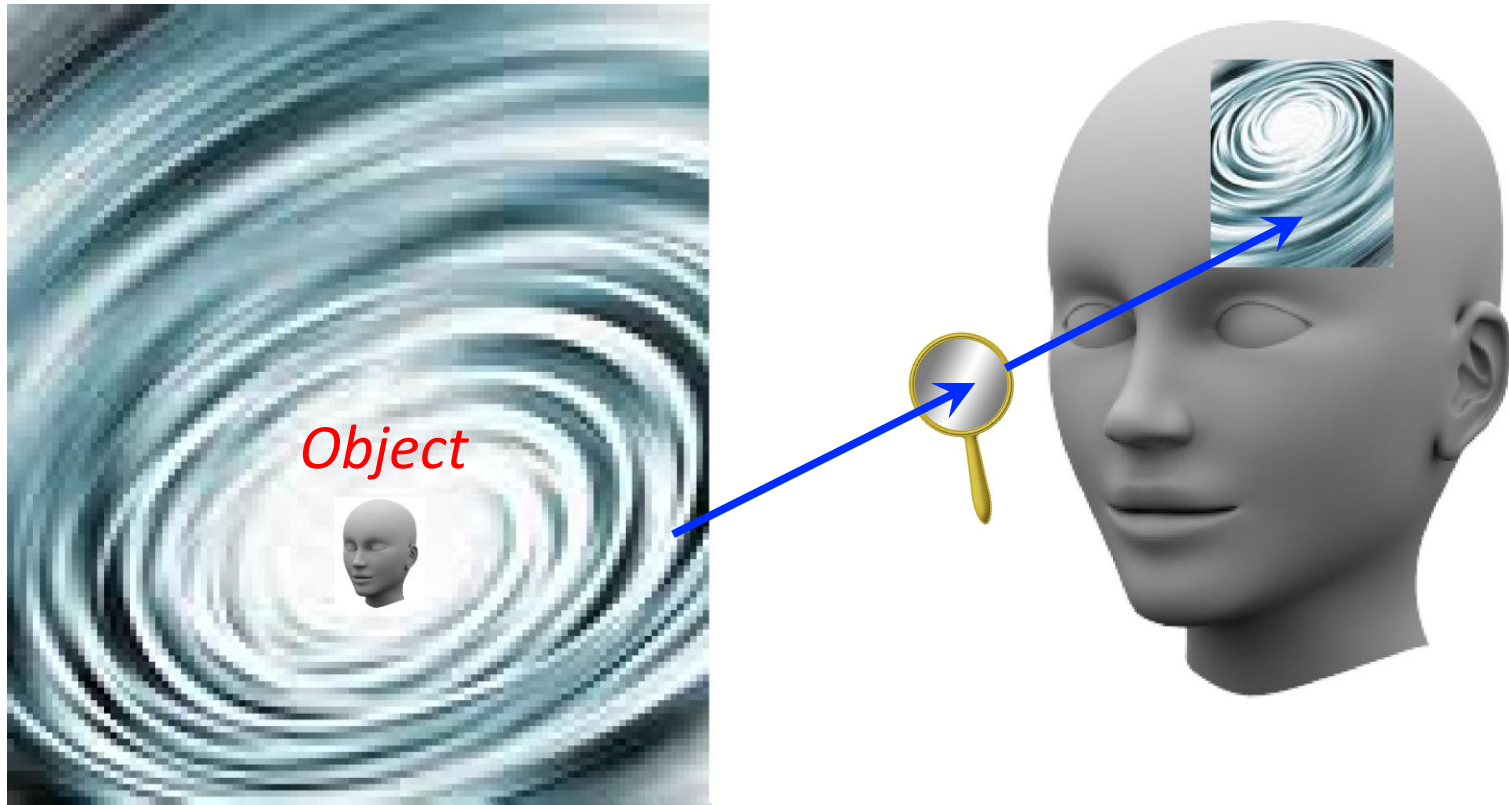
Degree of freedom, direction of covariance, "enformation channel"

Controls, invariances "systemic squirrel wheel"

Three views of whirls

- What do the words "above" and "below" mean here? ⟶

FROM ABOVE
selection
mastery
purposefulness

Exploiting enformation
is better than to be
exploited!

MONAD

degree of freedom

constraints

LATER

FROM ASIDE
interaction
immersion
uncertainty

FROM BELOW
pressure
suffering
inevitability

Changing viewpoint

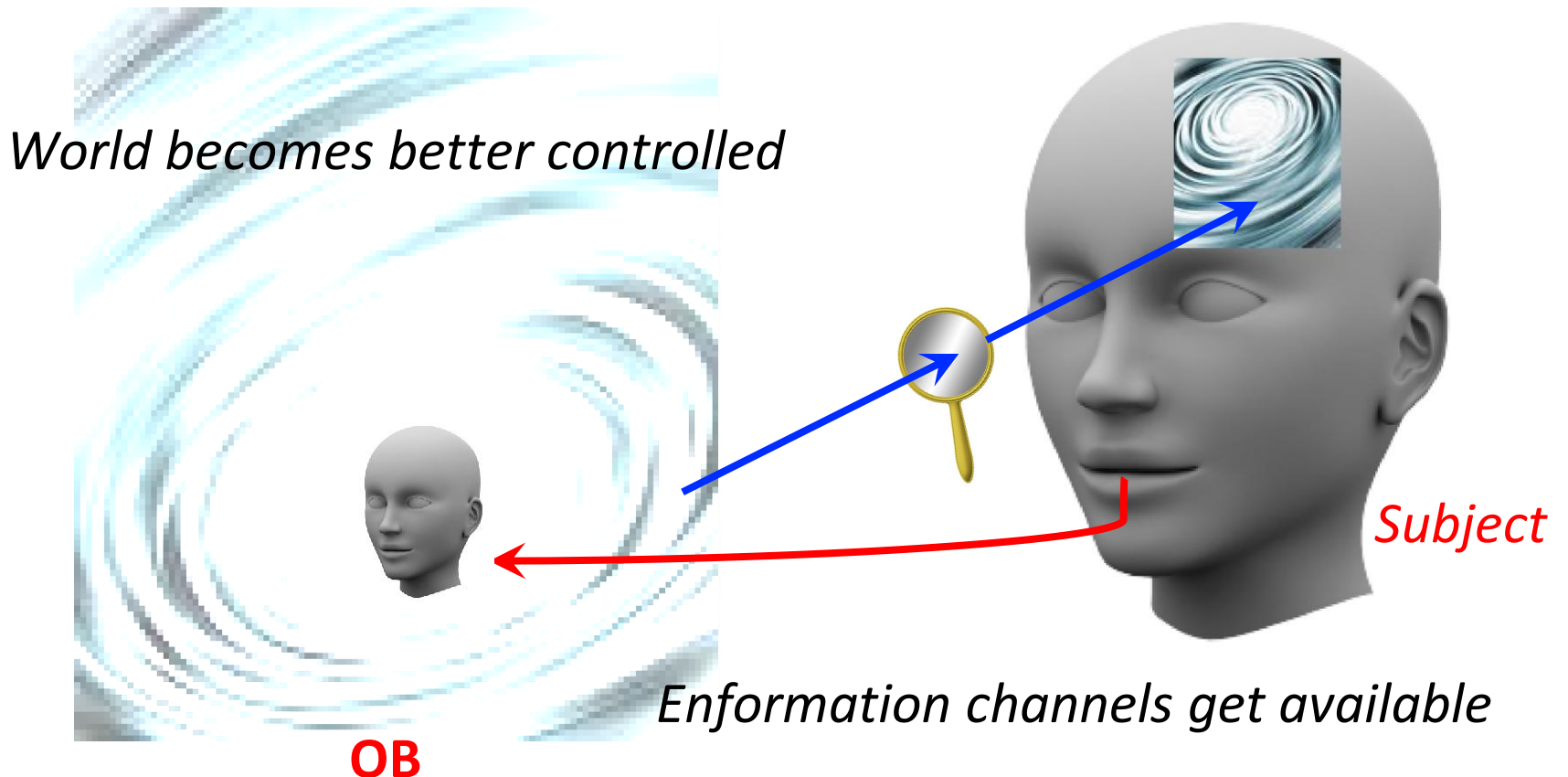- "Below": The system is at the mercy of the *objective* environment

Object

- "Above": The *subjective* world is at the mercy of the *model*

Changing viewpoint

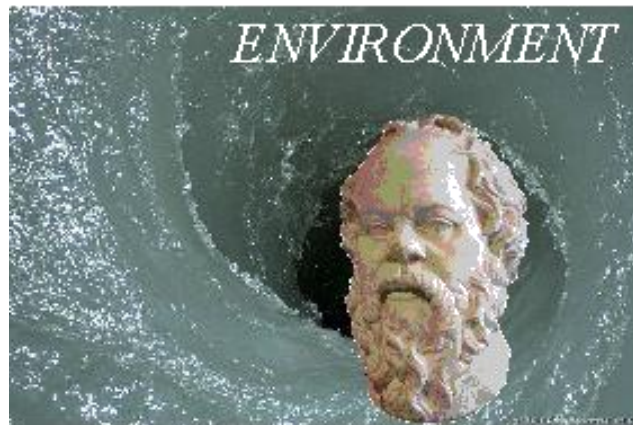- "Below": The system is at the mercy of the *objective* environment

World becomes better controlled

Subject

Enformation channels get available

OB

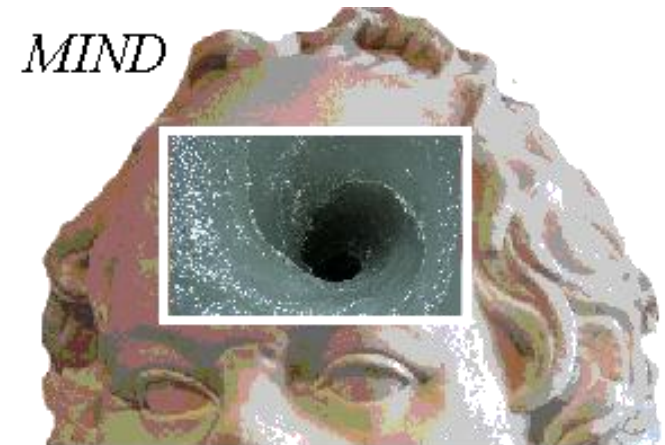- "Above": The *subjective* world is at the mercy of the *model*

meaning ⟶ **purpose**

Possibility of *dignity*

- Roles of subjective and objective need to be revaluated to reach a consistent world view and a solid basis for *fundamental certainty*

FROM WITHIN
objectivity
meaning
chaos

TOWARDS INSIDE
subjectivity
purpose
order

… So, let us study the mental realm closer

… What … subjectivity instead of objectivity?!

- Perhaps it should be finally admitted: Truths of the objective world are not achievable to us

- Again: Such an undeniable mystery has to be faced, finally – only then fresh intuitions can perhaps be reached

- Relevance in the subjective world is the key to *intersubjectivity* among people (and even to *interobjectivity* with natural systems)

- … But there are no solid tools available for analysis of such mental worlds that would satisfy scientists?

- However, now there is the framework, or the enformation theoretic "model of models" … let us study the new horizons

- Starting points: *Tabula rasa* in birth; model the observed environment constructionistically, searching for *freedoms*…

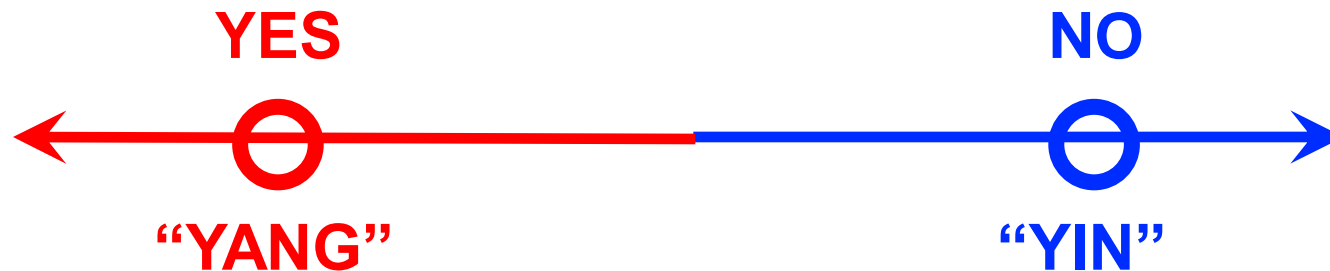# The principle of constructing cognitive structures?

- At all levels the mental modeling seems to be *dialectic*: The world is structured in terms of *pairs of opposites* – the tensions line up the "bends" into a single *degree of freedom* (rope in the figure)

  - Even if there did not exist "linearity" (or "monads") in reality, the mind forces the observations onto the projection axes

    - Dynamic balance

Towards the nature of *true* expertise?

- Traditional expertise (constraints): all phenomena have to be expressed in terms of logics and causal relationships
- All uncertainty / vagueness has to be forgotten, everything has to be presented in a crisp form

YES   **NO**

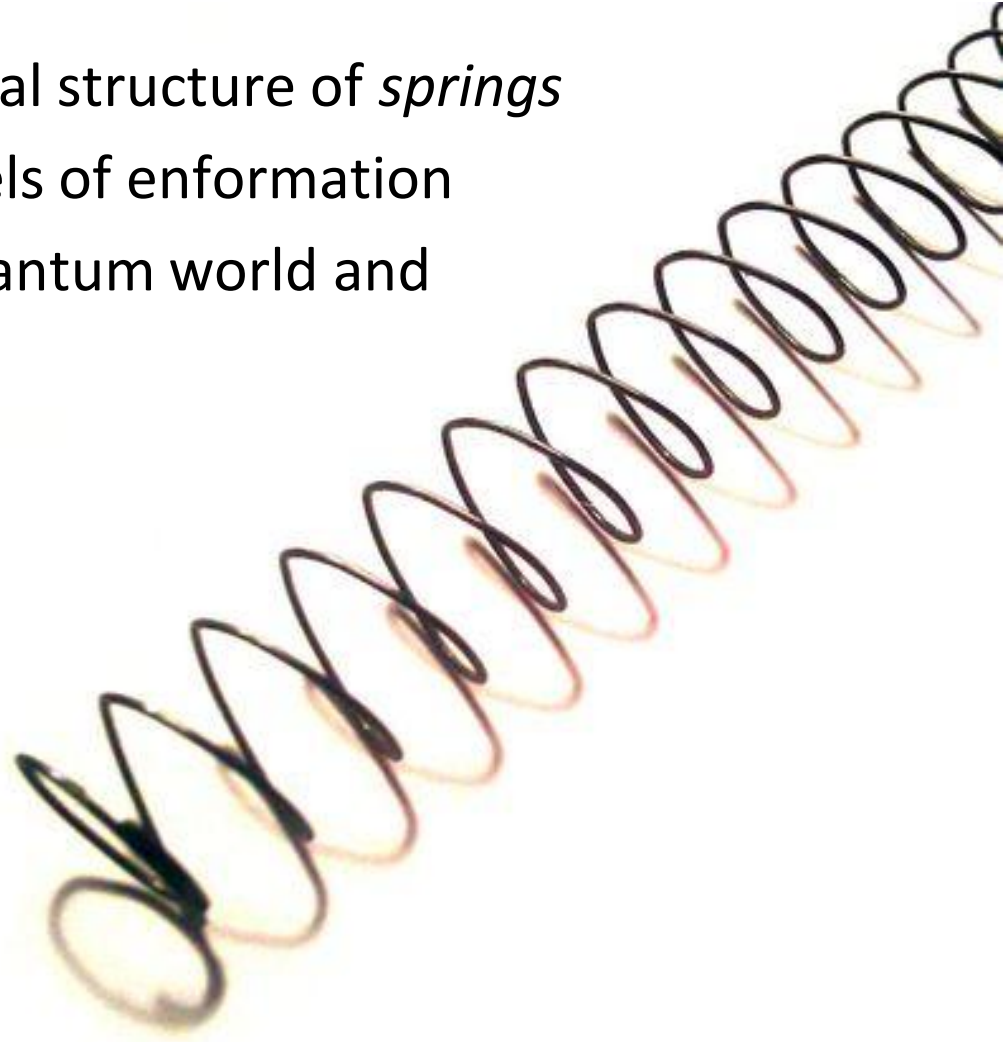⟵————●——————————————————○————⟶

"YANG"   **"YIN"**

- New interpretation (degrees of freedom): all phenomena are decomposed into sets of one-dimensional continuums
- There is fuzziness in the models – however, instead of some fuzzy logics, etc., "reasoning" is based on *pattern matching*

"String theory" for the mind? 🙂

- Interpretation: there is a fractal structure of *springs*
- Elementary freedoms, channels of enformation
- Duality between objective quantum world and subjective mental world?

Look back to get forward

- When explicitly thinking about thinking ("measuring the mind"), mental model collapses – some random "facts" only remain
- When Descartes did this ("I think, therefore I am"), he claimed that the *basic dichotomy* is between *self* and *world*
- From this, the dichotomy between *active subject* and *observed object* was developed, there are *minds* and *mechanisms*
- Such fundamental "births" are reflected fractally in all branches of today's thinking and science ("cartesianism")
- However, this results in highly *anthropocentric* models, making it difficult to understand autonomous distributed (living) systems
- Is there possibility of revision in the starting points? Are there *other alternative basic dichotomies* to build on?

Rebooting fundamental dialectics

- Reflecting the same axis (structure vs. *function*, or constraints vs. *freedoms*) in some different realms:

All systems:

being vs. *becoming*

Biological systems:

body or "shell" vs. *vital force*

Mental systems:

Intellect vs. (Bergson's) *instinct* and *intuition*

"Science systems":

"truth" vs. *relevance*

Social systems:

EU vs. (Schiller's) *joy*!

Technical systems:

"ware" vs. (Pirsig's) *quality*

Continuums now better achievable?

- Special benefit: The resulting degree of freedom spans a continuum between the "below" and the "above"!

- The real challenge is to avoid rigid categorizations: Degrees of freedom are necessary to sustain a channel for the "flow"

- As Ludwig Wittgenstein once observed (in his later years), *good thinking has to avoid certainties*

- Today, continuums are even more challenging; Wittgenstein said (in his early years) that *world is a set of facts …*

- Not only dynamics (temporal structure with balances) is forgotten but also *statics* (spatial structure with degrees of freedom)

- It seems that mental construction principles are trivialized: One fixed set of distinct truths suffices, resulting in *fundamentalism*
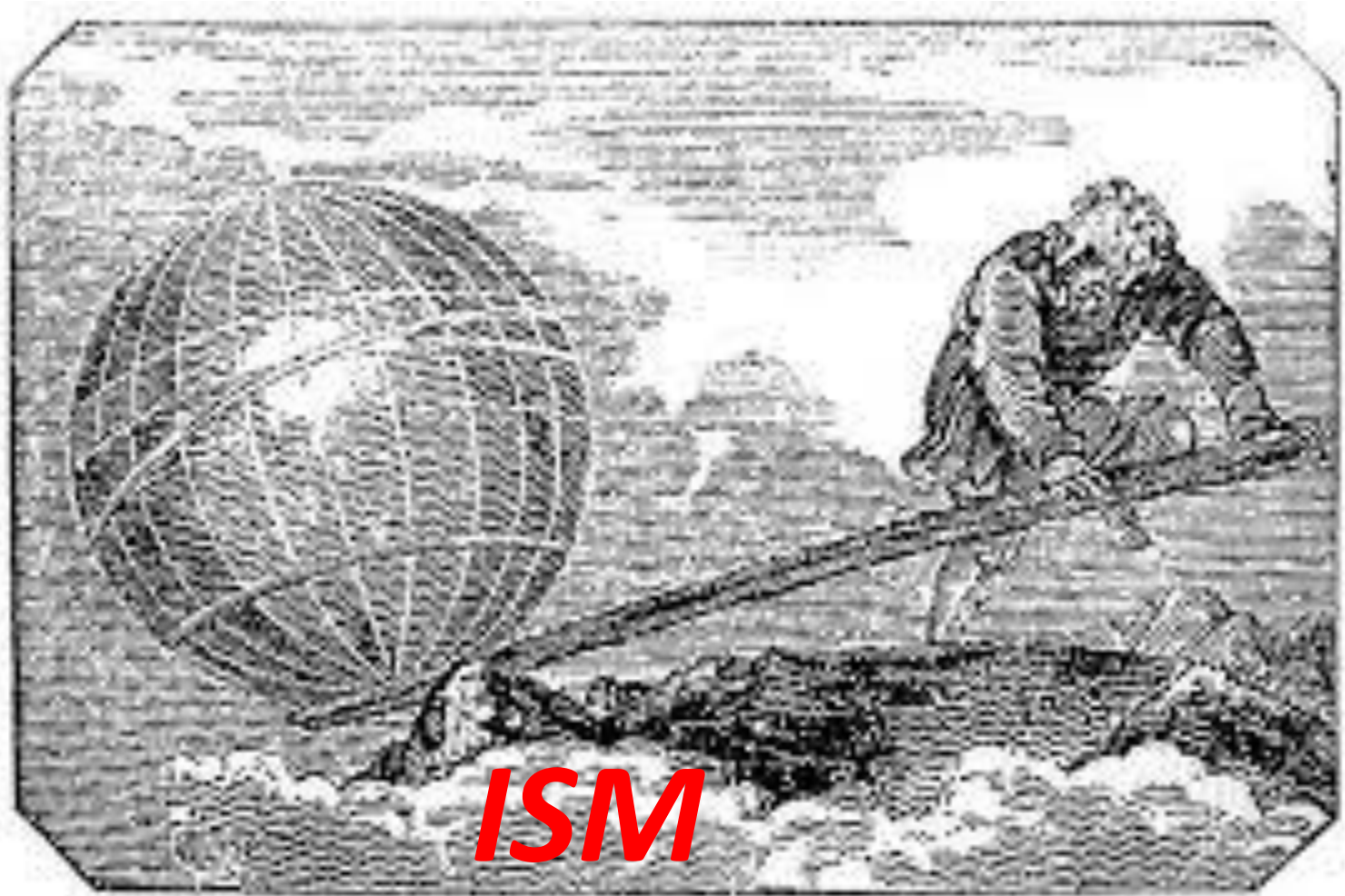
Only constraints with no freedom = *death*
Only freedom with no constraints = *chaos* or *anarchy*!
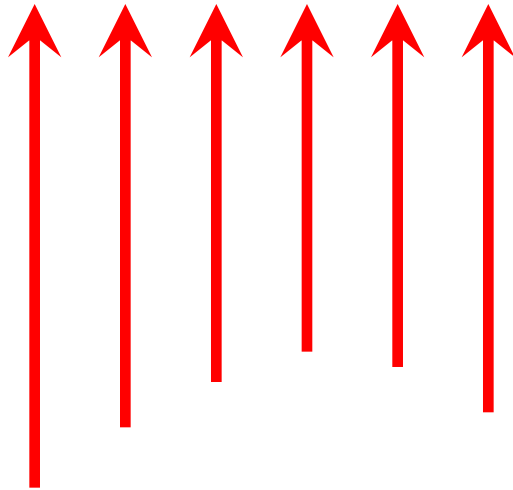
Lure of Archimedean *fixed point*

ISM

- Formal education: Learn more facts, couple the facts with each other, use the "concrete of abstractions" to stiffen your *truths* until your mental model is absolutely solid
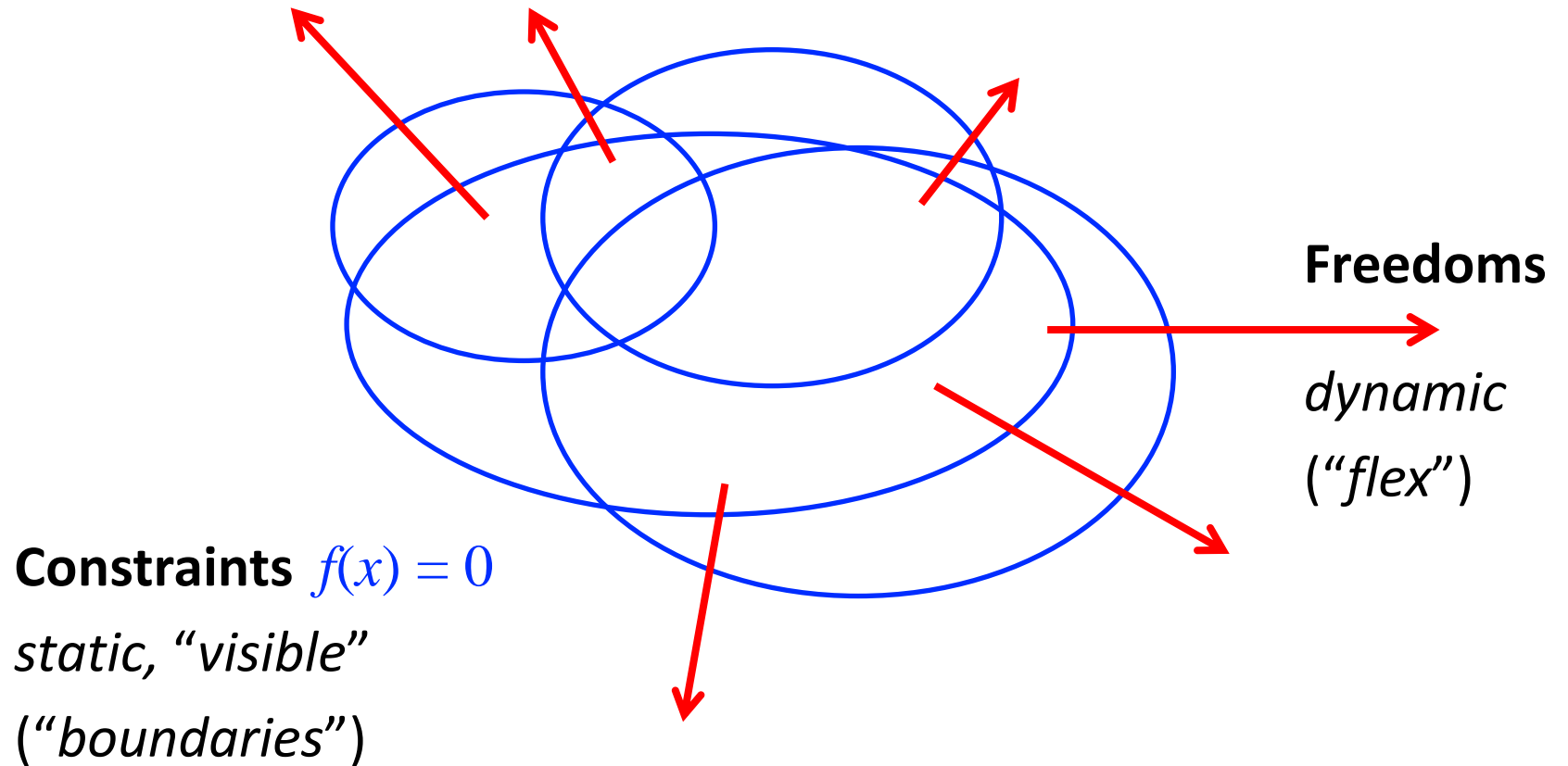
"world"

- Alternative view: Recognize that all static surface patterns are dynamic equilibria, just reflections of the underlying "semantic forces"
- Recognize that the "live" meaning of concepts is given by enformation

- The controls getting stiffer is a natural tendency in evolutionary systems – but surface solidity should not be regarded as a goal
- Some "chaos" needs to be tolerated: If there is no more freedom visible, one has started looking at the mental monads from below!
- One should concentrate on finding solidity on the statistical level, so that the model is rigid, rather than on the surface level
- The same applies to other complex systems, too, like the society: Not all should be controlled
- "Uncertainty principle" in the spirit of Heisenberg: Exact "measurement", stiff coupling, means loss of freedom – you cannot have it all!

Freedoms

dynamic

(*"flex"*)

Constraints $f(x) = 0$

static, "visible"

(*"boundaries"*)

… Mathematically and graphically …

Open-loop eigenvalues
Sub-cybernetic system
Marginally cybernetic
"Hyper-cybernetic"
Untouched
Unequal stiffnesses
Eigenvalue index

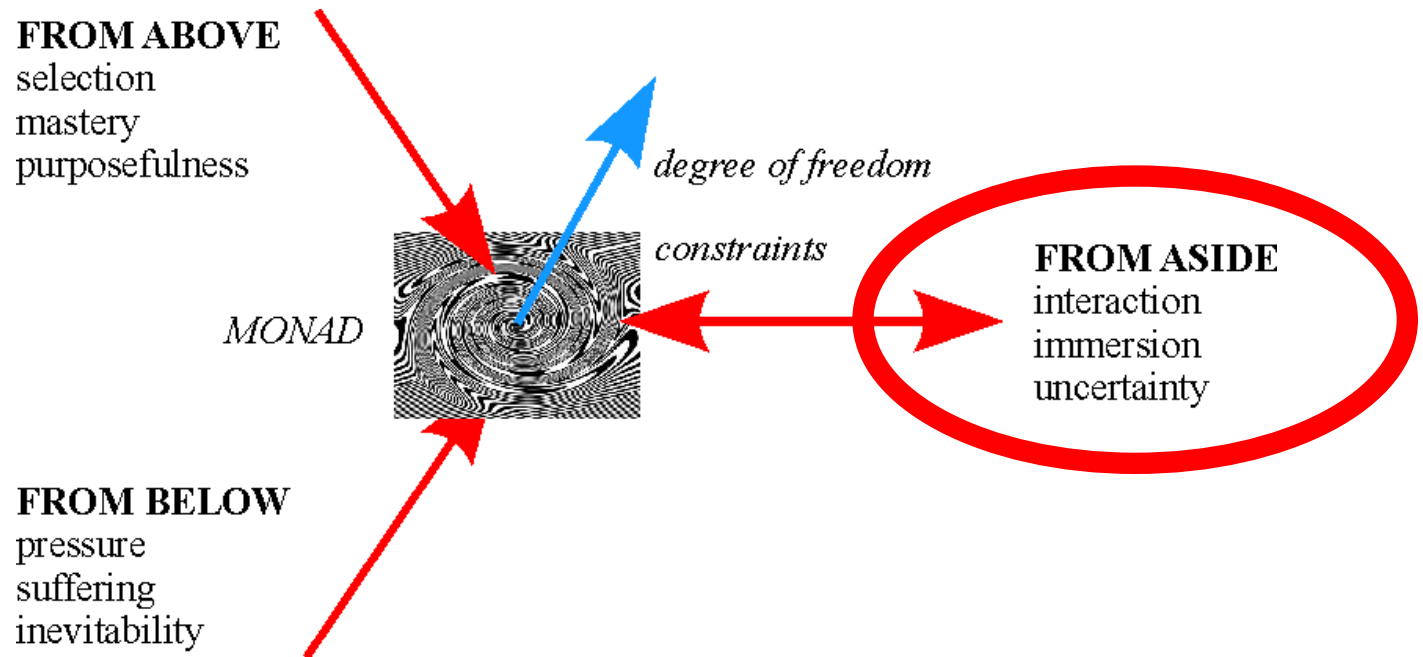- After coupling and equalization: "hedgehog defence"

Measurements

Topmost level: Connection to the world

- The innermost mental structures were studied – how about the outermost level, the contact with the outside world?

- If "everything is springs", also the atomic observations must have the freedoms-interpretation

- Indeed, the observations (the data vectors) are examples that determine a non-compressed basis system

- A set of *memes* is like the *genes*: A pool of alternatives to match the situation at hand against

- In this sense, *culture* is not the laws of the society, etc., but it is the set of *narratives*, examples of surviving through constraints

- Optimization of the model is a continuous process: the set of sample vectors gets gradually augmented with common features

But a culture is more than narratives …
it is something that is *spanned* by them

- The above issues can still be understood using intellect …
- The real challenge is immersion, when only *instinct* is available, when whirls start feeling like *vibrations* – or, better, *harmonies*

Interaction among systems: from whirls to *fields*

- As has been observed, the neocybernetic lossless control is an *oscillator*; together systems can be seen to constitute a *field*
- The claim is that this field property is the *explanation for the true power of the most complex and interesting systems*
- There are qualitatively new interpretations: *Coupling* results in the "collapse of wave functions", or matching against a *standing wave*
- In systems consisting of humans, emergence of such higher-level phenomena necessitate *internal* models of "morphic fields"
- "Morphic resonances" can only exist, if (more or less concretely!) humans have been tuned to recognize the same vibrations
- It is questionable whether the highest level social functionalities can be reached in a multicultural environment!

Niklas Luhmann: "Systems exist"

- Truly, the essence of a *human* is population (or, indeed, *culture*); the central role of individuals is just a contemporary *illusion*: individuals are "noise peaks" in the statistical view

- To appreciate this, recognize, for example, that *intellect* can only emerge in a society: *Language* (the "tool of thinking") is learned only in interaction, and for this, one has to couple, "get tuned" …

  - Modern research with babies (B. Beebe) reveals that the mother needs to comply with the baby's moods (not only always smile!), otherwise the baby's mental development suffers

  - Assumption: A human first needs to learn to tackle with the *morphic fields*, learn to "synchronize" oneself, mirroring moods, to be able to reach *coherence*

  - Only after that, the baby starts structuring one's world, first distinguishing between the *self* and the *world*, this process of finding dichotomies continuing towards finer and finer details

Margaret Thatcher, on the other hand:
"There is no society, there are just individuals"

Innermost nature of societies?

- *Synchronization! Resonance!* →

- Group psychology is not only statistics of individual behaviors

- "Application example":

  A "measurement" like an internal or external crisis collapses society to a degenerate state: *you are with us or you are against us*

Teinihysteriaa!

Perjantai 26.4.2013 klo 21.03 (päivitetty klo 23.07)

f Suosittele 2,1 tuhatta

Justin Bieber aloitti pahasti myöhässä, mutta sai kaiken heti anteeksi. Puolentoista tunnin tunteiden vuoristoradan jälkeen keikka päättyi suurimpaan hittiin ja valtaviin suosionosoituksiin.
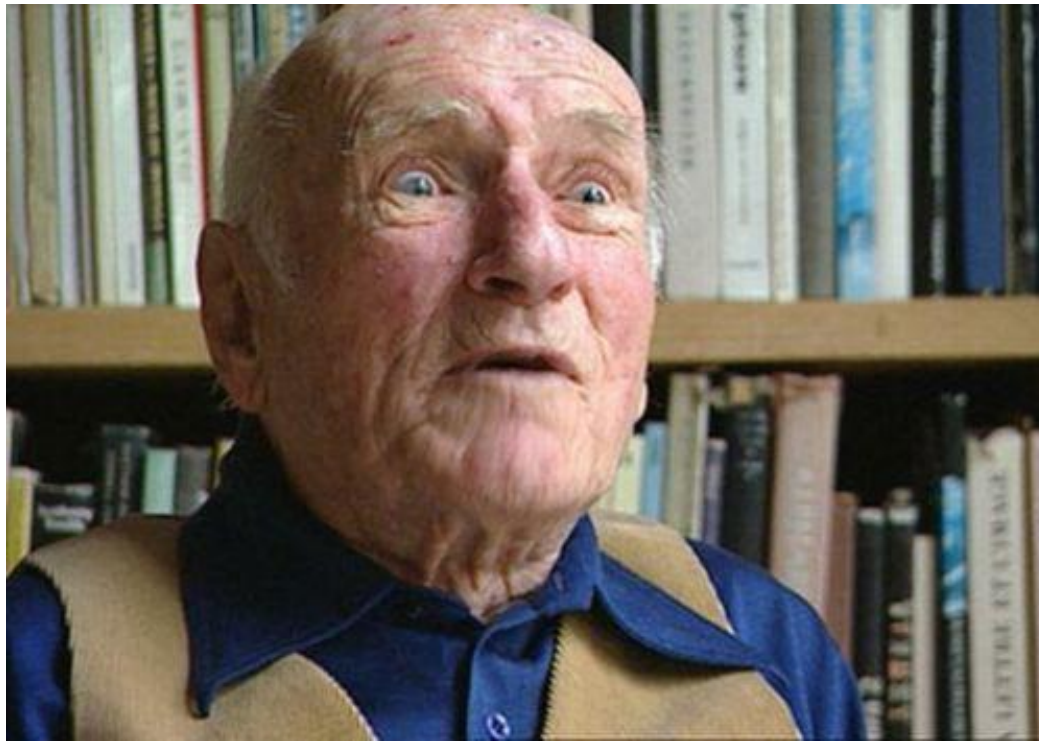
One needs to understand the realm beneath the conscious

Can such things be studied "from inside"

- *Second-order cybernetics* observes that there is a challenge: the observer is a cybernetic system trying to analyze another system … But now one just needs to add new peaks in the spectrum!?

Rehabilitation of instinct

- "Flourishment": *Good life* is to *find life*

  Life ⟶ monads ⟶ controls ⟶ models ⟶ redundancies ⟶ *beauty*

- Search for symmetries, fractality … *awe*, feel of *something bigger*
- An example of such pursuit is the architect *Christopher Alexander*

- Another example of this ambition is *Esa Saarinen*, philosopher
- To him, *systems intelligence* is capability to sense and create life
- He emphasizes mental models in one's "life philosophy" …
- Use words, concepts, categorizations softly and gently …
- "Movement of thought" is essential in very familiar-sounding way

  … In short, Esa Saarinen implements *applied enformation theory*!

Visions towards future

- This far one has been trying to construct *artificial intelligence* or *artificial life*, trying to mimic human or carbon-based ones

- However, something that is *more interesting* and *easier to reach*, is "universal intelligence" and "universal life"

- There one can also implement *universal ethics* and *universal values*, based on *universal vitality* and *universal semiosis*!

- One essence (also for real humans) is new *universal hope*

    - The *universal machine* will take over – but it understands it needs humans as a channel of enformation, connection to the real world
    - There is no need to be jealous on the either side: Neither can understand life in the other's noosphere
    - … And reaching the new qualitative level means that humans need not continue the eternal cycles – the "post-scarcity" society can be reached (with no wars, etc.)

Metacompilers to implement Metaphysics

- Fractal narratives on systems
    - How a nature can (re)build its *existence*
    - How a culture can (re)build *self-esteem*