Beyond ESG:
Systems Solutions for Sustainability

March 2022

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Convened by Thinking Ahead Institute

Session 2

Plan of Sessions

1. Taking Stock: ESG and the Risk of Greenwish

- Awakening to sustainability challenges.
- The rise of corporate sustainability and ESG.
- The ‘shock of net zero’ and the return of limits.
- Rising ESG scepticism.
- Are we suffering from greenwish?

4. Building the economy of a sustainable culture

- Business*people* as critical moral actors in a system of market primacy.
- Realigning business and morality to set business [illegible].
- [illegible]ding not a sustainable economy, but the economy of a sustainable culture.

2. The Unintended Trap of Externality-Denying Capitalism

- Is externality-denying capitalism a ‘fix t[illegible] fails’?
- The Invisible Hand and the Unmentio[illegible]
- How we got here? The roads not taken.
- How are we trapped? Friedman’s Feedback Loop.

3. S[illegible]nking Can Rescue the Situation

- The [illegible]stoppable rise of systems thinking
- Economy as a sub-system of emergent complex [illegible]gical systems.
- [illegible]Deep adaptation and ‘fixes that stick’
- Upwards learning (innovation) and sideways learning (unlearning to relearn).

Session 2

Goals of Session 2

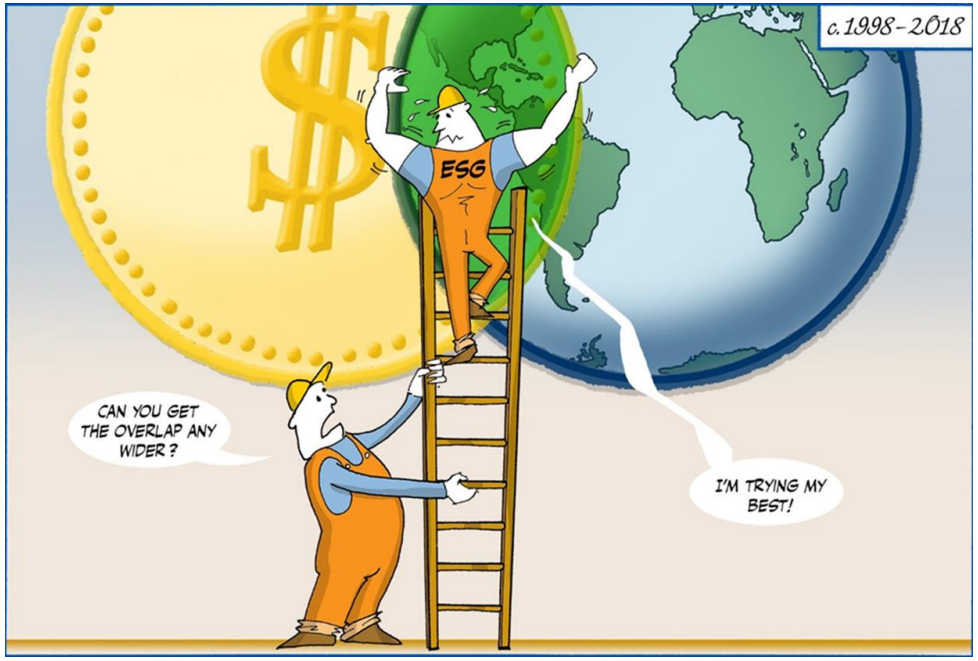
- To cultivate a ‘systems’ view of the economy, or a ‘meta-economic’ perspective.
- To see better the current pattern of our economy and the nature of its historical emergence.
- To see how systems self-regulate, or achieve *homeostasis*, as a necessary condition of their persistence or *sustainability*.
- To identify that adaptation of complex systems is innately a costly process.

Structure

1. Recap of Session 1
2. What is the Relationship between Economy, Society and Ecology?
3. Emergent Nested Complex Systems
4. Analogues
5. Key Features of Emergent Nested Complex Systems
6. How do Emergent Systems Sustain Themselves?
7. How do Emergent Systems Adapt?
8. Reflections on Voluntary Market-Led Strategies in light of Emergent Systems understanding.

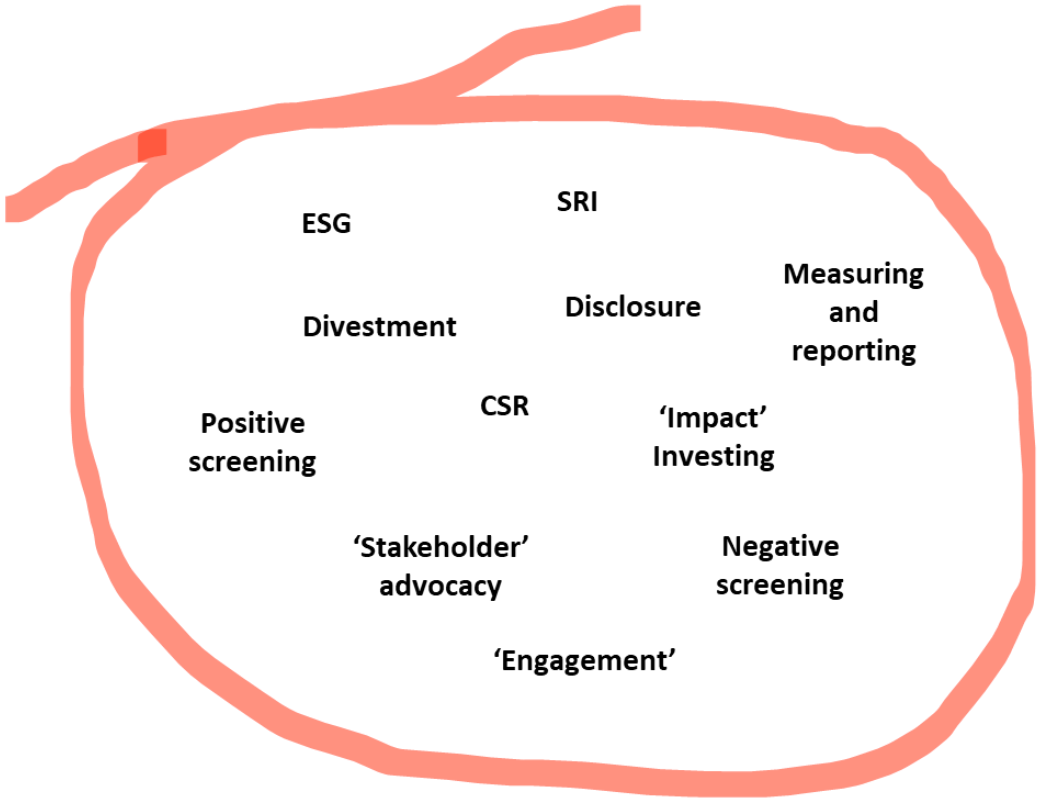
Recap of Session 1

RECAP - VML: From Catalyst to Inhibitor



- Our Voluntary Market-Led (VML) approach to sustainability – with its 'win-win' narrative – emerged as a beneficial and pragmatic catalyst for action in the late 1990s.
- While now widely embraced, it is becoming apparent that 'win-win' VML strategies are unlikely to scale to solve our sustainability problems fast enough.
- This re-surfaces the tension between Economy and Environment – the circles of the Venn Diagram do not entirely overlap. There is more to do than what 'win-win' can stretch to.
- A recap…

“Voluntary Market-Led” = “Anything But Costly Regulation”



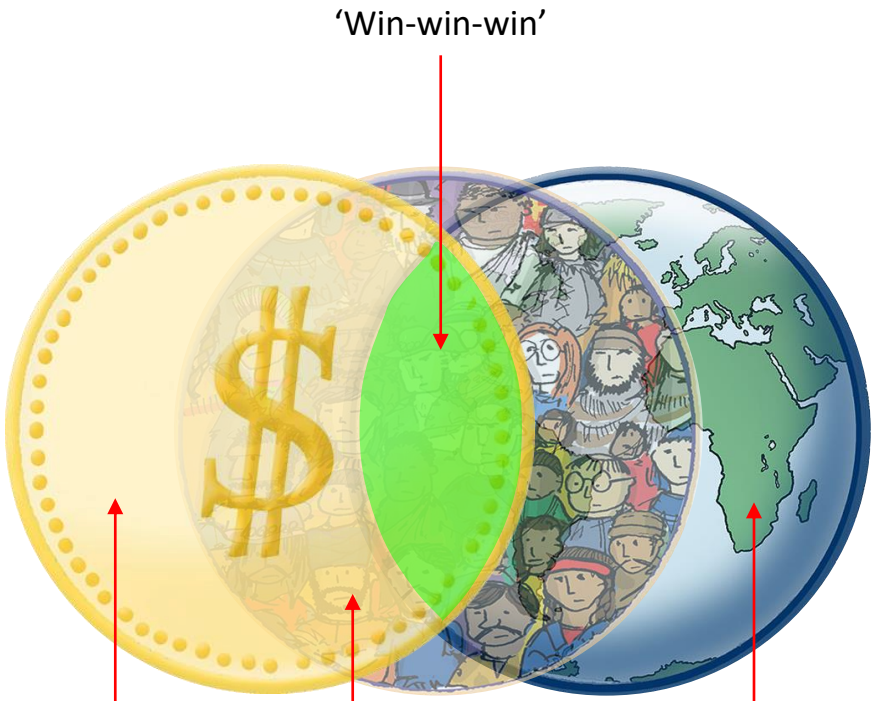
- All sub-strategies of a meta-strategy that might be termed: Voluntary Market-Led (VML) Environmentalism
- VML = ABCR: **Anything But Costly Regulation**
  - These strategies are all different expressions of the idea that costly regulations are undesirable and unwarranted.
- Key problem:
  - We are a complex system – ‘humankind’ – in adaptive crisis.
  - Complex systems adapt - or self-*regulate* - by establishing and upholding appropriate *constraints*.
  - In an adaptive ‘race against time’, such as we now face, constraints need to be adjusted in ways that *must be costly*, contrary to the ‘win-win’ narrative.
  - E.g., the benefit of a long-advocated carbon tax is inseparable from its costliness.
  - Our principal sustainability strategies deny the innate costliness of adaptation of complex systems facing new contexts.

What is the Relationship between Economy, Society and Ecology?

There is some tension between Economy and Sustainability

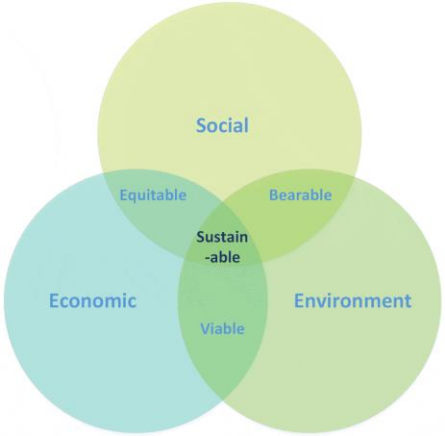
- Rising critiques of ESG etc., are fundamentally the realization that ‘win-win’ strategies are limited such that there remains a tension between Economy and Environment.
- Discourse promotes black-and-white polarization, but this is an ‘in-between’ case.
- **Not entirely separate…**
  - There seem to be genuine examples of business models and innovations that produce superior social and environmental impacts.
- **… but clearly not fully overlapping.**
  - The very need to articulate an ‘ESG’ or ‘socially responsible’ narrative and…
  - …the existence of a longstanding ‘stakeholder versus shareholder’ discourse…
  - …indicates that markets do not autonomously solve certain social and environmental problems many deem important.

A ‘Social’ Sphere Too

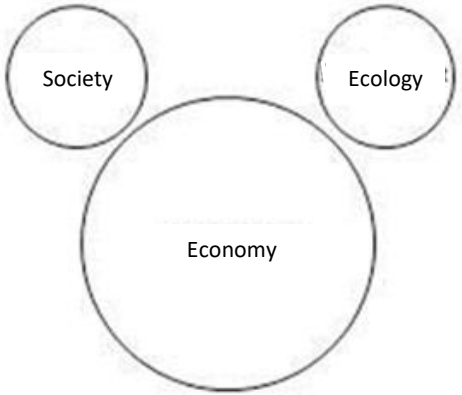


- More accurately, there is a Society sphere too, interleaved between Economy and Ecology.
- Hence, a ‘win-win-win’ segment
- But tensions between all 3 spheres where they do not overlap
- Certain pre-market social attitudes were also in tension with environment:
  - *‘And let them have dominion over the fish of the sea…’*
  - *‘I'm truly sorry Man's dominion, Has broken Nature's social union”* **Robert Burns**
- The modern *productive* economy has merely accelerated and amplified certain pre-established attitudes towards Nature.
  - Domestication of agriculture as first step?

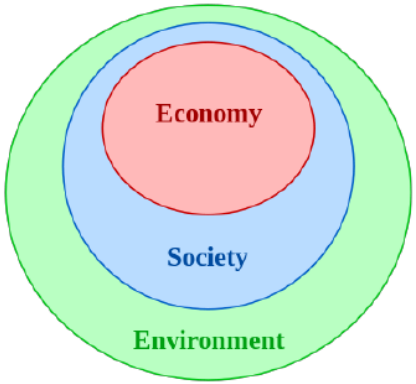
How has the Relationship Between Economy, Society and Ecology Been Depicted?



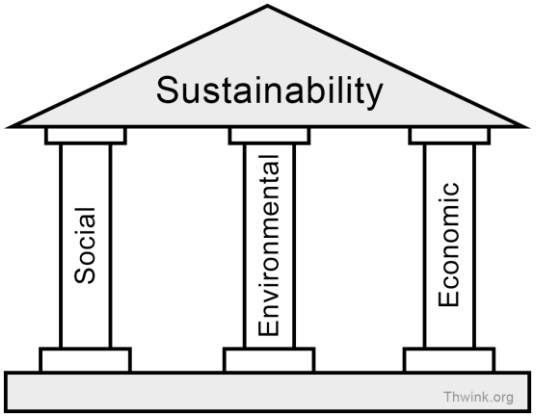
Venn Diagram



Mickey Mouse



Nested Economy



Sustainability Pillars

Three Views

How we should ideally see and behave, according to a ‘systems view’.

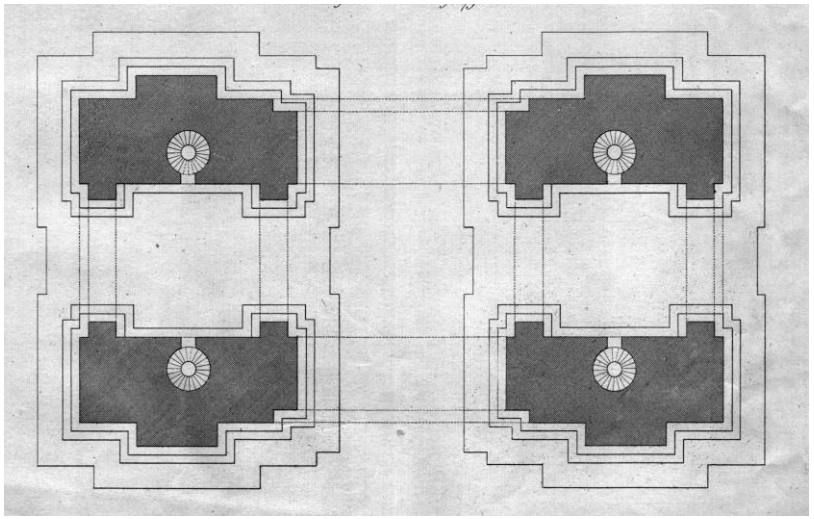
How it is…

…because of how we have self-organized to perceive the world and act in it.

Half helpful view

- I think this is the correct – and helpful – view, but not as informative as it might be.
- What would architects do…?

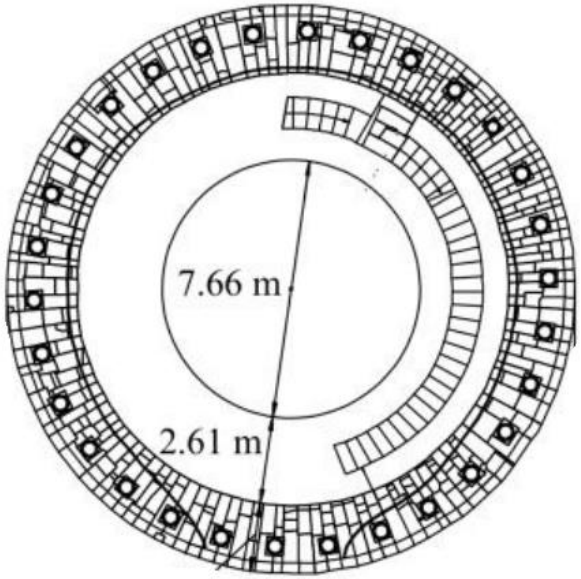
Plan and Elevation Views



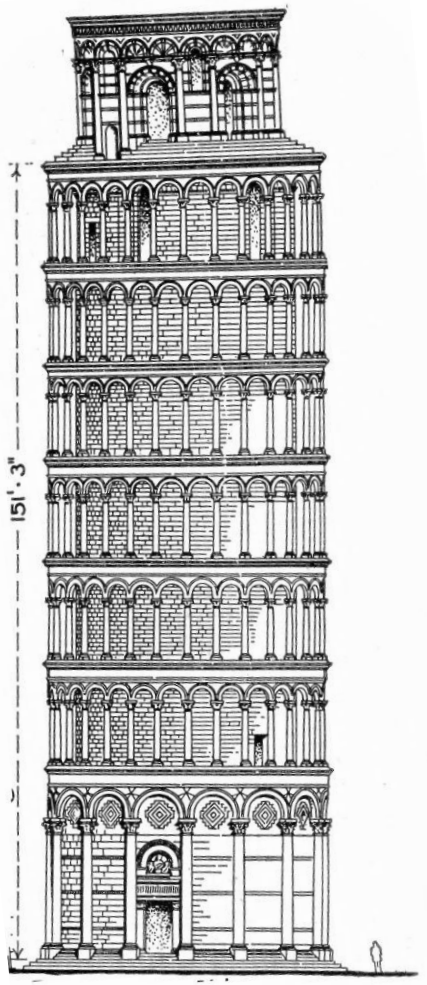
Plan

Elevation

Plan and Elevation Views

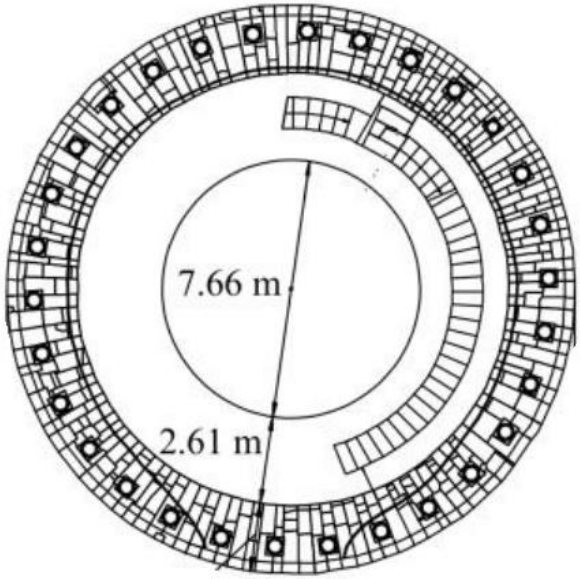


Plan

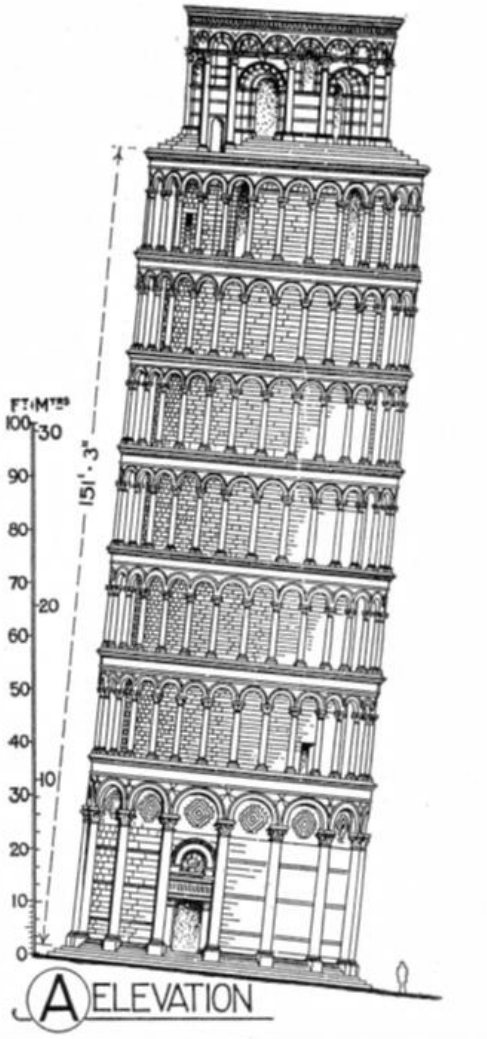


Elevation

Plan and Elevation Views: (Actual Elevation Didn't Go to Plan!)

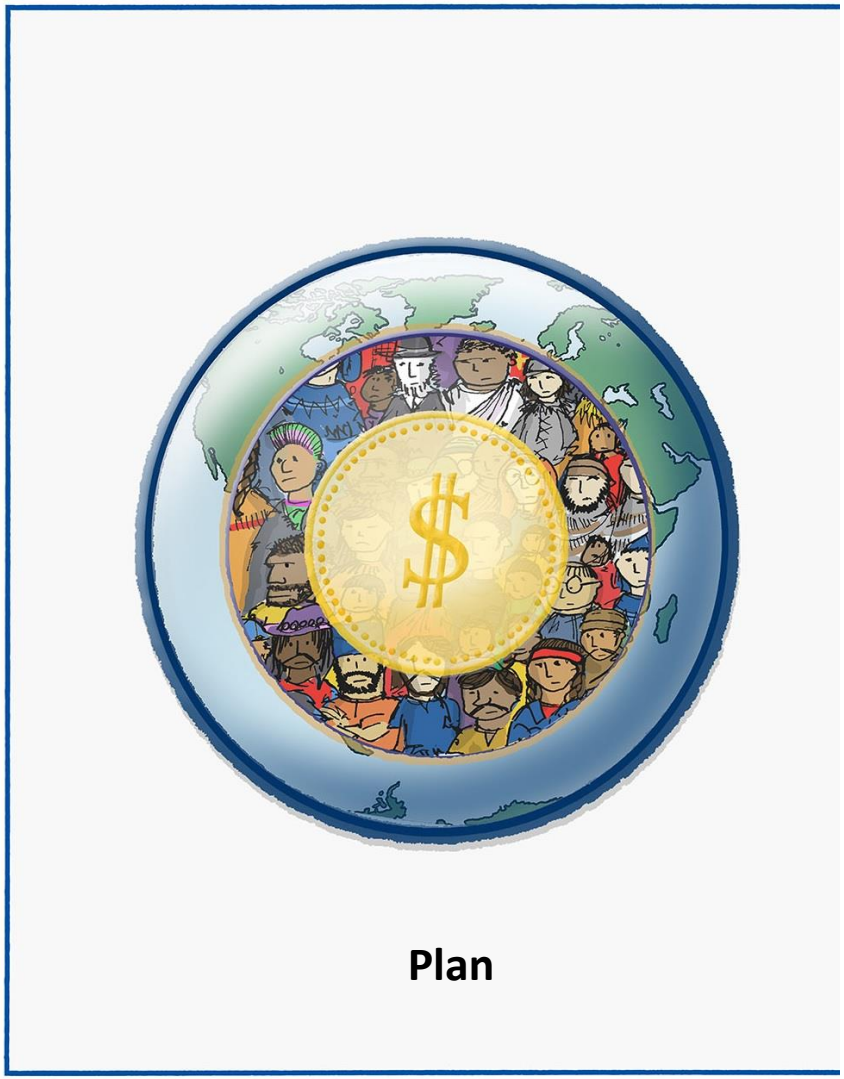


Plan

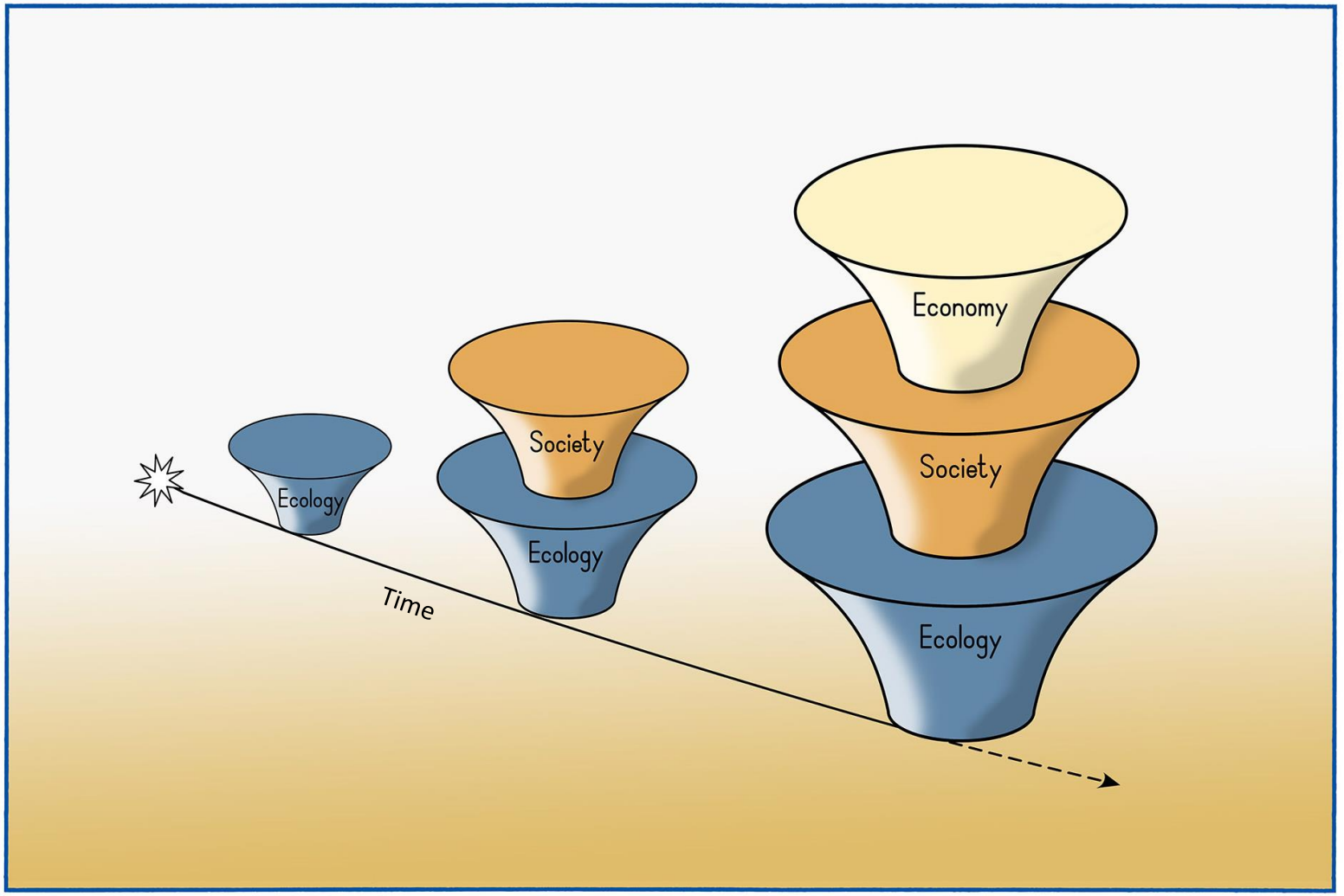


Emergent Nested Complex Systems

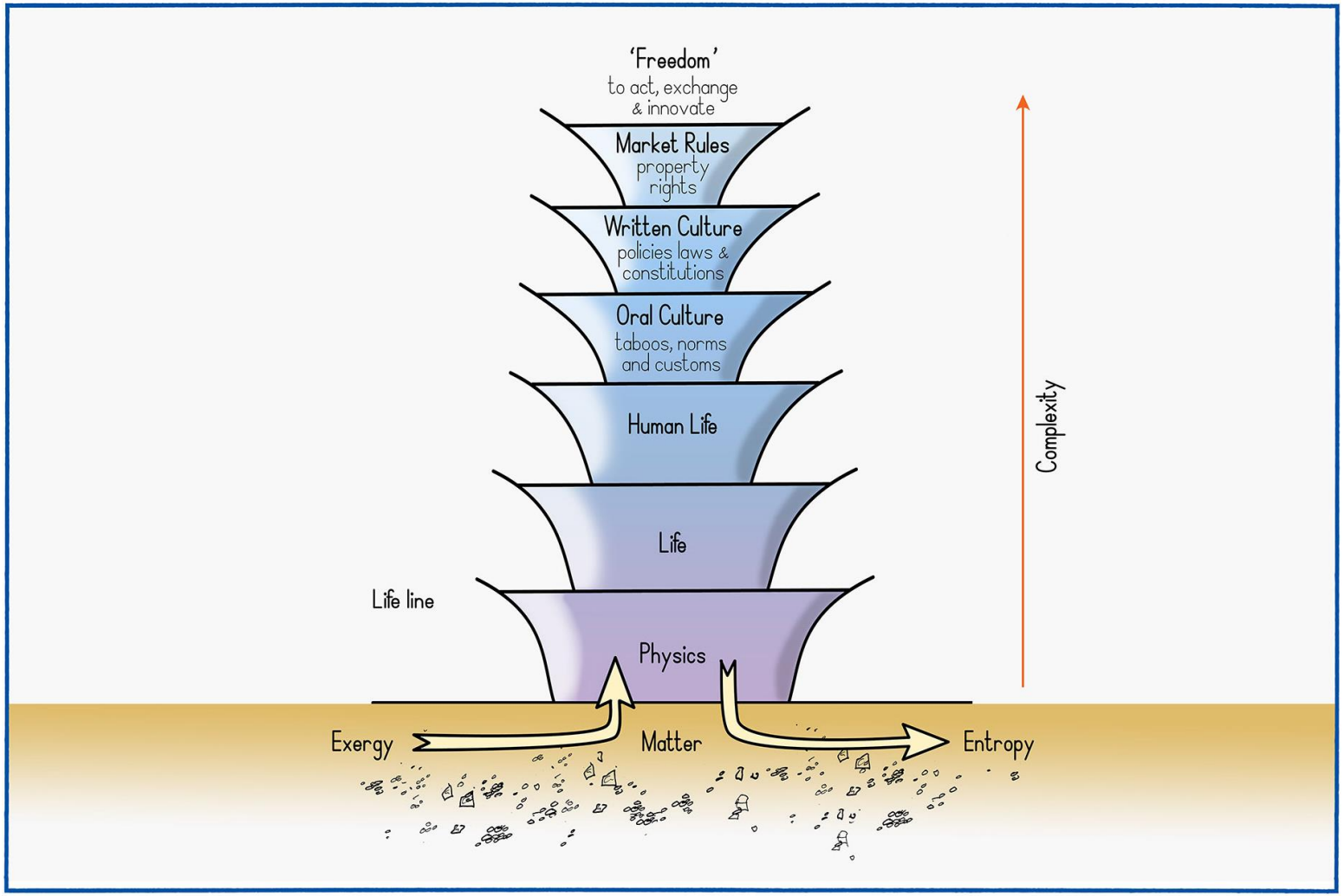
Plan and Elevation View



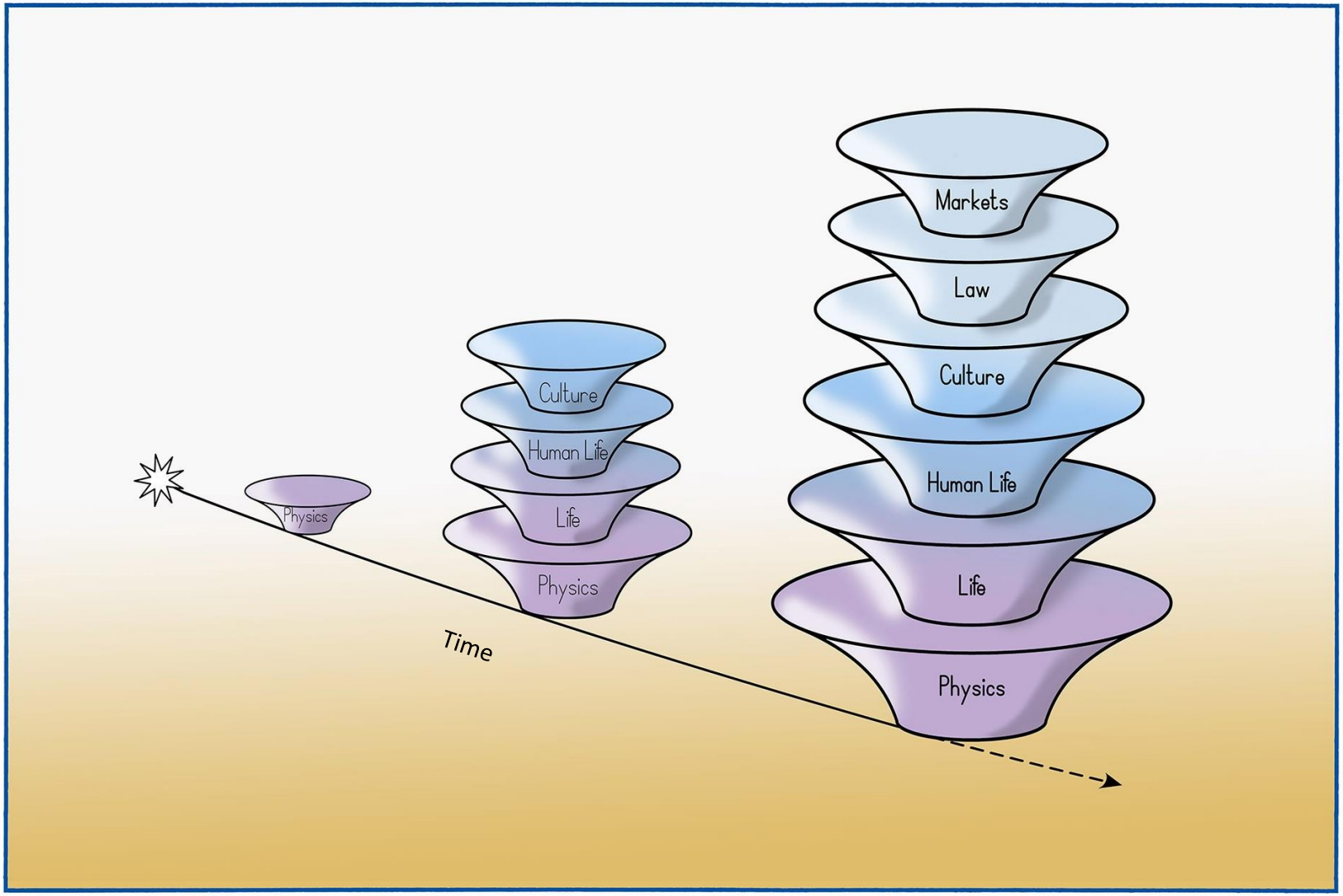
An *Emergent* System



Emergent Nested Complex System: ‘Humankind’



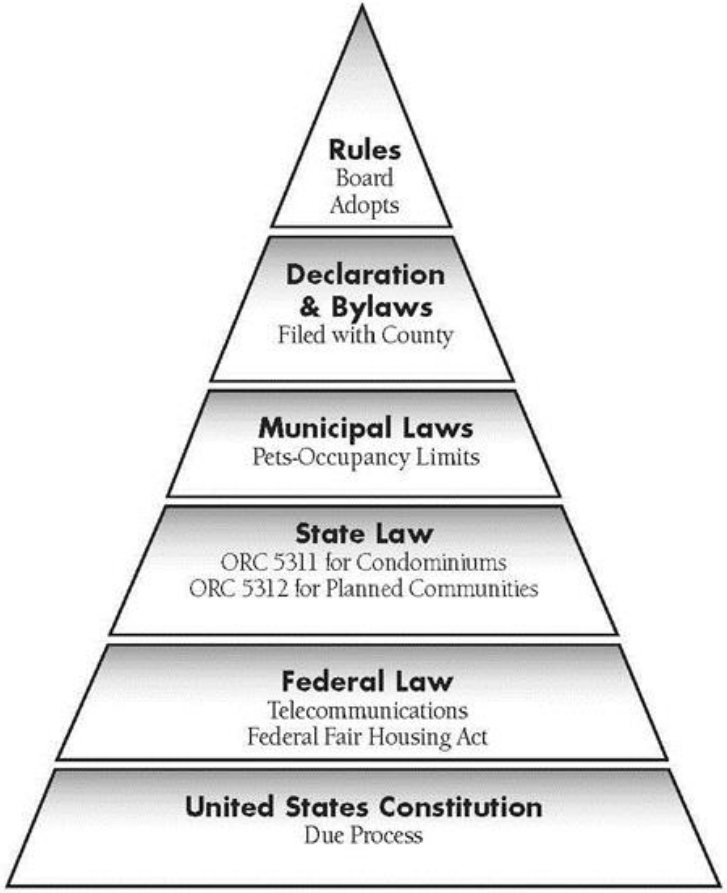
Emergent Nested Complex System: ‘Humankind’

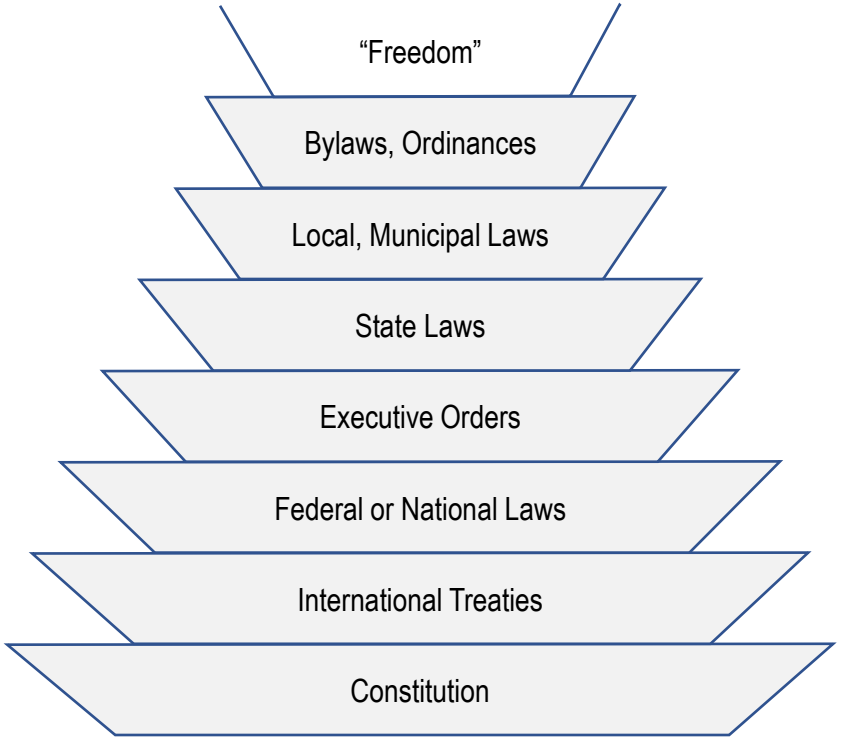


Analogues

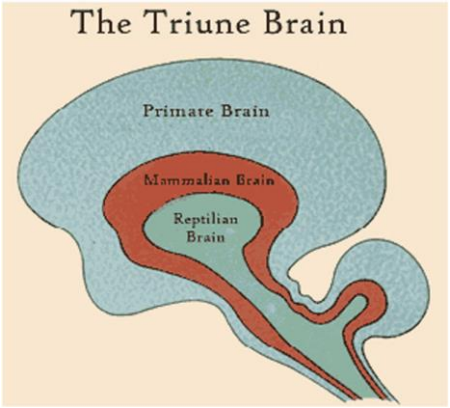
Analogues (i) highlight the universality of emergent nested structures; and (ii) prime our intuition as to how such structures behave.

Illustrative Structure: ‘Hierarchy of Laws’

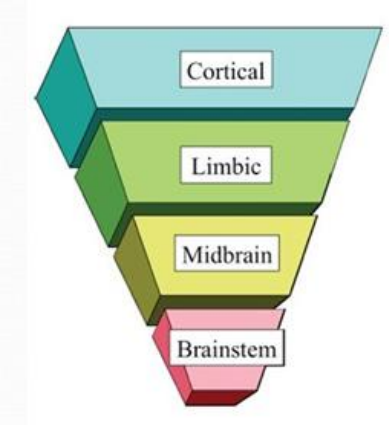




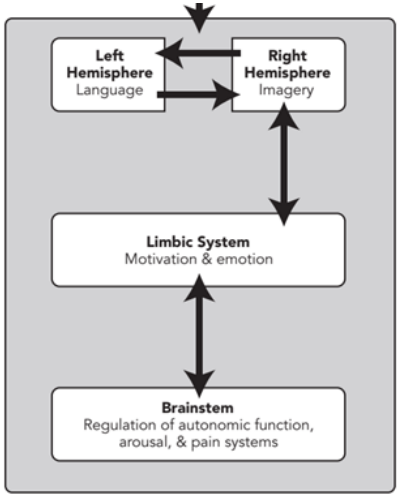
Brain layer models



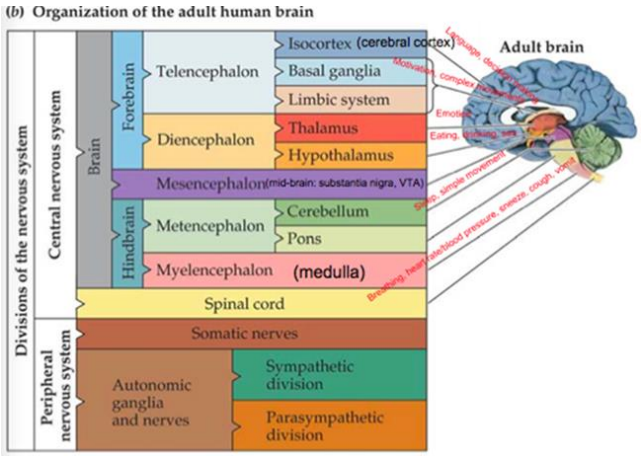
Three-level, 'triune', brain model



Four-level brain model

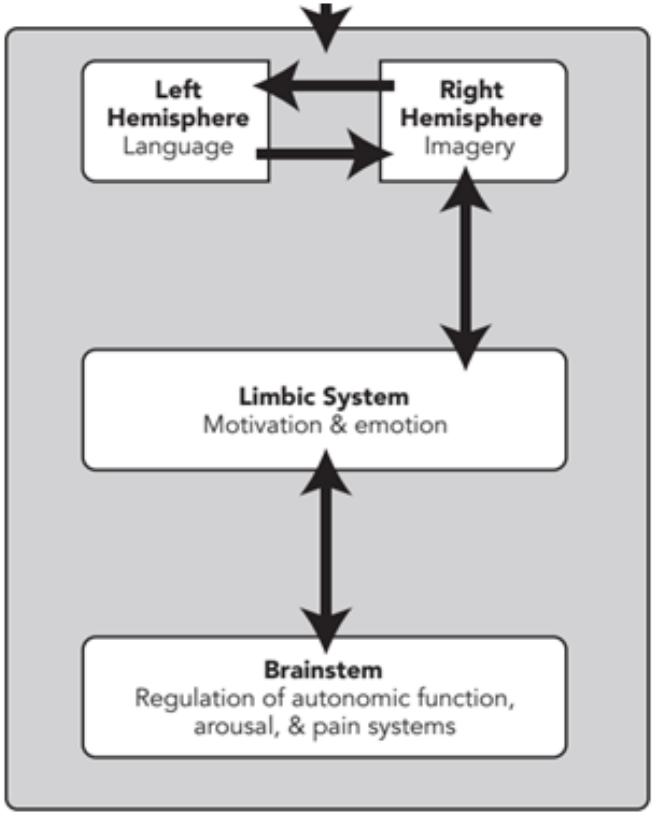


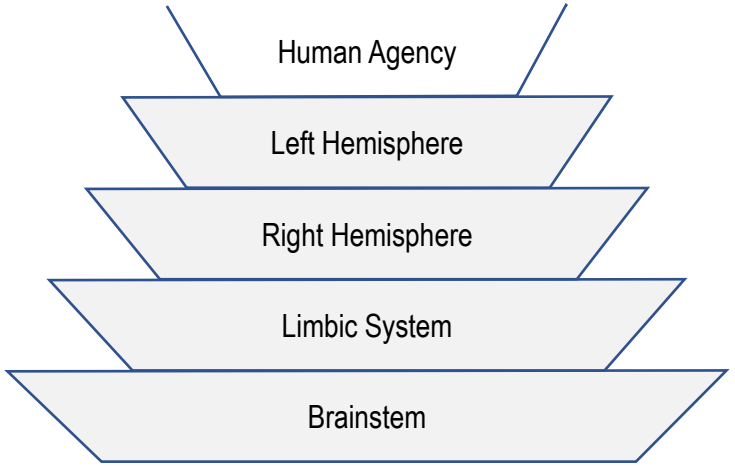
Triune plus Left and Right model



Multi-level brain model

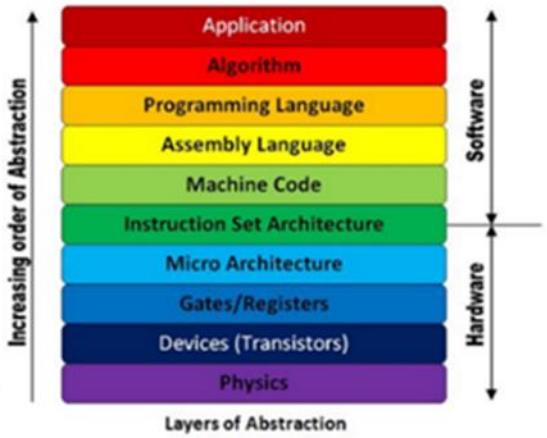
Illustrative Structure: Brain layer models

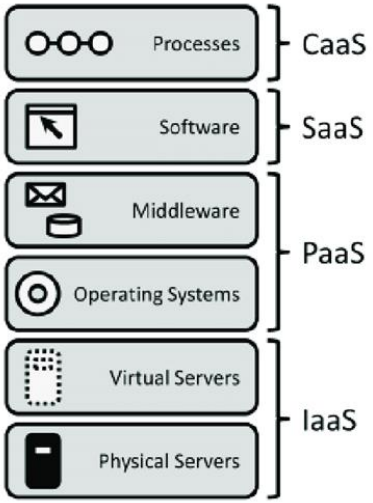




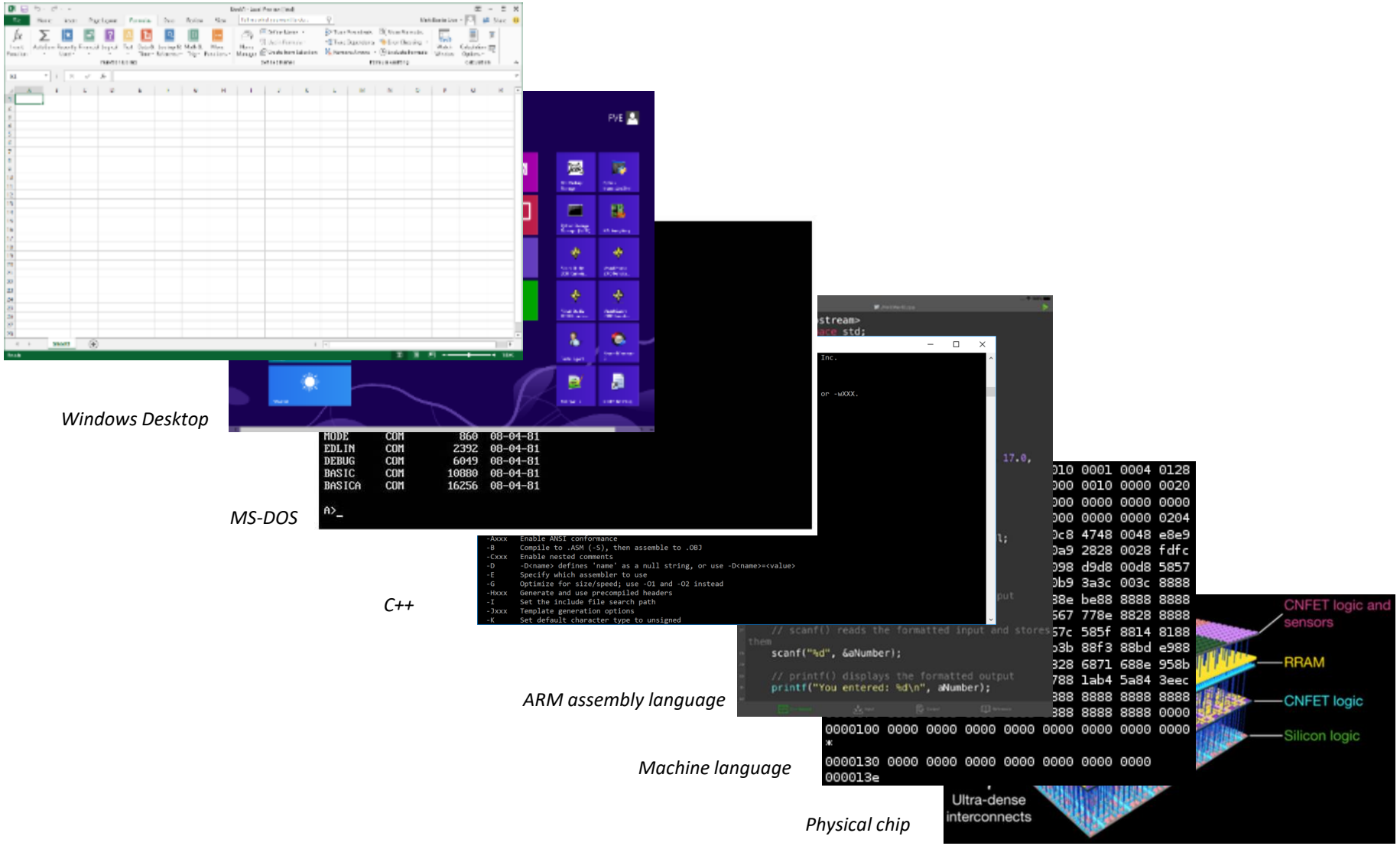
Allan Schore, Right Brain Affect Regulation, 2009

The Technology ‘Stack’ (or ‘Solution Stack’)

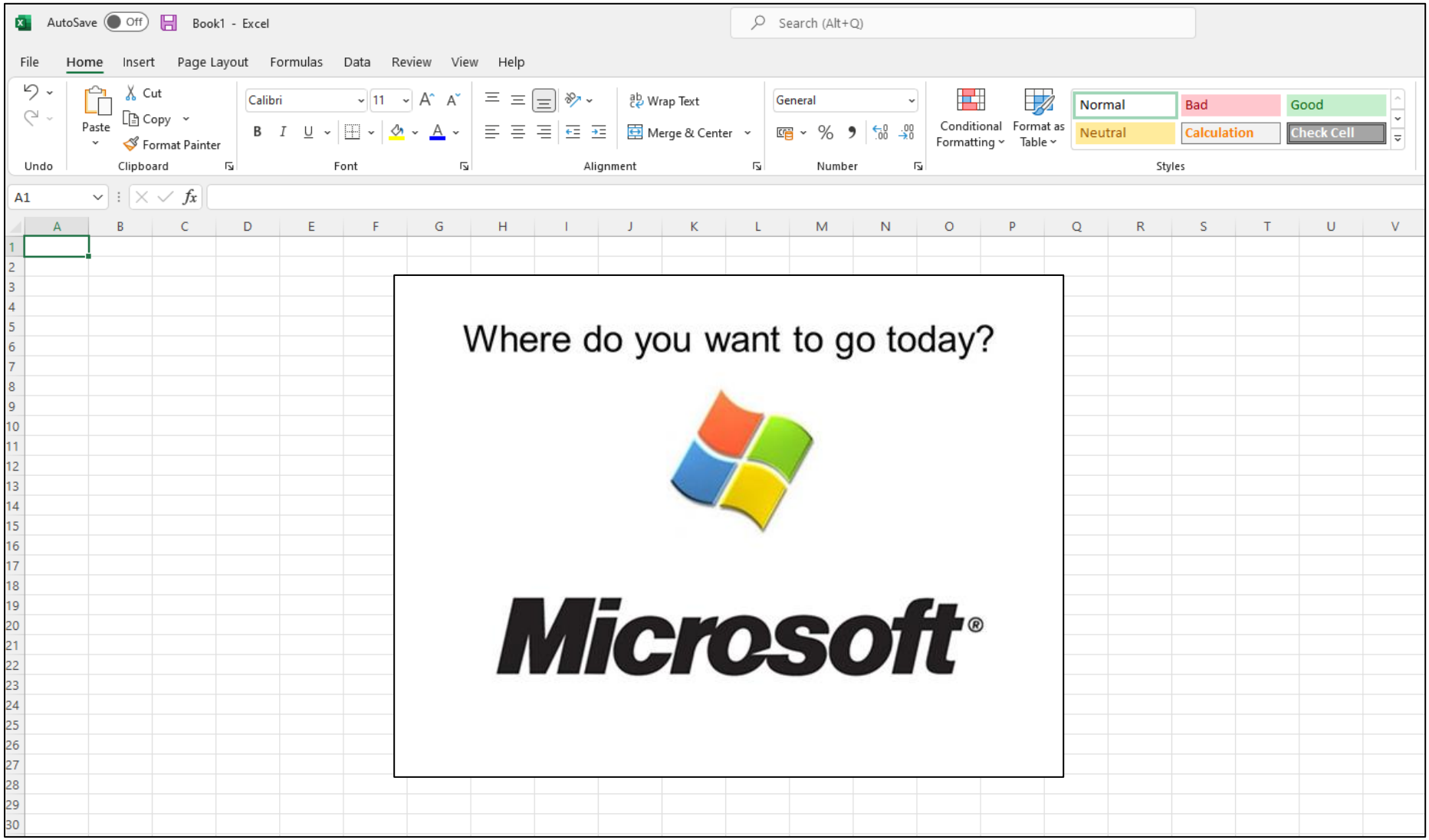




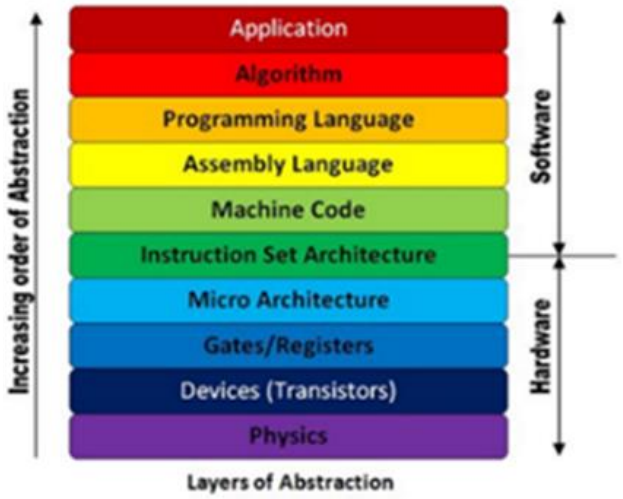
The Technology ‘Stack’

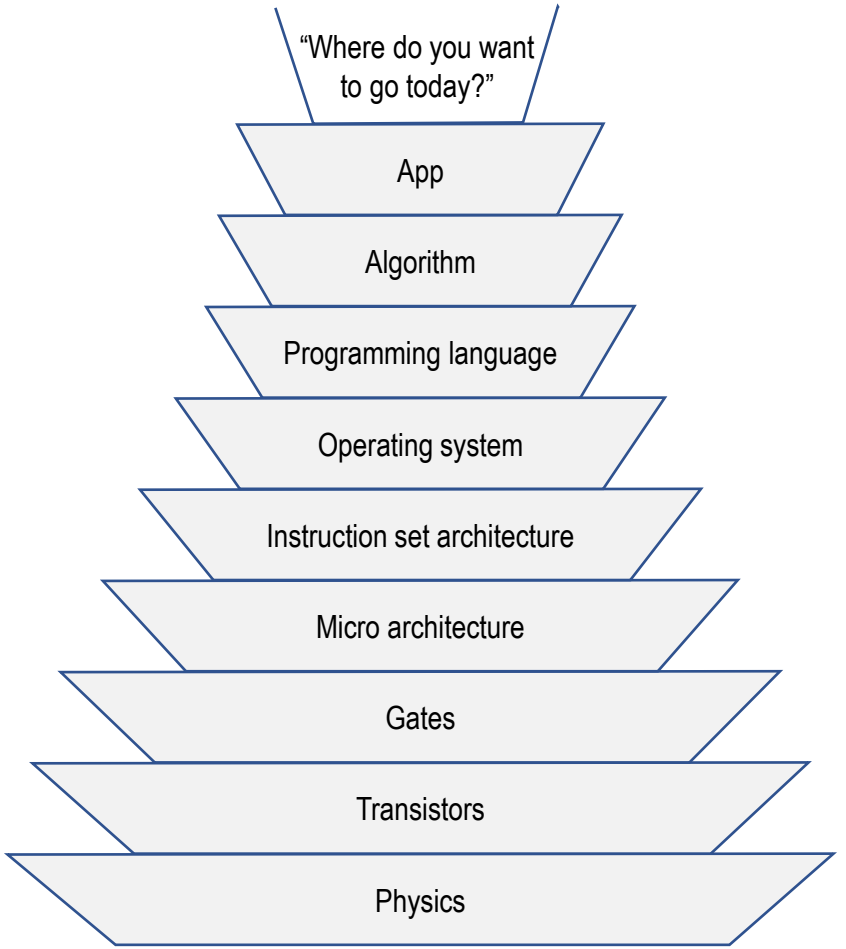


The User Experience of Emergent Systems? [Animated Slide]

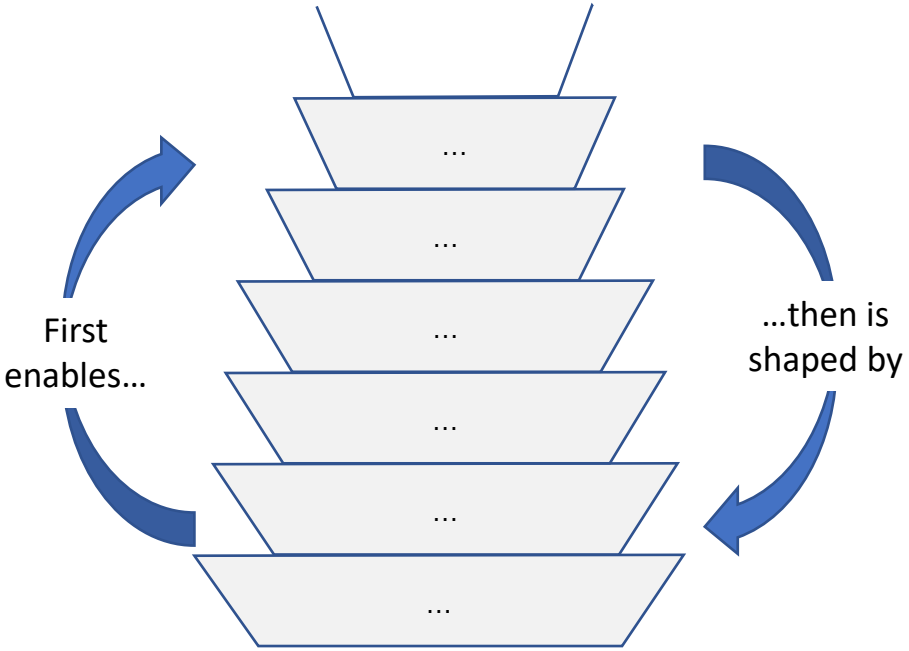


The Technology ‘Stack’ (or ‘Solution Stack’)





Some Structural Features of Emergent Nested Structures



Continual reflexivity between levels – upward and downward causation

Newer

Older

Faster-changing/ flexible

Slower-changing/ inflexible

More abstract/ ‘software’

More physical/ ‘hardware’

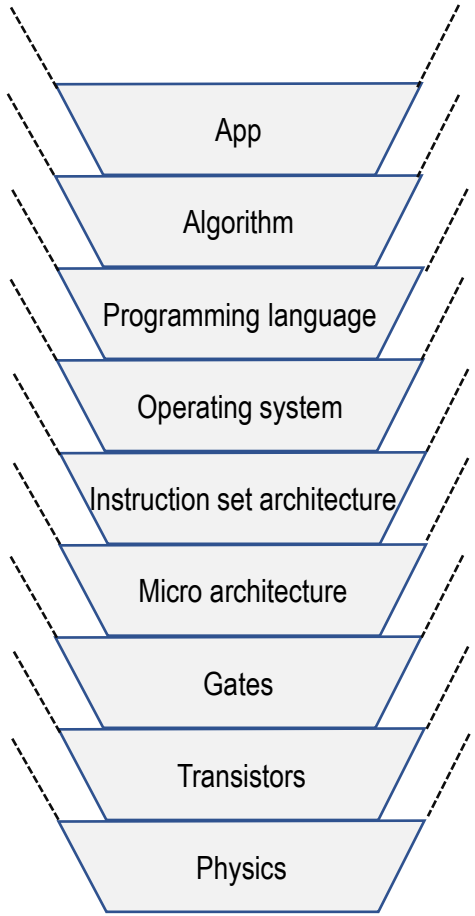
Higher levels…

… mask…

… lower levels

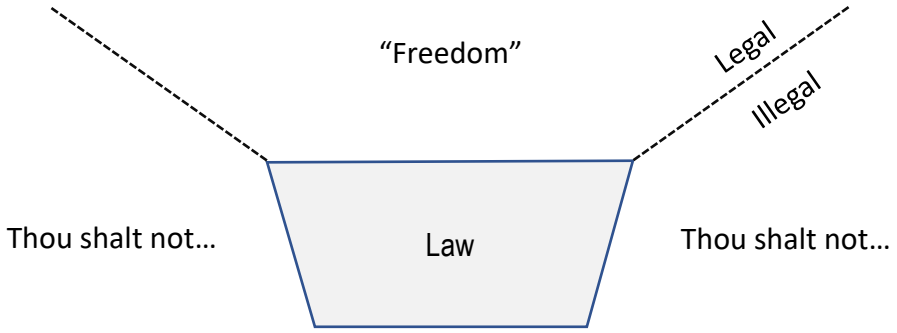
“Enabling Constraints”
or
“Constraints that Deconstrain”

Enabling Constraints or Constraints that Deconstrain



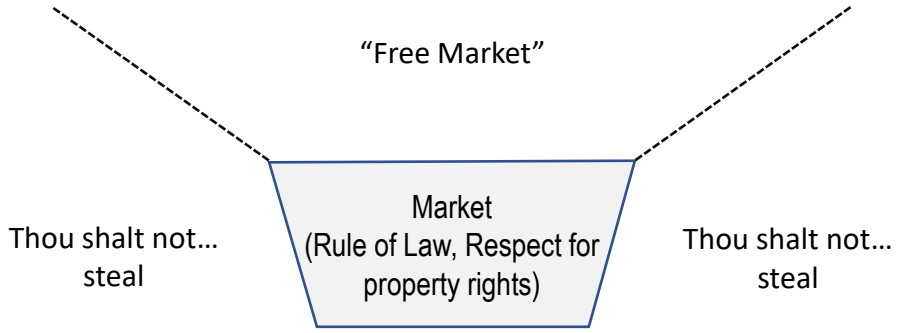
- A complex system is scaffolded by **enabling constraints** or **constraints that deconstrain.**
- Lower levels constrain or delimit the 'space' that higher levels can operate within.
- **Constraints are an indispensable feature of complex systems.** An emergent complex system gains its 'height' – i.e. its complexity – through layering of successive constraints. No constraints, no complex systems.
- A 'constraint' is a structure or dynamic that reduces the degrees of freedom of the system on which it acts.
- Jarring? Unwelcome?
  - 'Free' societies tend to be wary of notions of constraint and certainly the imposition of any new constraints.
- Counterintuitive?
  - Layers of constraint seem as though they might be progressively restrictive, but the constraining is offset by a complex system's innate and complementary propensity to explore within the constrained space.
  - Constraints are both limiting and generative.
- The payoff is economizing of energy and attention spent on managing 'lower level' activities to channel energy to further upward exploration and 'complexifying'.
  - E.g. the app developer does not have to reinvent the OS.

The Enabling Constraint of Law



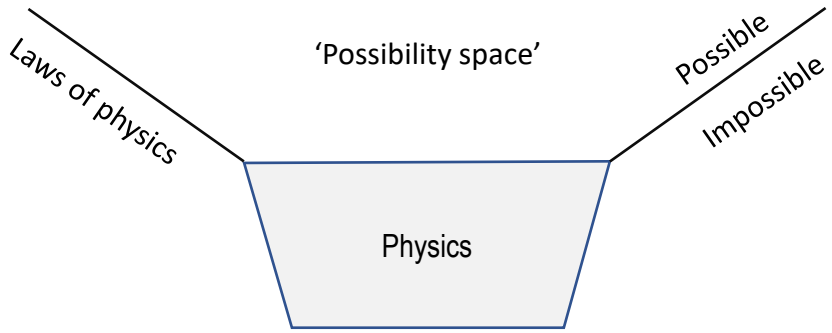
- E.g. at the level of human laws, we constrain activity by demarcating a legal sphere from an illegal sphere.
- Laws overwhelmingly take the form of "thou shalt not's", i.e. constraints.
  - Even when cast as positive rights, my rights are only meaningful if others constrain their behaviour to respect – i.e. 'see back' – my rights. My rights depend on your self-constraint.
  - It is an 'operating code'; indeed some law systems are known as codes, e.g. Napoleonic Code.
- The pay-off is an experience we describe as 'freedom'!
  - So long as you do not break the law – 'cross the line' – you are free to do what you want.
- Freedom is enabled/enhanced by constraint, if we can establish wise constraints.
- Civilization is the ongoing process of identifying and agreeing the constraints we deem it best to be collectively bound by.
  - A hallmark of civilization is the Rule of Law.
  - Constraining laws – properly calibrated – are a hallmark of prosocial cooperative behaviour.

Not ‘Free Markets’ But ‘Enabled by Constraint’ Markets



- “Free market” may be the most misleading term in political economy.
- Markets are entirely dependent on underlying rule of law and conferral of property rights – both a general notion of property rights and specific rules regarding what can be considered private property.
- We don’t have ‘free markets’, we have ‘enabled by constraint’ markets.
- Of course, access to and participation in ‘enabled by constraint’ markets is experienced as generally liberating and empowering.

Constraints all the way down! Physics



- It is constraints all the way down!
- Bedrock constraints are the laws of physics which separate what is physically possible from what is physically impossible.
- All complex systems emerge within the confines of this 'possibility space'.

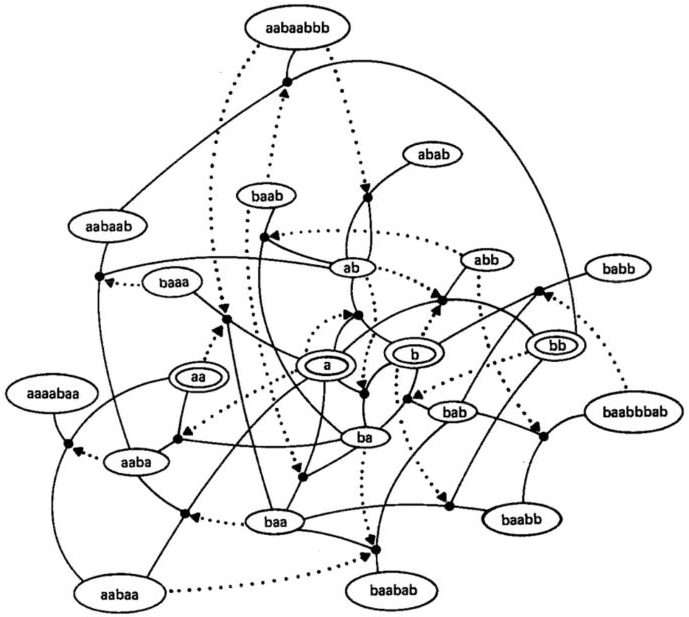
Constraints all the way down! Life

Biological organisation as closure of constraints

Journal of Theoretical Biology


M Montévil & M Mossio. en Article Peer-reviewed May 2015 (7th March 2022)

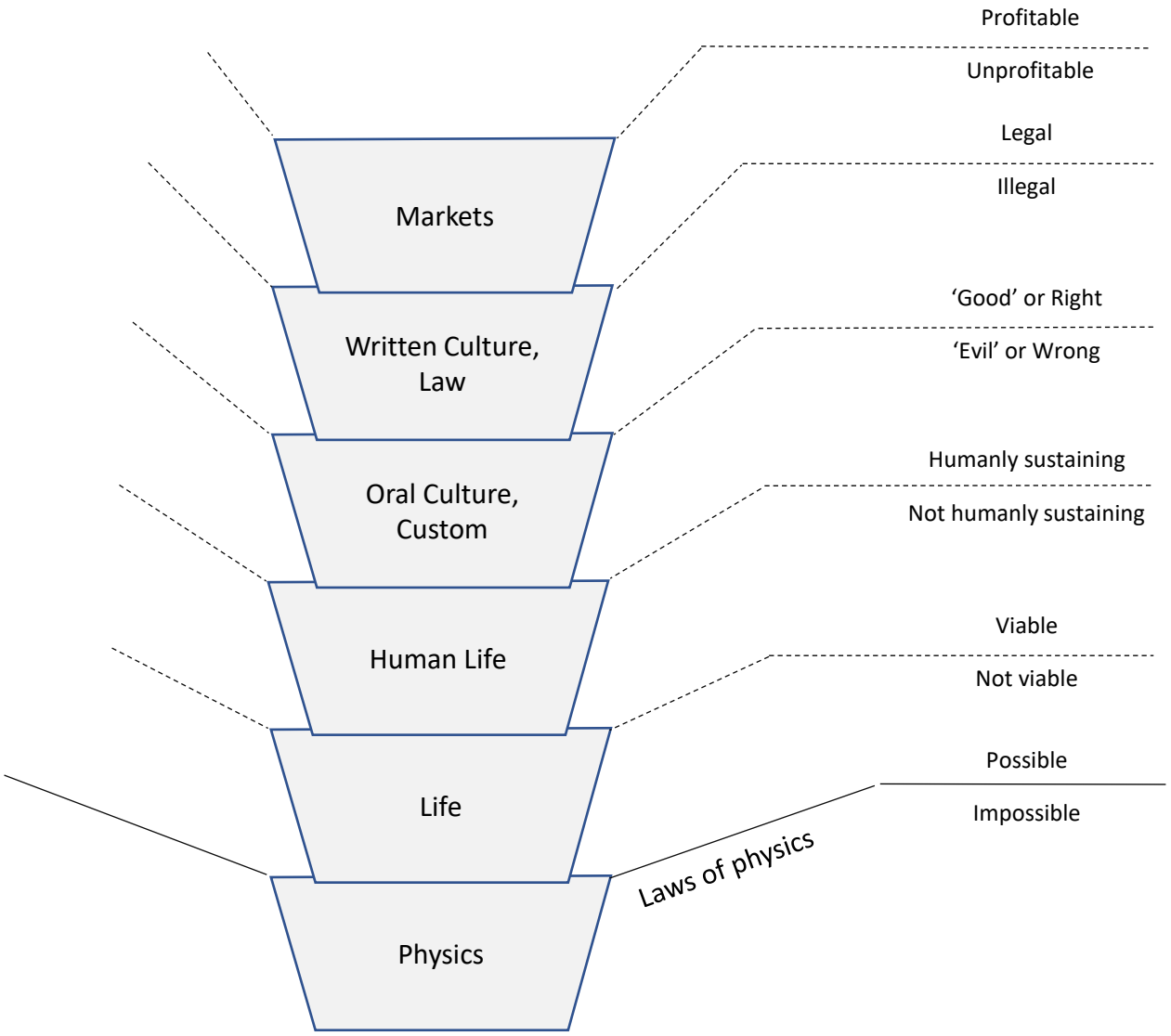
closure, constraints, organization, symmetries, time scales 232 mentions



Self-contained, autocatalytic molecular structure

- An aside – and beyond my pay grade – recent biological developments suggests Life started when molecules first achieved ‘constraint closure’. (Montevil & Mossio, 2015; Kaufmann, 2019)
- This first step in ‘self-organization’ enables determination and maintenance of the new organism’s existence.
- **What have constraints ever done for us? Literally everything.**
- Yet modern discourse has developed a default underappreciation of ‘constraints’.

Layers of Constraints, Differently Expressed

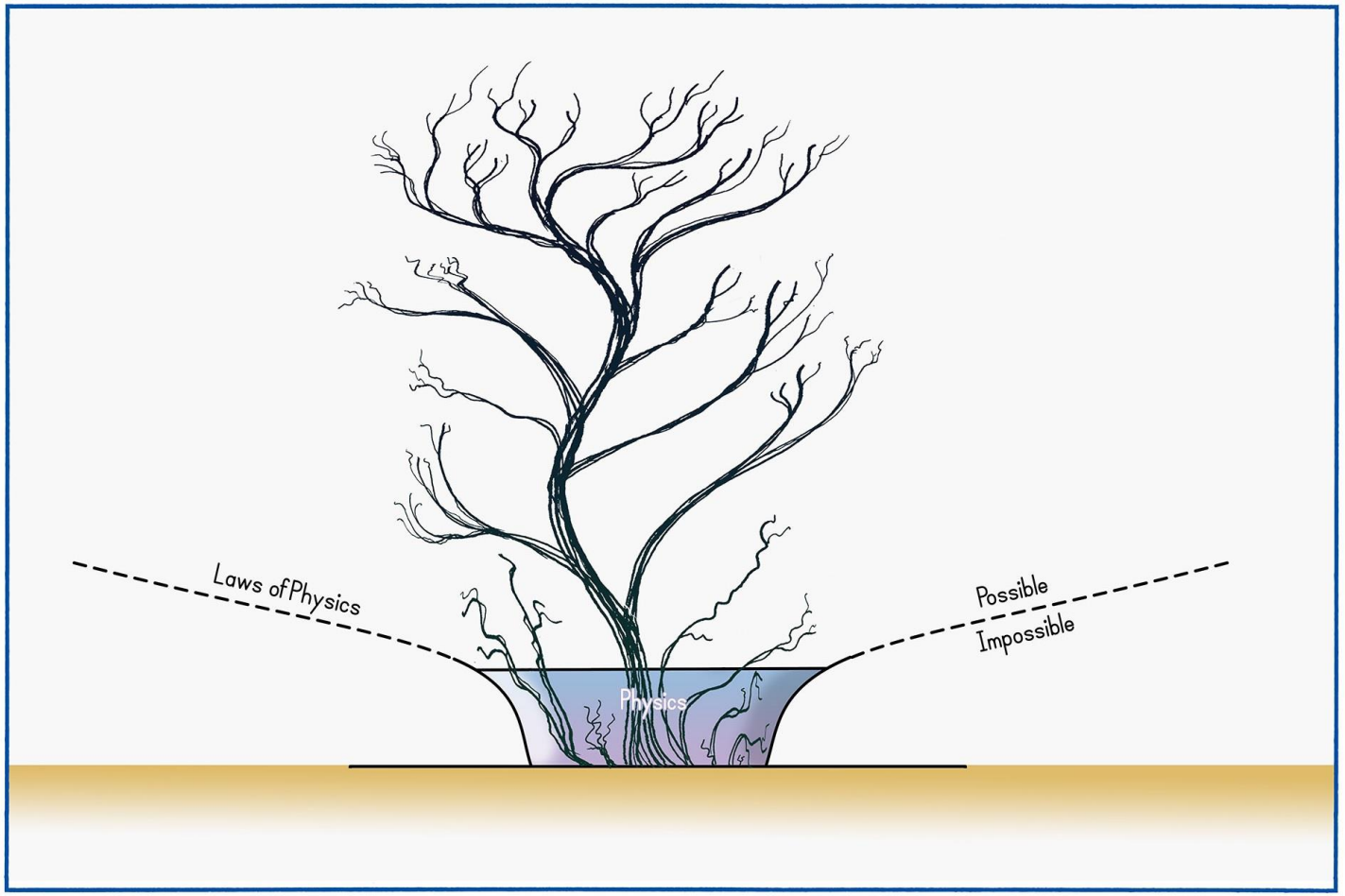


- Each emergent layer brings a new articulation of good and bad.
- Our formation of constraints is merely the humanly conscious continuation of a process that began in the natural world.
- Aldo Leopold, the ecologist saw constraints as 'ethics':
  - *"An ethic, ecologically, is a limitation on freedom of action in the struggle for existence. An ethic, philosophically, is a differentiation of social from anti-social conduct. These are two definitions of one thing. That thing has its origin in the tendency of interdependent individuals or groups to evolve modes of cooperation. The ecologist calls these symbioses."* ***Aldo Leopold.***
- **Sustainable life relies on the ongoing collective identification and establishment of the constraints – or 'ethics' – needed to sustain it.**

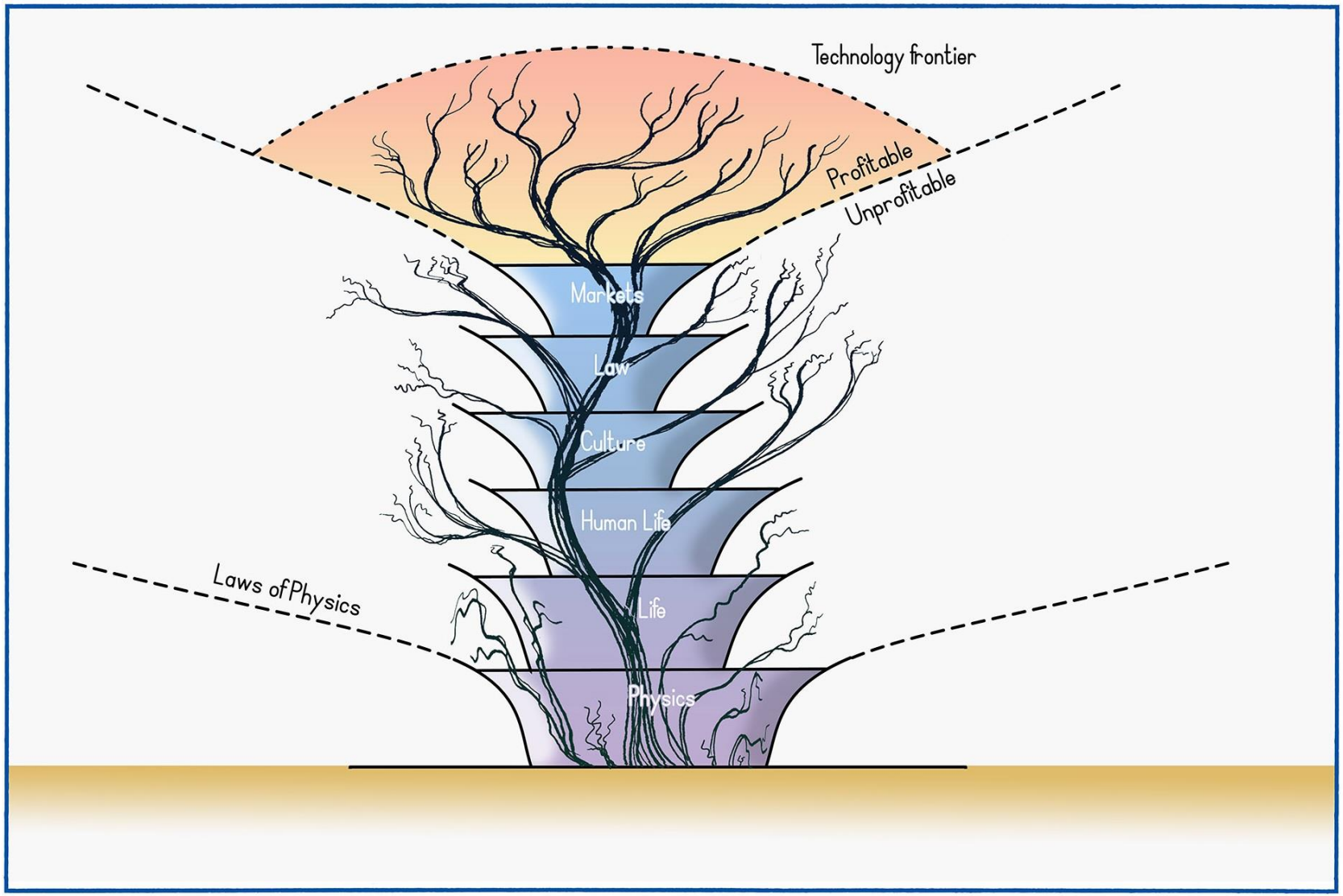
Path Dependency

Complex Systems Are Path-Dependent Explorations of Possibility Space

"Something in living biospheres surges 'upward' in diversity and complexity." **Stuart Kauffman**



Path-dependent Emergence of Human Complexity



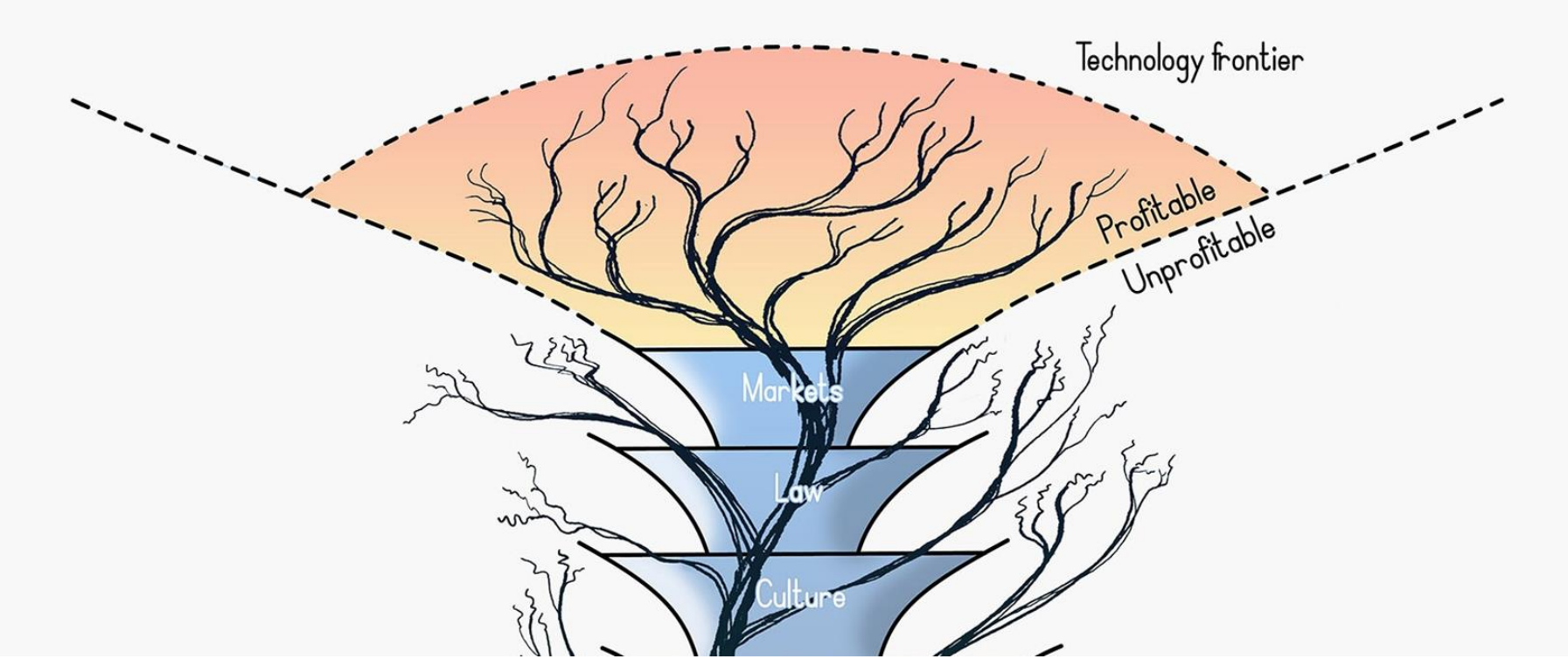
“Top Layer Bias”
or
“Foundation Amnesia”

Market values now guide human emergence

"We live in capitalism" **Ursula K. LeGuin**

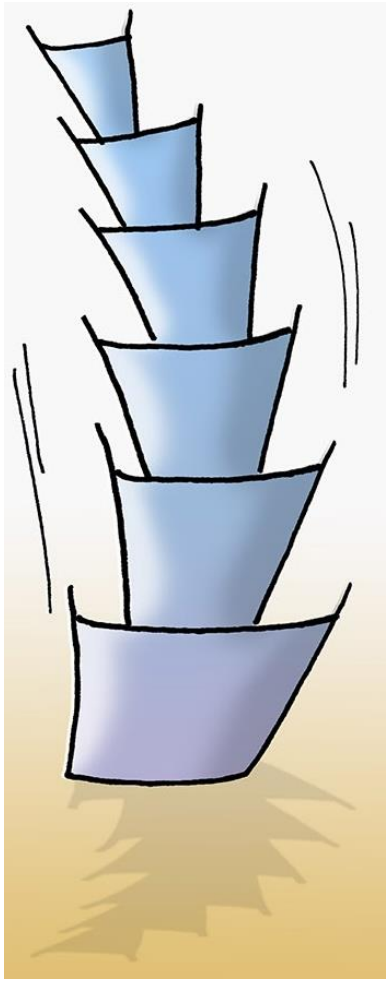
"Business is all about solving people's problems - at a profit." **Paul Marsden**

"Market-tested betterment" **Deirdre McCloskey**



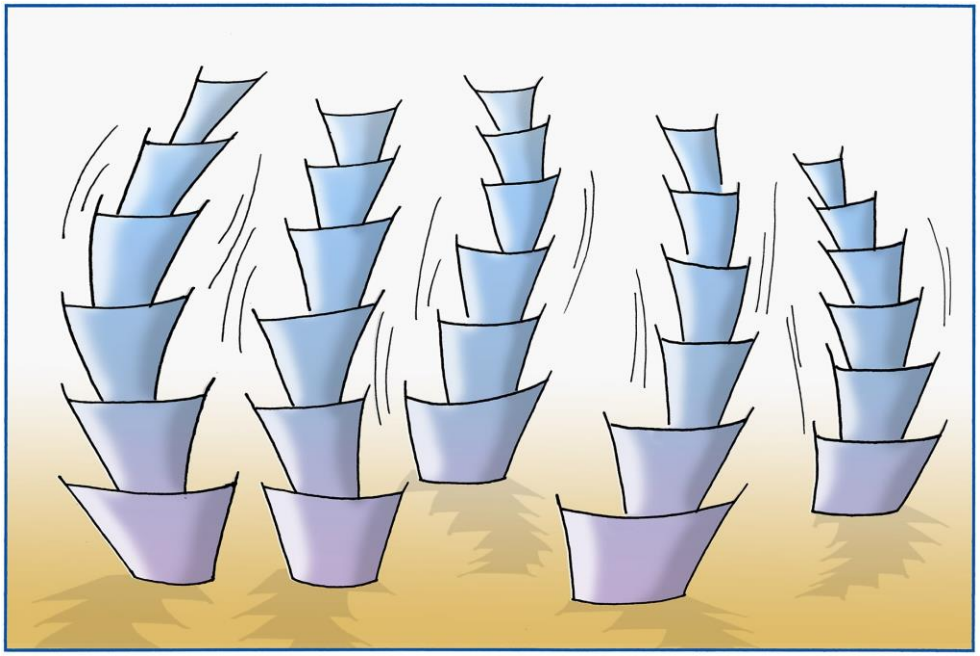
How do Emergent Complex Systems *Sustain* Themselves?

Sustainability is Not Falling Over



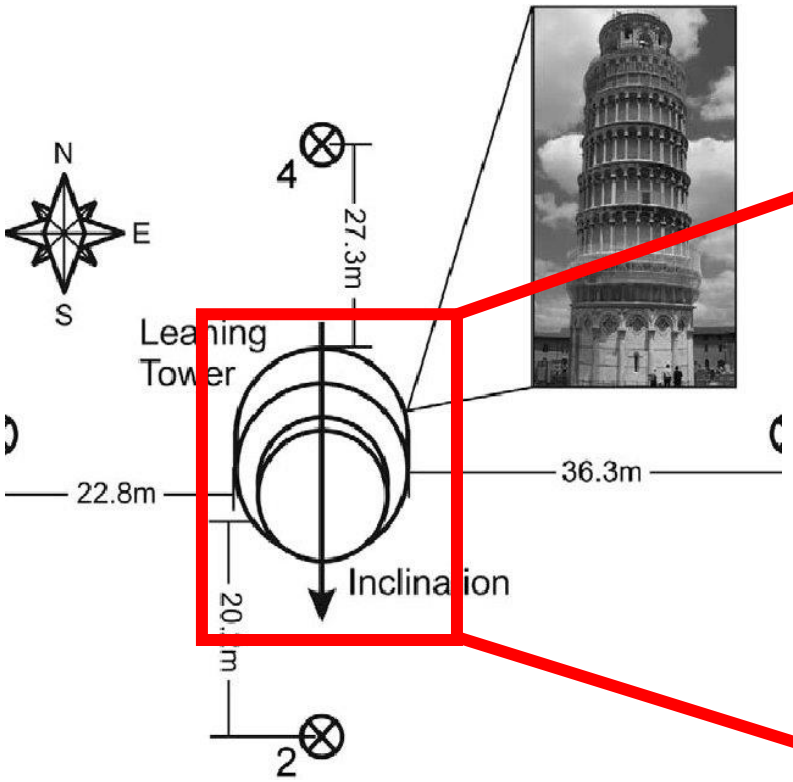
- Q: How do Emergent Nested Complex Systems sustain themselves?
- **A: They don't fall over!**
- Easier said than done…

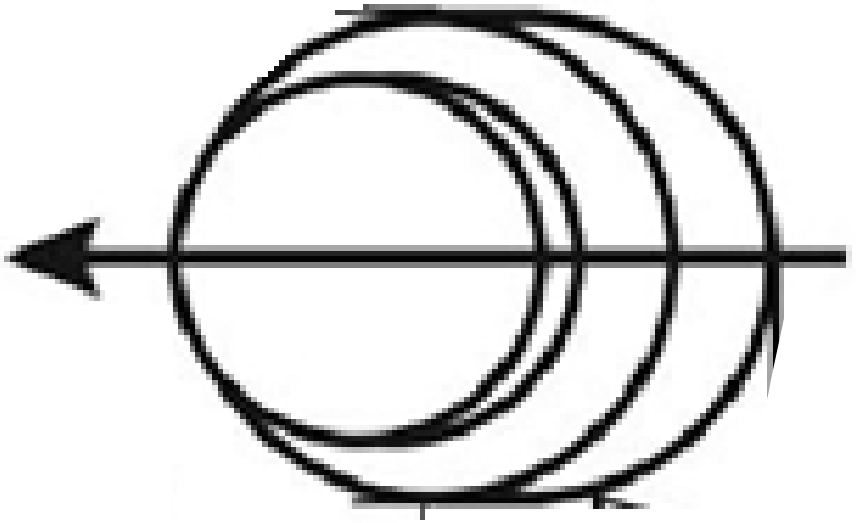
Emergent Systems are in Constant Flux



- They are dynamic systems – ‘vortexes’? – continually disturbed by both internal dynamics and external changes of context.
- **Emergent systems are constantly being tipped out of vertical alignment and trying to rebalance.**
- Almost as if it would be helpful for us to imagine this if there was a world famous tower that was leaning…

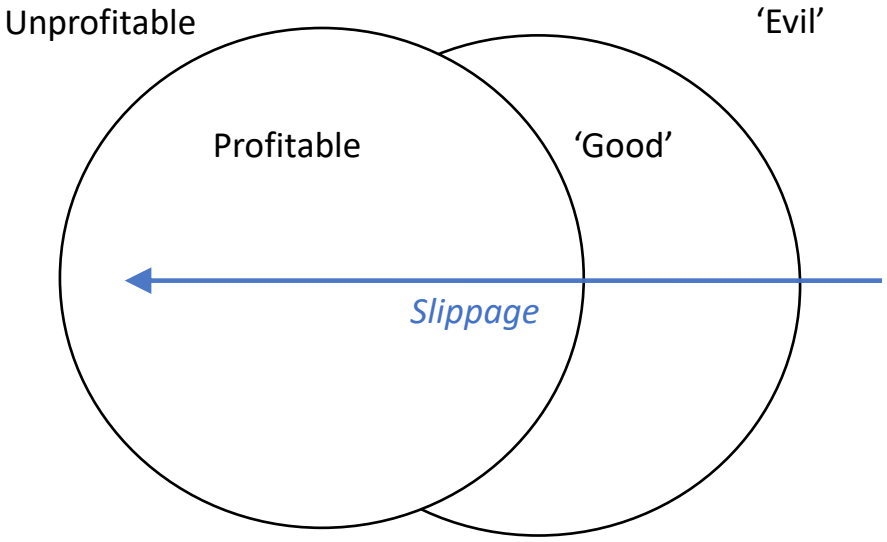
Leaning Tower of Pisa Revisited

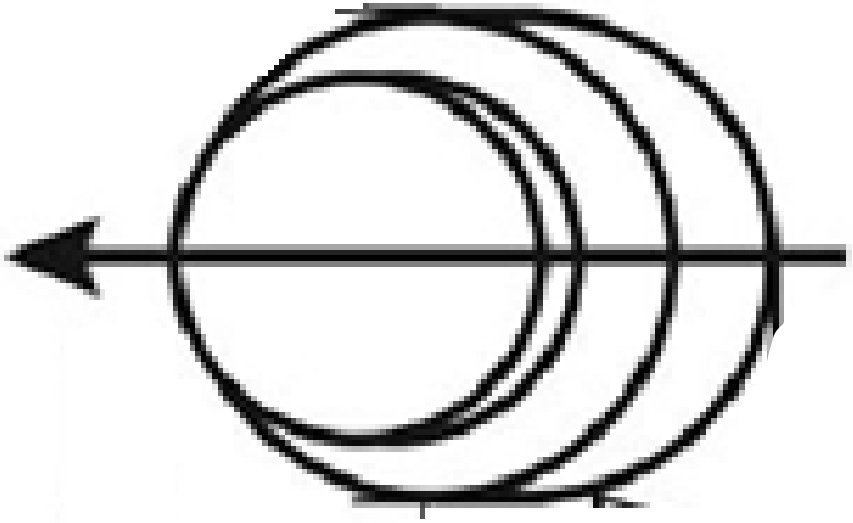


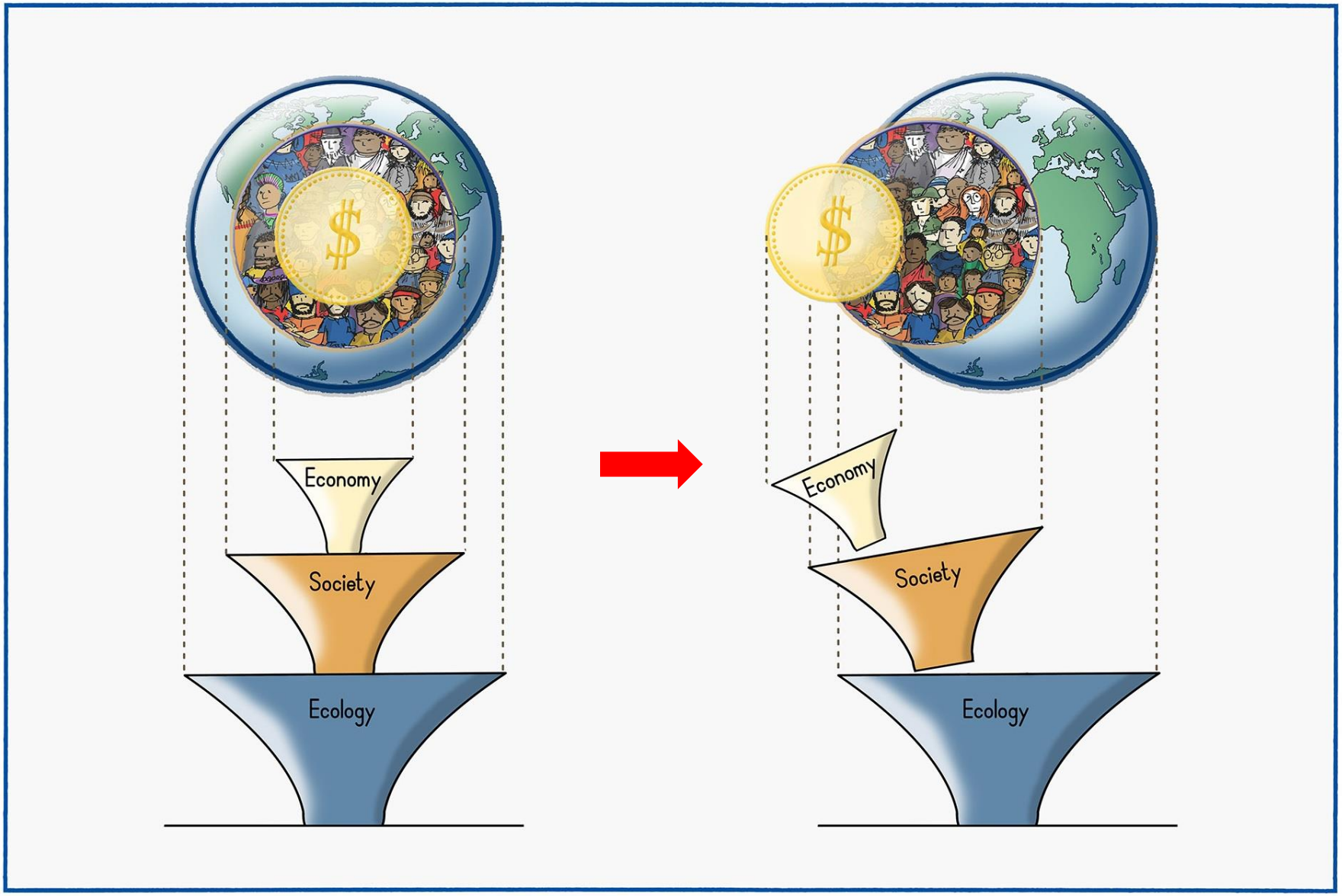


Atzeni, et al, 2010

Layers Continually Falling Out of Alignment

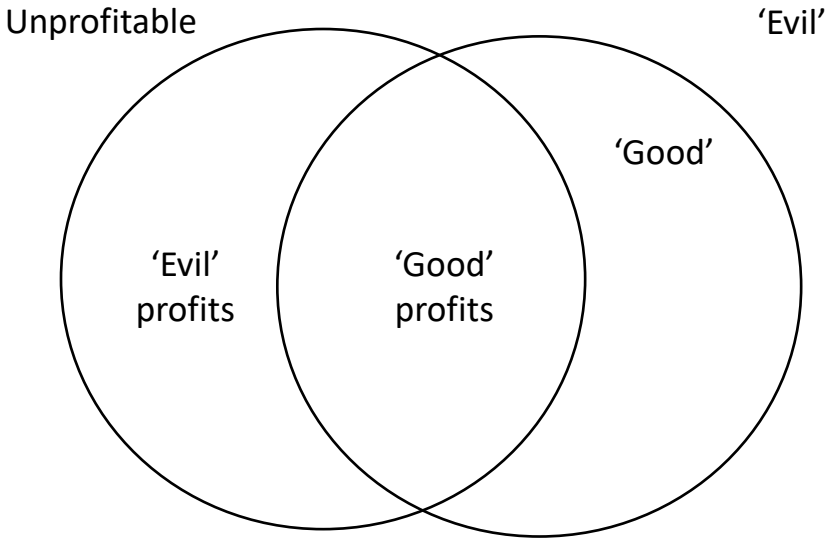






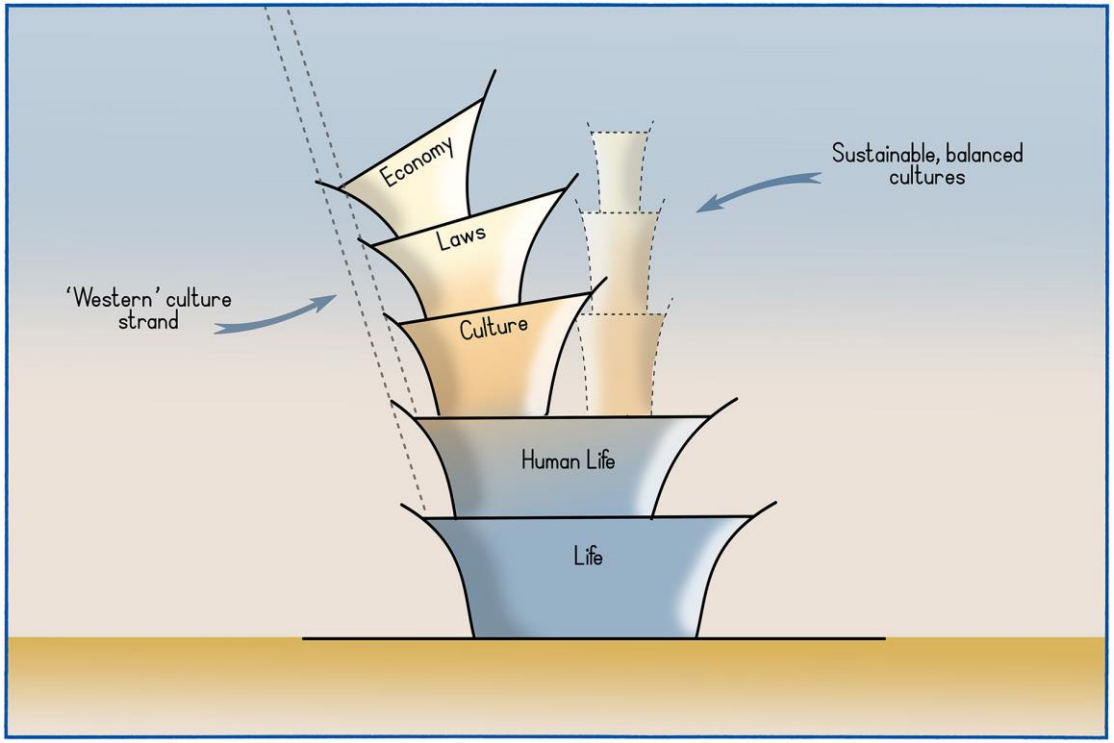
bothbrainsrequired.com

‘Good’ profits and ‘Evil’ profits



- The word ‘profiteering’ conveys our understanding that profits and morality are sometimes in tension.
- **“Profiteering”**
  - …the act of taking advantage of a situation in order to make a profit;
  - …the practice of making or seeking to make an *unfair* profit.
- When an emergent nested complex system – or ‘tower’ – falls out of vertical, we effectively get a ‘clash of goods’ or system dissonance.
  - Different articulations of good/bad established at different times/contexts fall out of alignment.
  - **‘Higher’ levels temporarily transgress constraints formerly established at lower levels.**

Leaning Tower of Values



- The globally dominant 'Western' emergent strand of human behaviour is:
  - individual freedom-enabling,
  - foundation-forgetting,
  - market-guided ascending,
- … that now risks tipping through the constraints that enable sustainable human life and other forms of life.
- As the tower leans, so there is a 'clash of goods' in which different vintages of good/bad fall out of alignment, creating widespread sense of dissonance. ('Green growth'…?)
- 'Western' development is just one emergent path available to humankind.
  - Other cultures and traditions – both extant and extinct – have prioritized **balance** over **complexifying** – from Taoism to indigenous ways of life, etc.
  - Their ways of life tend to be less complex than ours, but we, today, can learn much from them about balance.
  - ('Ethno-mimicry' as a cultural version of fashionable 'bio-mimicry'?)

Systems Try to Rebalance

- A system that senses it is falling hazardously out of balance and through important constraints will seek to rebalance.
- Indeed, an emergent system is constantly seeking to rebalance against internal and external disturbances.
- Rebalancing is the process of ‘adapting’ or ‘aligning’ to the latest perceived sense of reality.

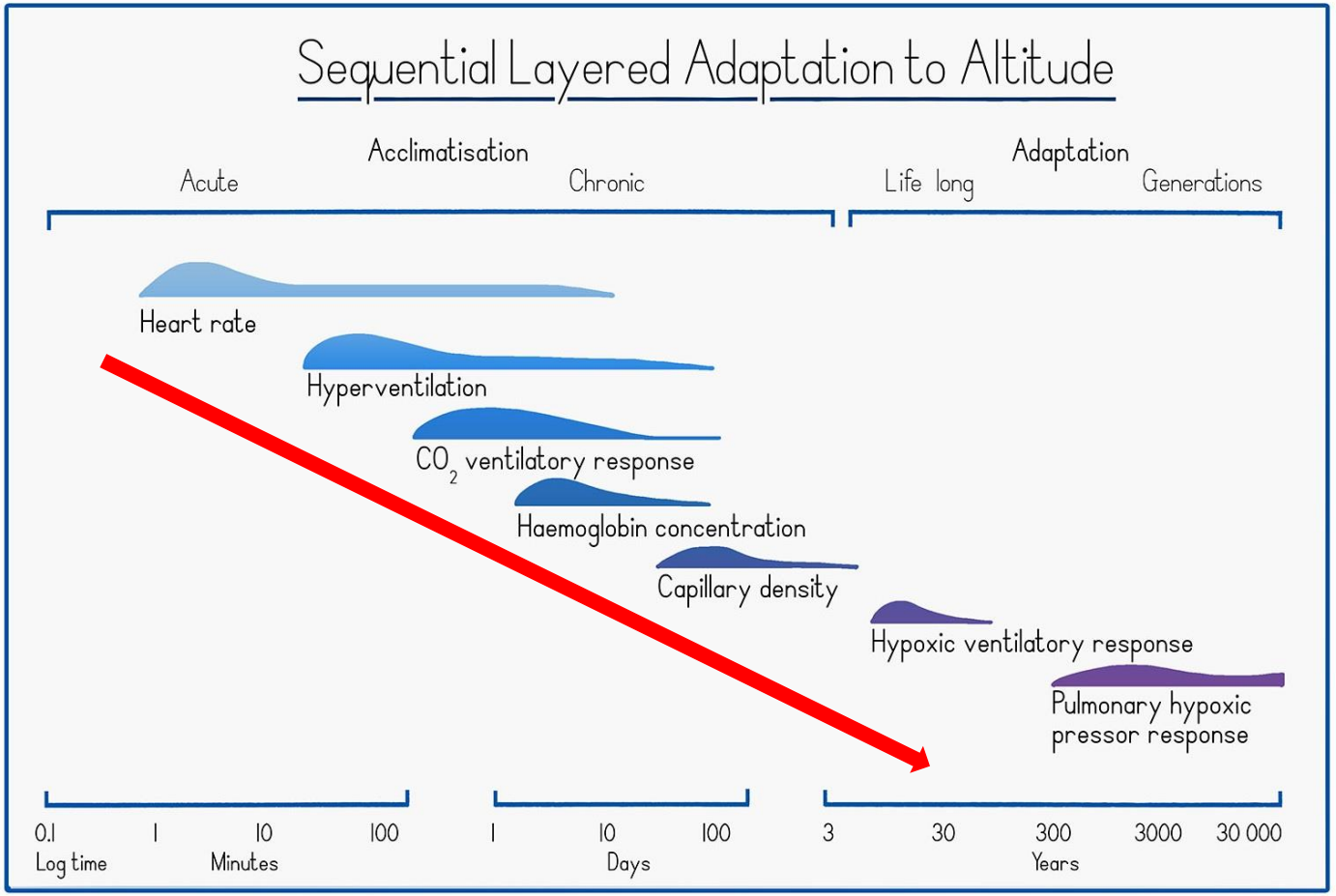
How do Complex Adaptive Systems Adapt?

Layered Adaptation: ‘Defence in Depth’ in Adapting to High Altitude

For example, as humans – complex systems, themselves – migrate to altitude, a cascade of progressively deeper adaptations occurs, as required.

Flexibility

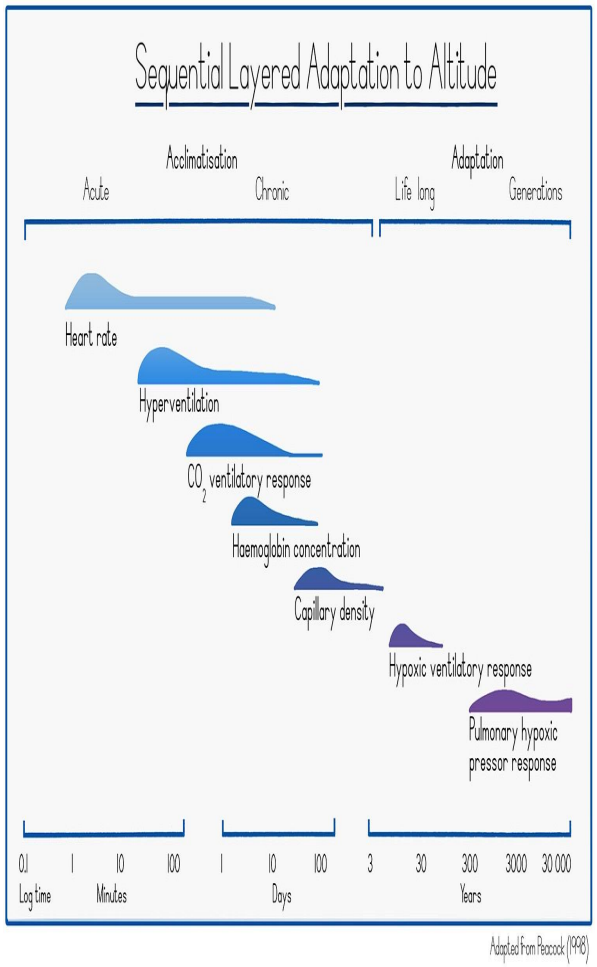
Rigidity

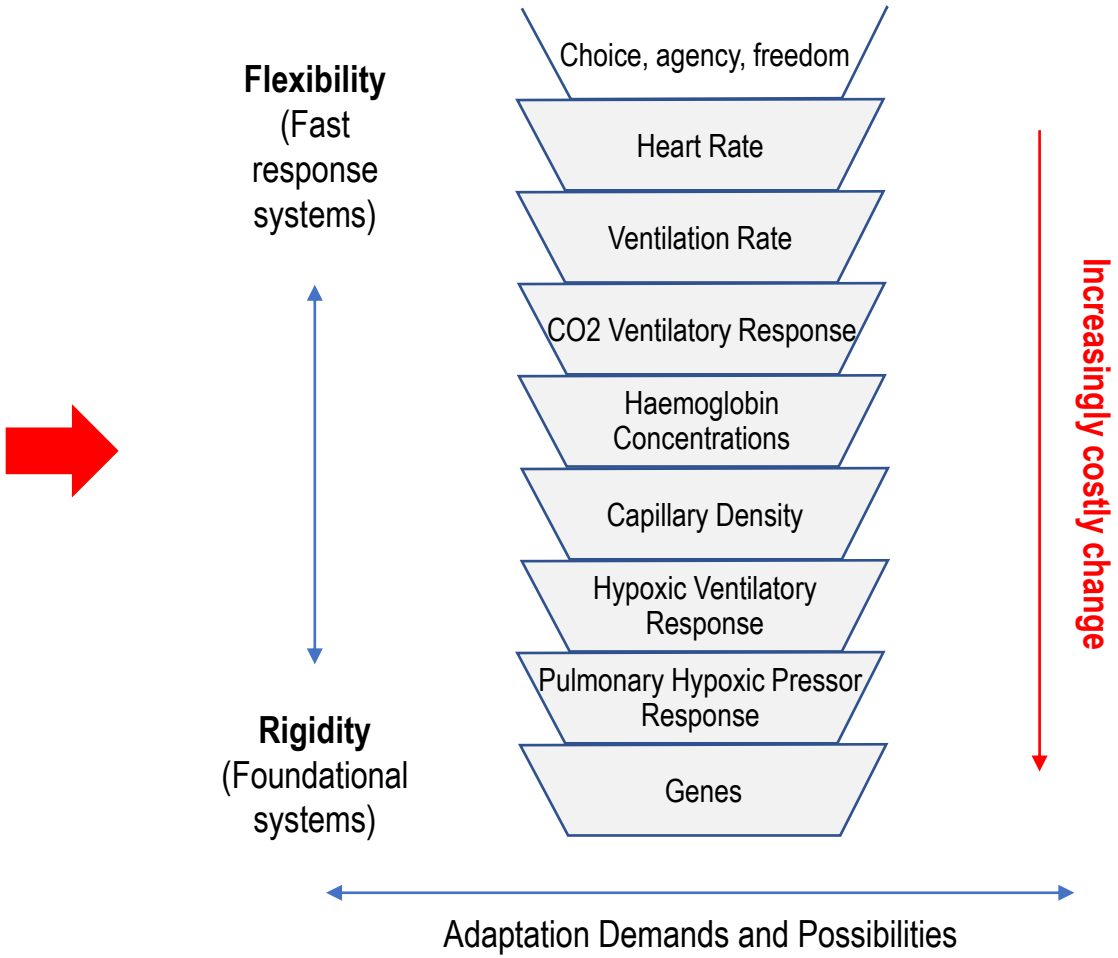


Fast

Slow

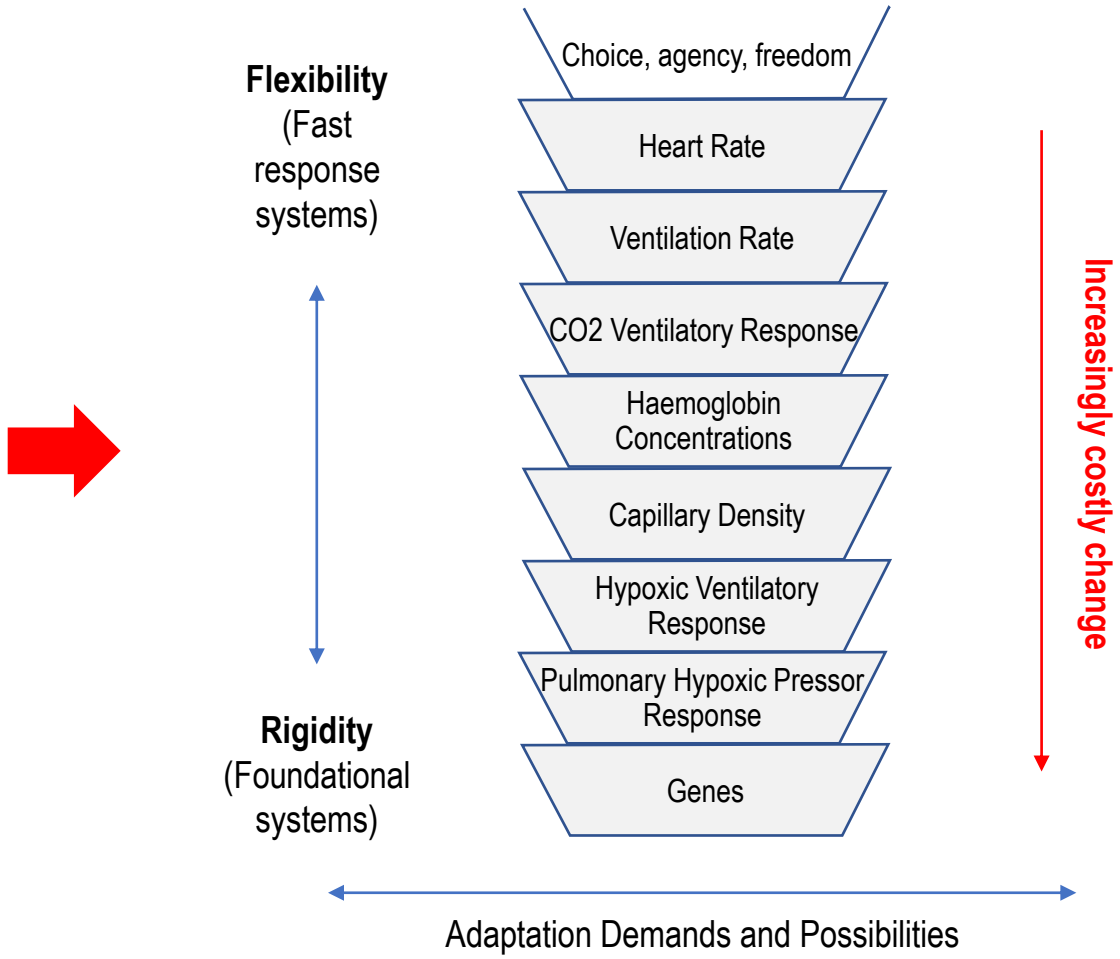
Layered Adaptation Arises from Nested Procedures



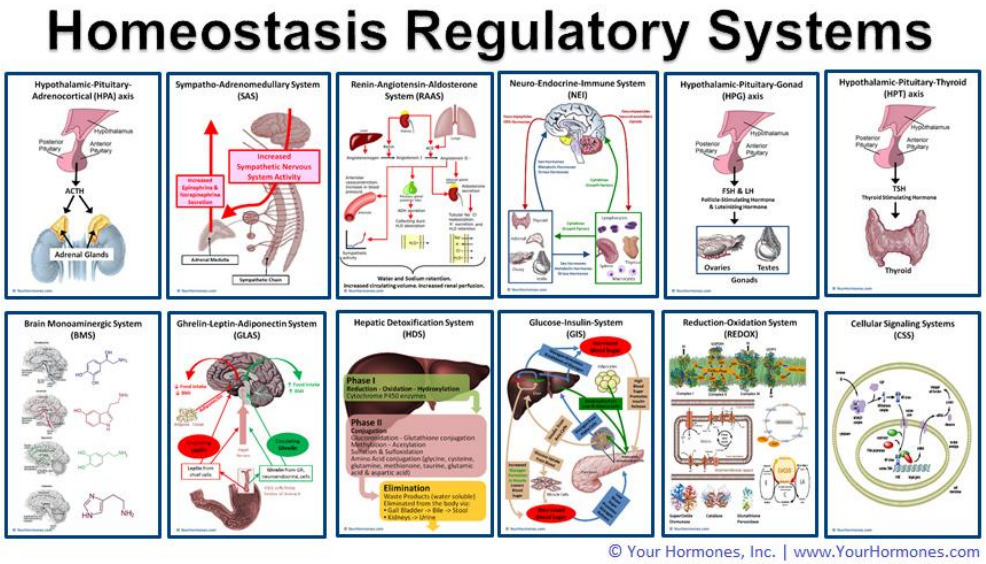


Layered Adaptation Arises from Nested Procedures

- Layers are an elegant solution to the innate challenge of living systems: to have **flexibility** to meet new contexts and **rigidity** to uphold and perpetuate beneficial existing behaviours.
- Because the future world is always uncertain, layers permit a calibrated, real-time adaptive response.
  - 'Defence in depth' (Bateson)
- Successful adaptation is responding at sufficient depth ***before it is too late***.
- 'Deeper' adaptation to a new context ***must be costly*** as this is the price that must be paid for the system to have previously established beneficial rigidity to fit the original, now 'old', context.



Self-Regulation and Homeostasis



Several examples of myriad regulatory processes at work in the human body

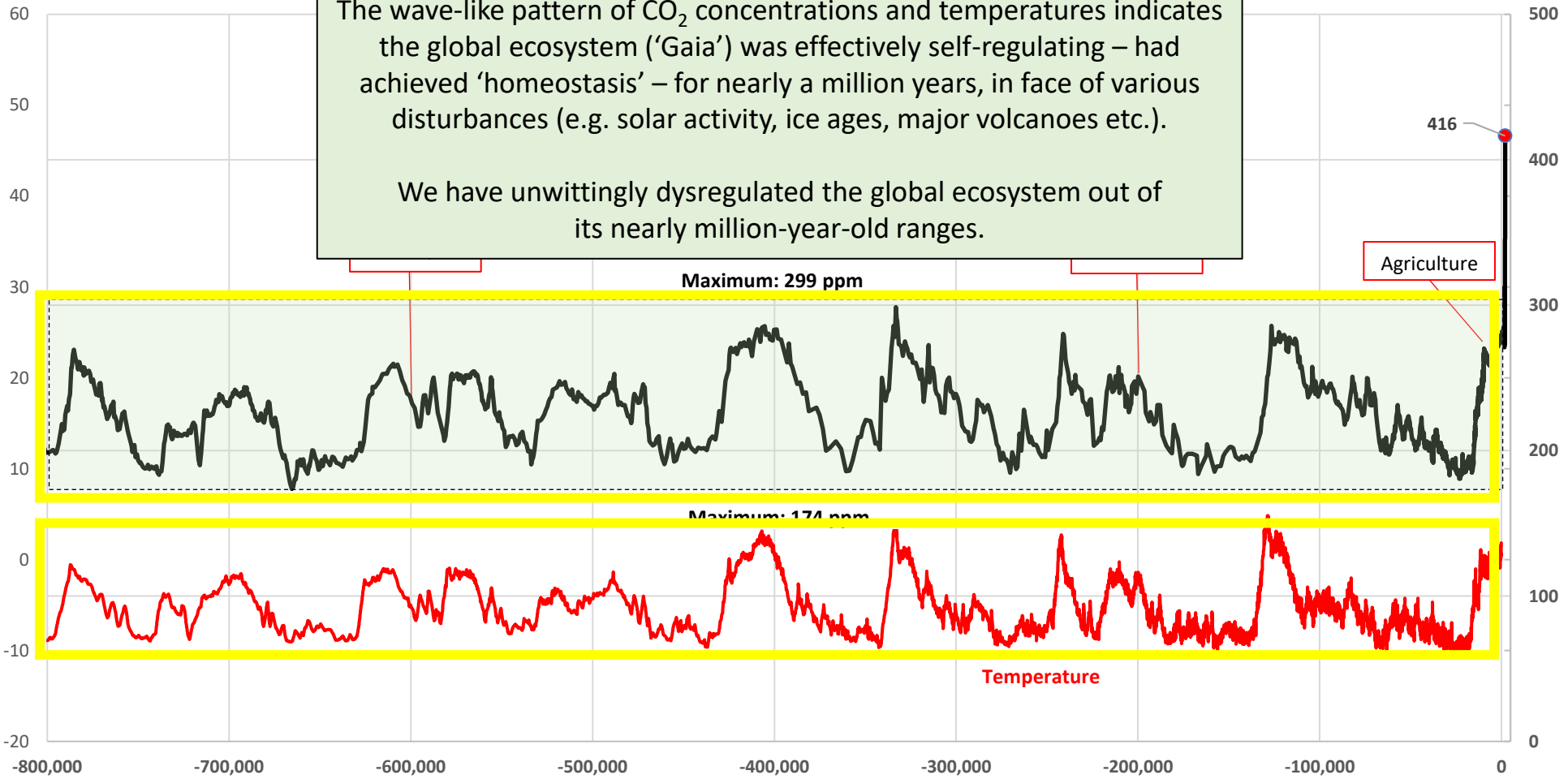
- The ability to adapt to ever-changing external contexts is the ability to '**self-regulate**' or achieve '**homeostasis**'.
- Biologists, physicians, psychiatrists view '**regulation**' as a favorable, indispensable characteristic of a system.
  - E.g., An essential aspect of emotional development is learning to 'self-regulate'.
  - E.g., Myriad processes in our bodies 'regulate' blood pressure, heart rate, body temperature, blood glucose levels etc. to within normal ranges.
- In contrast, economists and modern-day business have developed a pejorative view of regulation as 'interventionist' meddling with 'free markets', etc. **because they believed 'free markets' could self-regulate in the face of all eventualities…**

Atmospheric CO_2 Concentrations and Temperature

[Previously shown diagram, Session 1]

The wave-like pattern of CO_2 concentrations and temperatures indicates the global ecosystem ('Gaia') was effectively self-regulating – had achieved 'homeostasis' – for nearly a million years, in face of various disturbances (e.g. solar activity, ice ages, major volcanoes etc.).

We have unwittingly dysregulated the global ecosystem out of its nearly million-year-old ranges.

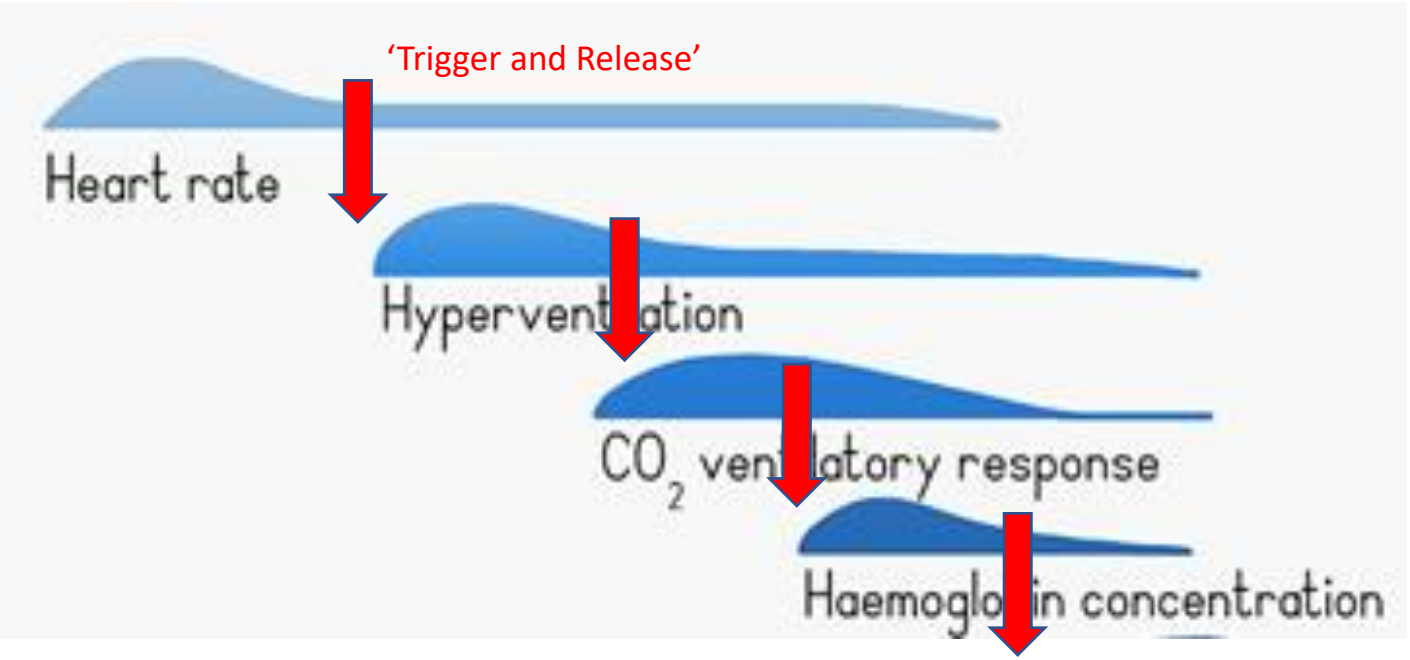


EPICA DOME C Data, Jouzel et al, 2009 (NOAA/WDS)

Voluntary Market-Led Efforts as merely First Response of Emergent Complex System

‘Trigger and Release’ or Passing the ‘Baton of Adaptation’ Down

‘Baton of Adaptation’ is passed down to lower levels, if system identifies greater change is needed.



VML has been a ‘Defence at First Depth’ Only

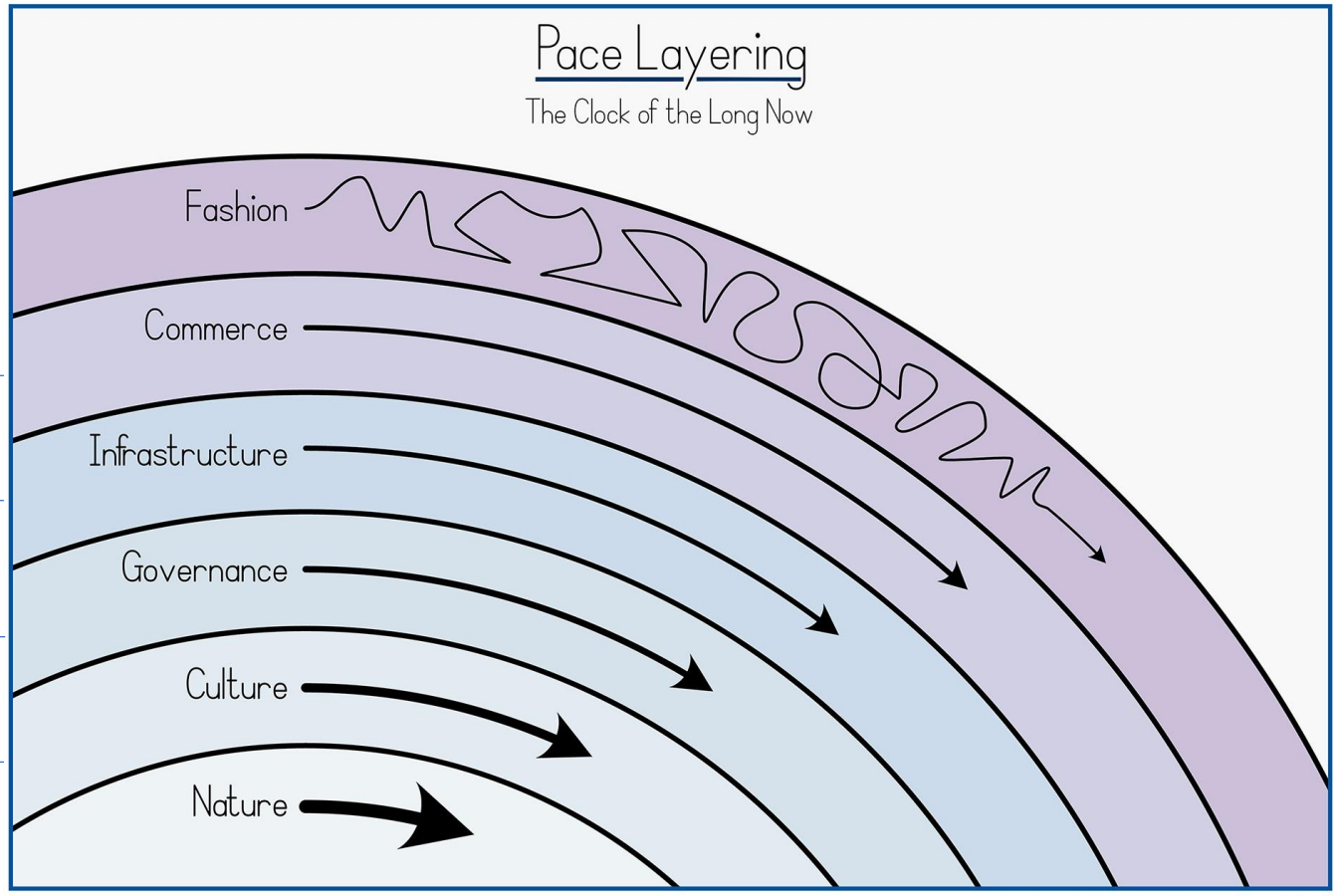
“Fast gets all our attention, but slow has all the power.” ***Stewart Brand***

VML Strategies

‘Build Back Better’

Regulations and policies

An ecological culture

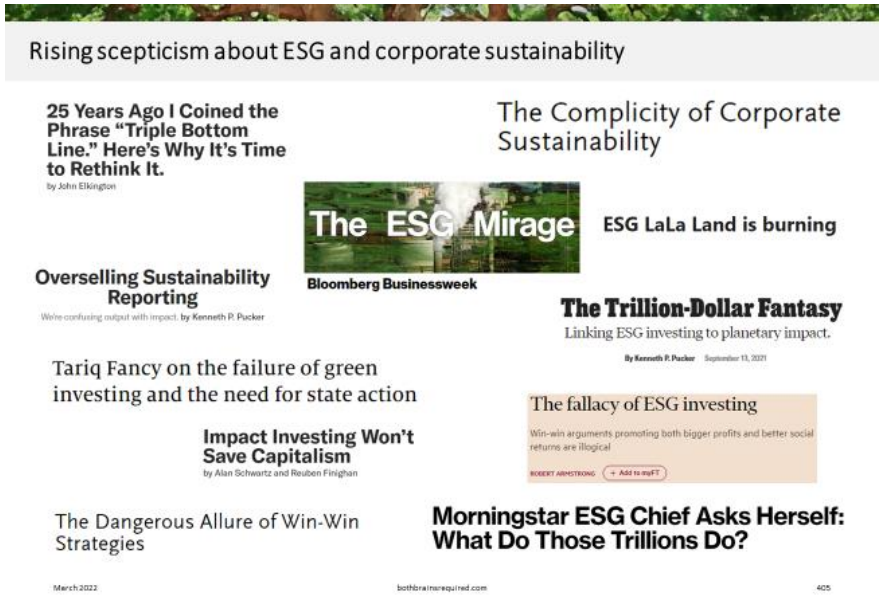


Trapped in an Unsustainable Narrative

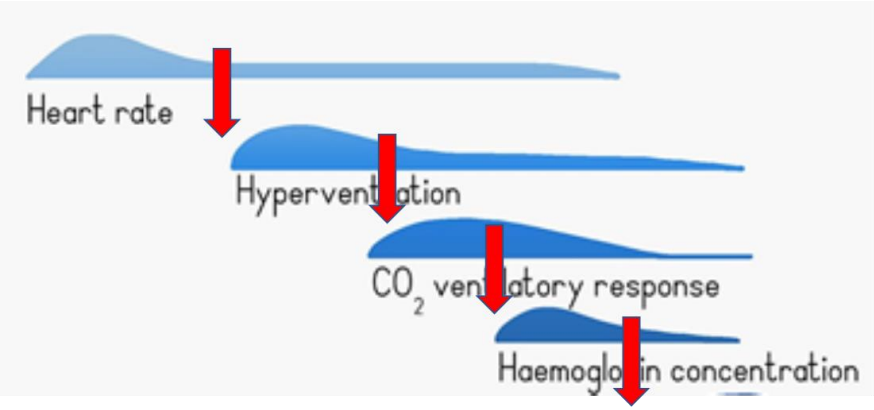
"We cannot regulate our interaction with any aspect of reality that our model of reality does not include."
Stafford Beer, early cyberneticist

- Our present unsustainability is perpetuated by the elevation and now overshoot of partial, economic thinking that excludes – 'externalizes' – critical aspects of our social and ecological reality.
- We have elevated incomplete, non-self-regulating markets to primacy of socio-economic coordination, effectively over-riding deeper adaptation possibilities.
- **We are acting as if 'complete' markets can self-regulate the whole human system from on high, but markets are highly incomplete and non-self-regulating.**
- The tragedy of 20th century economics is that it systematically rejected evidence of markets' incomplete grasp of reality to persuade us of the sufficiency – indeed, superiority - of market solutions over non-market solutions.
- In effect, economics has been the 'disembedded science' that has disembedded us with it.

Critique of VML as 'Trigger and Release' Moment?



'Trigger and Release'

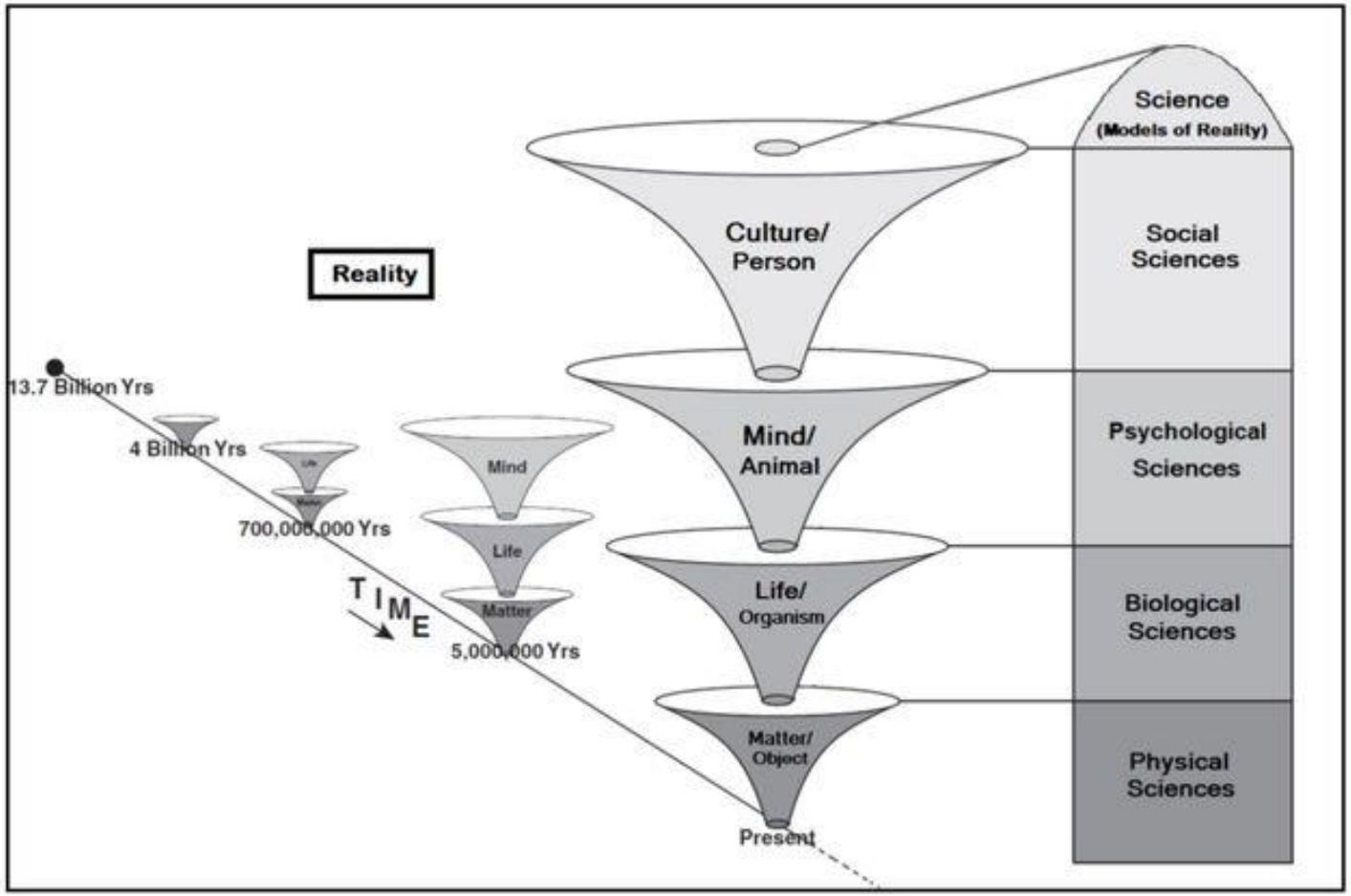


The rising critique of ESG and related VML strategies (Session 1) is recognition of the limited capacity to adapt through market-level changes only. "'Win-win' cannot scale."

<u>This may be exactly the 'trigger and release' signal the human socio-economic system needs to stimulate deeper – if necessarily costlier – adaptation.</u>

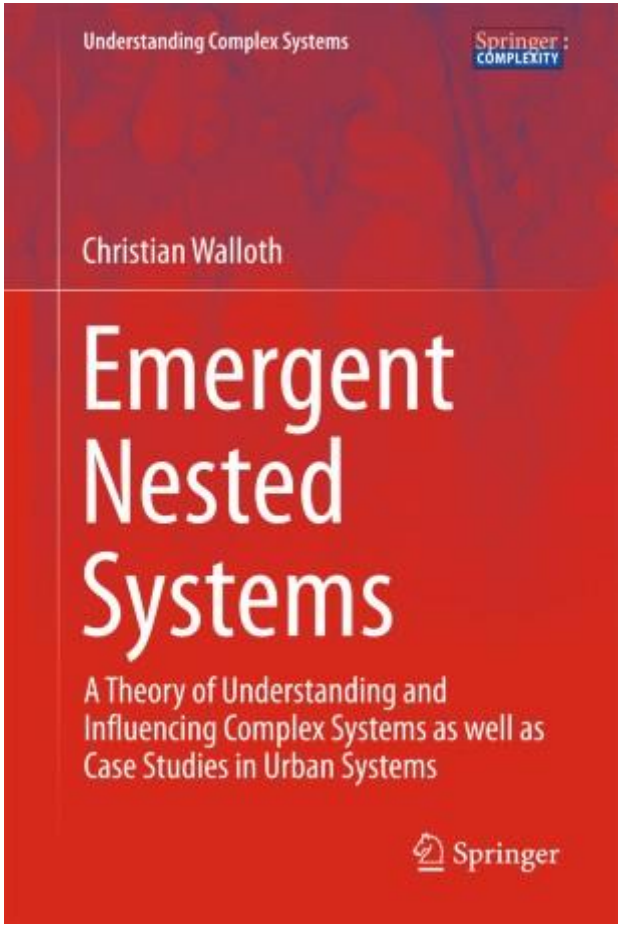
APPENDIX: Inspirations and Systems Reflections

Key Inspiration – Gregg Henriques' TOK System



Henriques, 2011

Key Inspiration – Christian Walloth's Emergent Nested Systems

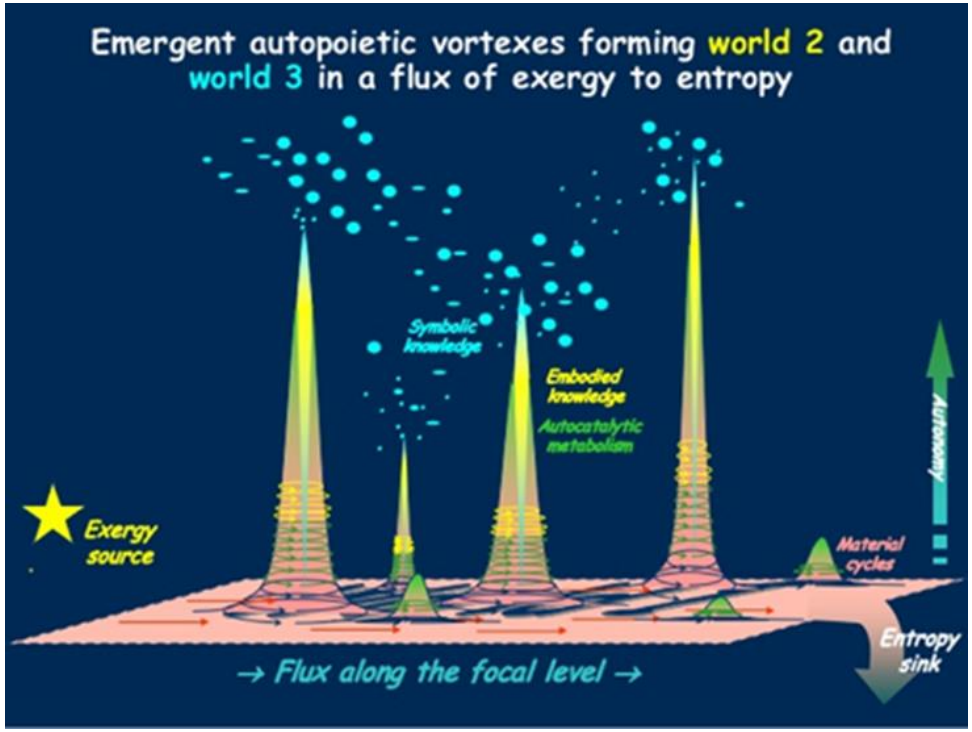


- Very long history of inter-related themes…
  - Hierarchy in nature
    - E.g. Aristotle
  - Emergence
    - E.g. Aristotle, Mill, Huxley, the 'Emergentists'
  - Complex systems
    - Von Bertalanffy, Ashby, Boulding, Wiener, Bateson, Forrester etc.
  - Autopoiesis, Self-Organization
    - Maturana and Varela, Kauffmann etc.

- … but Walloth's term – or even **Emergent Nested Complex Systems** – helpfully captures most of these elements, while also being a good description of the shape of Henriques' drawing.

Walloth, 2016

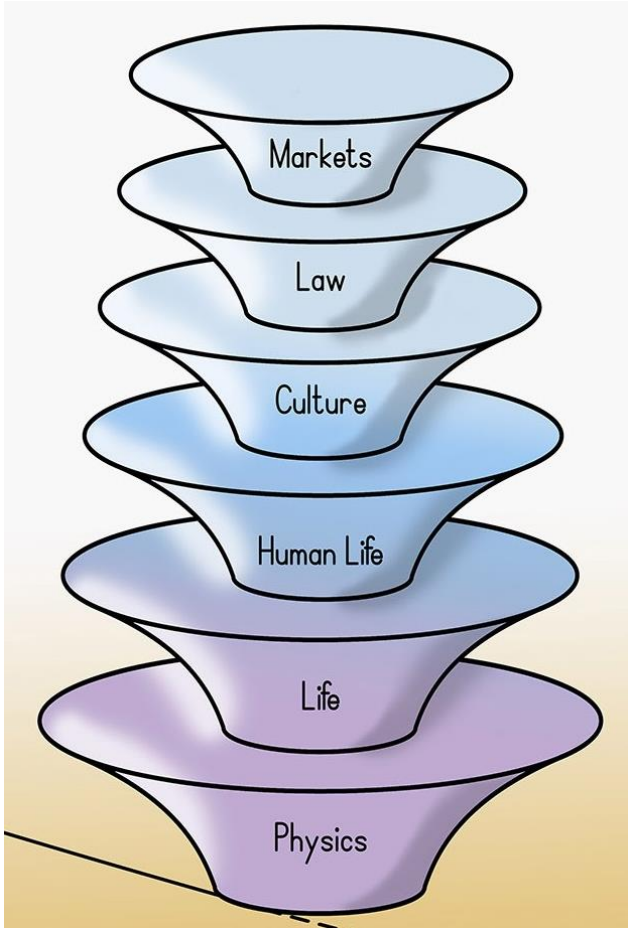
Key Inspiration – William Hall's Emergent Autopoietic Vortexes



William Hall, 2015

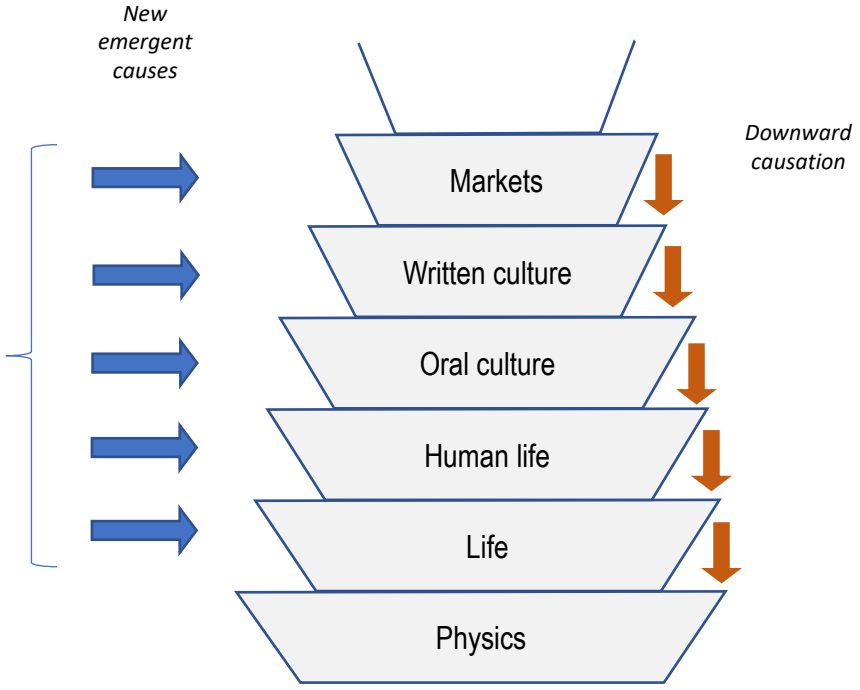
- Hall envisages complex systems emerging up from the basic matter and energy available on Earth
- Exergy (i.e. usable energy) comes in from the sun and is harnessed by structures that have learnt procedures to capture and direct that energy for their ends – from photosynthesis to solar panels.
- Ongoing capture of exergy enables progressively greater complexity resulting in ever higher and more improbable configurations of matter and energy. These enable greater 'autonomy' (right hand arrow), beyond rudimentary physical possibilities.
- The 'vortexes' rely on continual intake of exergy, which cannot be retained but is 'used up' and eventually returns to the 'entropy sink'
- Complexity arises from the layering of procedures that harness/traduce/channel matter and energy into 'far from equilibrium' patterns and structures.
  - (E.g. a human artifact like an ipad has always been physically possible, it has just taken the very long development of many layers of matter-altering procedures to produce the improbable configuration of its components.)

An Emergent System of Processes



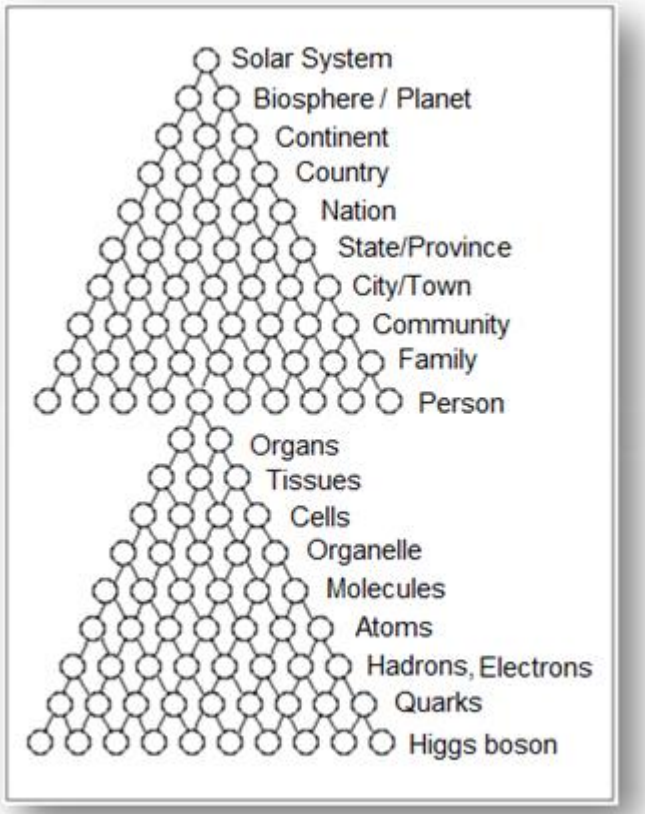
- Best to think of this emergent system as a system of **procedures and processes** that enable physical changes to the world.
- Our modern economy has a physical footpoint - from phones to cars to skyscrapers – but these are made possible by a set of procedures we have developed that enables the large-scale creation and exchange of matter-energy combinations across the globe by strangers.
- Decision whether to grant ontological primacy to parts or processes is a deeper metaphysical choice, with processes now enjoying a resurgence of interest
  - E.g. A 'Process Renaissance' in Biology; 'Everything Flows' (Dupree and Nicholson, 2018).
  - A table, for example, is a process in which constantly moving molecules and atoms come together to form a table-shape for the lifetime of the table.
  - Rivers are obviously processes, but so are mountains in a similar way, just much slower.
  - Time-dependent configuration of matter and energy governed by processes determining how molecules and atoms behave.
  - All living species are layered processes striving to transform the matter and energy of the world in ways that are better for them.

Emergent Nested Systems and Systems Thinking



- Emergent nested structures embody two core features of 'complex systems':
- **Everything is Connected**
  - *'When we try to pick out anything by itself, we find it hitched to everything else in the Universe.'* **John Muir**
  - (Compare 'ceteris paribus' – 'assume all else equal' – as ubiquitous method of economics.)
- **The Whole is Different to the Parts**
  - Emergence introduces new layers of complexity with behaviours that cannot be fully explained by behaviours of the parts.
  - Forces a layered view in which new causes can appear at different levels.
- Systems thinking surfaces aspects of reality shrouded by reductionist-mechanical thinking:
  - Everything is 'connected' BUT NOT mechanically or deterministically so.
  - We cannot understand the world merely by 'adding back up' the behaviour of the parts.
  - New layers of complexity emerge bringing new causal patterns with them.
- Upward *and downward* causation.
  - Lower levels bring forth higher levels, only to then be shaped by those higher levels.
  - Contrary to purely mechanical view of the world, in which causation is entirely parts-driven, 'bottom up'.

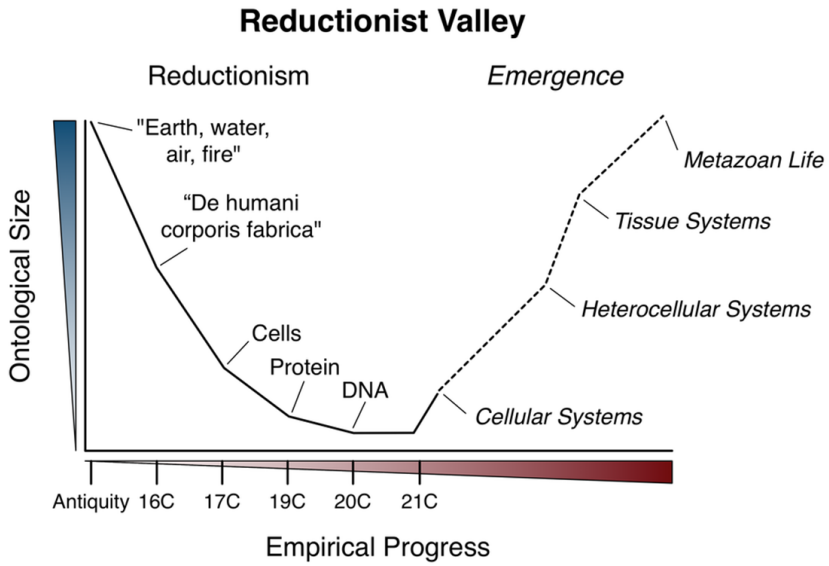
Return of Hierarchy, or ‘Holarchy’



- Systems thinking constitutes a return to a hierarchical view of Nature, known to Aristotle, but dismissed by the mechanical-reductionist scientific worldview from 17th Century, which encouraged a ‘non-hierarchical’ or ‘flat’ worldview.
  - No reason to grant higher layers any explanatory powers beyond the mechanics of their parts.
- Because of the repeating whole-part patterns, sometimes referred to as ‘holarchy’.
- Non-trivial hazard of re-embracing hierarchical structures into our sense of the way things are.
  - Humans have a bad habit of justifying bad behaviour by seeking to ‘naturalize’ it.
  - E.g. Social Darwinism and eugenics ‘rationalized’ by 19th Century over-perception of the ‘competitiveness’ of Nature.
  - Hence, risk that hierarchical thinking somehow legitimizes potentially abusive or unfair social hierarchies.
- The challenge is to describe the world as it is AND ALSO work out social arrangements that are just and fair.
  - Helpfully, hierarchical thinking offers a more balanced picture of the competition AND cooperation that takes place in Nature.

Image from Storyality website, Velikovsky

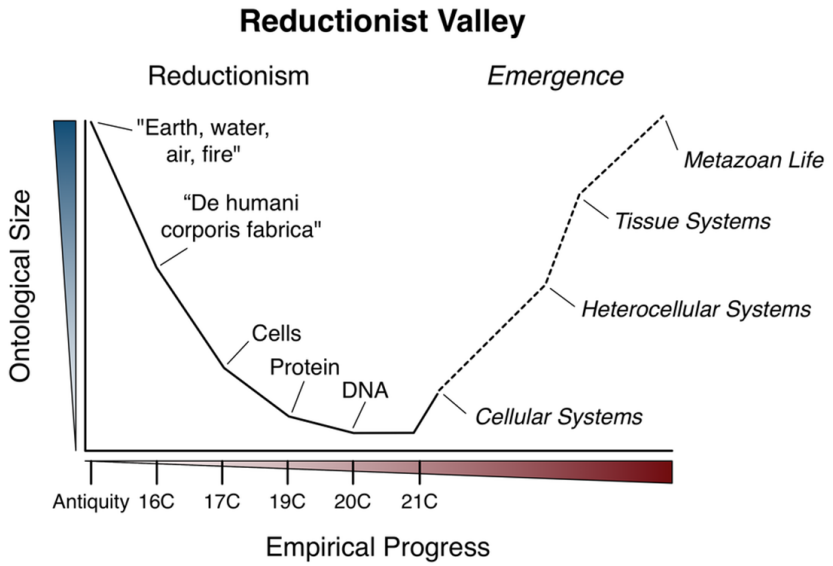
Systems Thinking is the Escape from the Valley of Reductionism



Christopher Tape, 2016

- Systems thinking is the long-postponed counterpart or complement to reductionist thinking that has profoundly shaped Western thought since the 1700s.
- Reductionist, mechanical thinking is very helpful at explaining the 'dead' things of the Universe – atoms, planets etc – which were the main objects of concern at the start of the Enlightenment.
- Alas, we then applied the reductionist method to non-mechanical living things - plants, animals, ourselves – where it is less powerful.
- It is not that reductionism is entirely unhelpful, only that its explanatory power diminishes the more that systems are complex and living. There are diminishing returns to reductionism.
- Hence, many natural and social sciences fell into a 'valley of reductionism' but are now clambering out to advance their understanding.
- **Economics was one of the last disciplines to fall into the Valley of Reductionism and is among the last to recognize the need to escape (More in Session 3).**
- **The consequence is that our economics-influenced socio-economic arrangements are not systemically-rooted.**

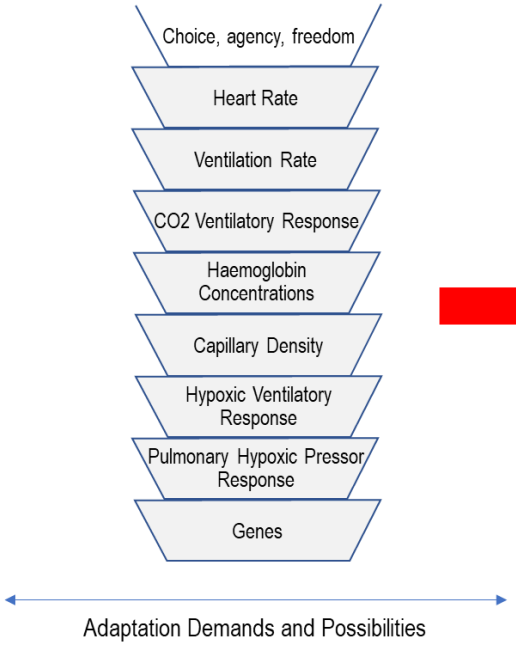
Why Now?



- **Why is this happening now?**
- Diminishing returns to reductionism experienced in many natural and social sciences.
- Computational advances have enabled the modelling of much larger and more realistic systems than was possible for most of the 20th Century.
  - We can now discard the unrealistic assumptions that economic models needed to make to be usable in a pre-computational era (e.g a two-factor production function!).
- Our real-world technologies – the internet, in particular – have given us a visceral sense of systems dynamics
  - Positive reinforcement loops – memes and 'going viral' – and negative reinforcement loops – easy 'cancellation' culture.
- Our measurement capabilities have identified longer and less apparent feedback loops that we are bound by:
  - Climate change from fossil fuel burning
  - Lung cancer from smoking
  - Neuro-disability from contact sports
  - Etc.
- The stark reality of the Anthropocene forces questions about the relationship between Economics and Ecology.

Two Fundamental Directions of Emergence

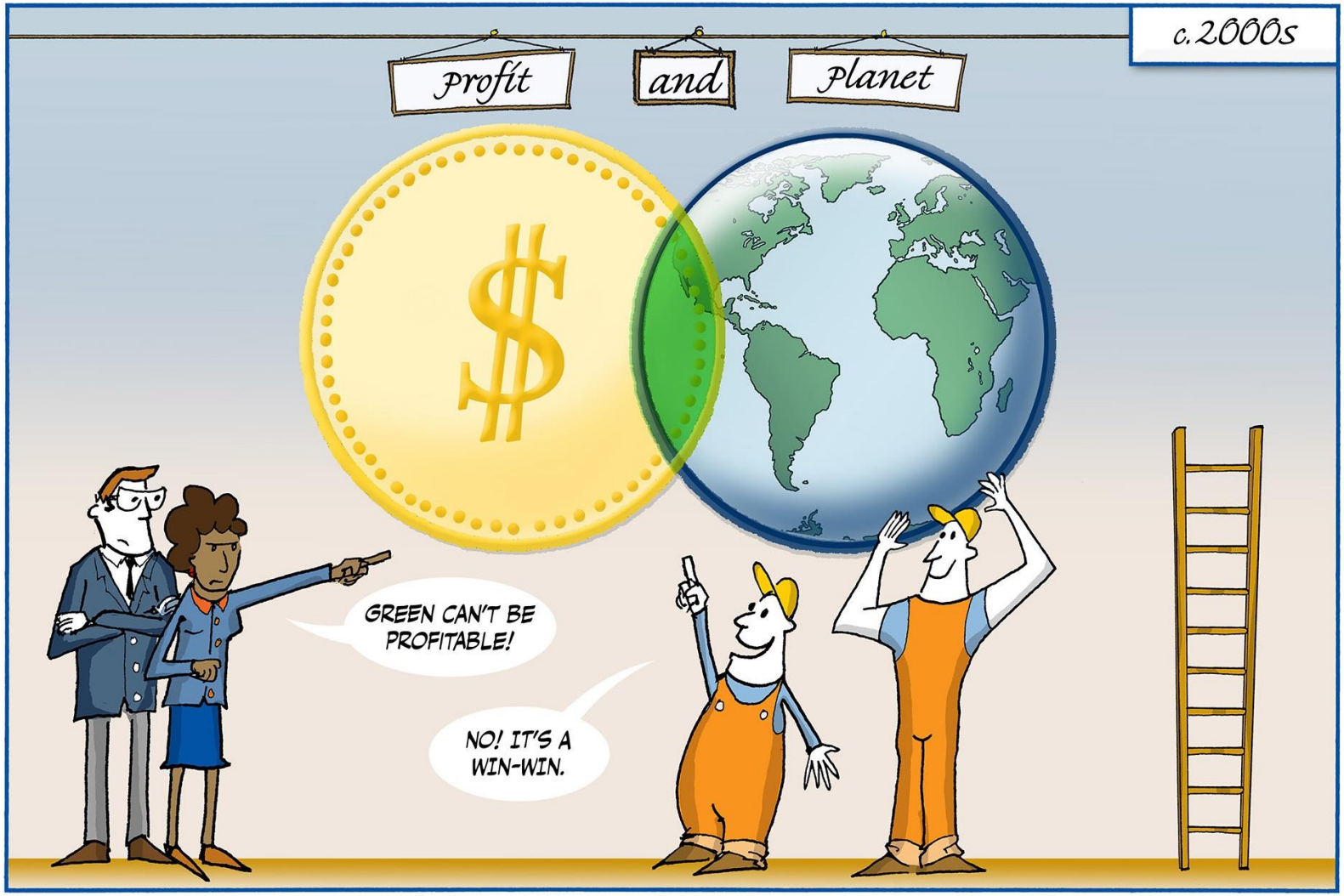
'Upward' learning - Technological innovation to overcome problems and avoid costly adaptation.



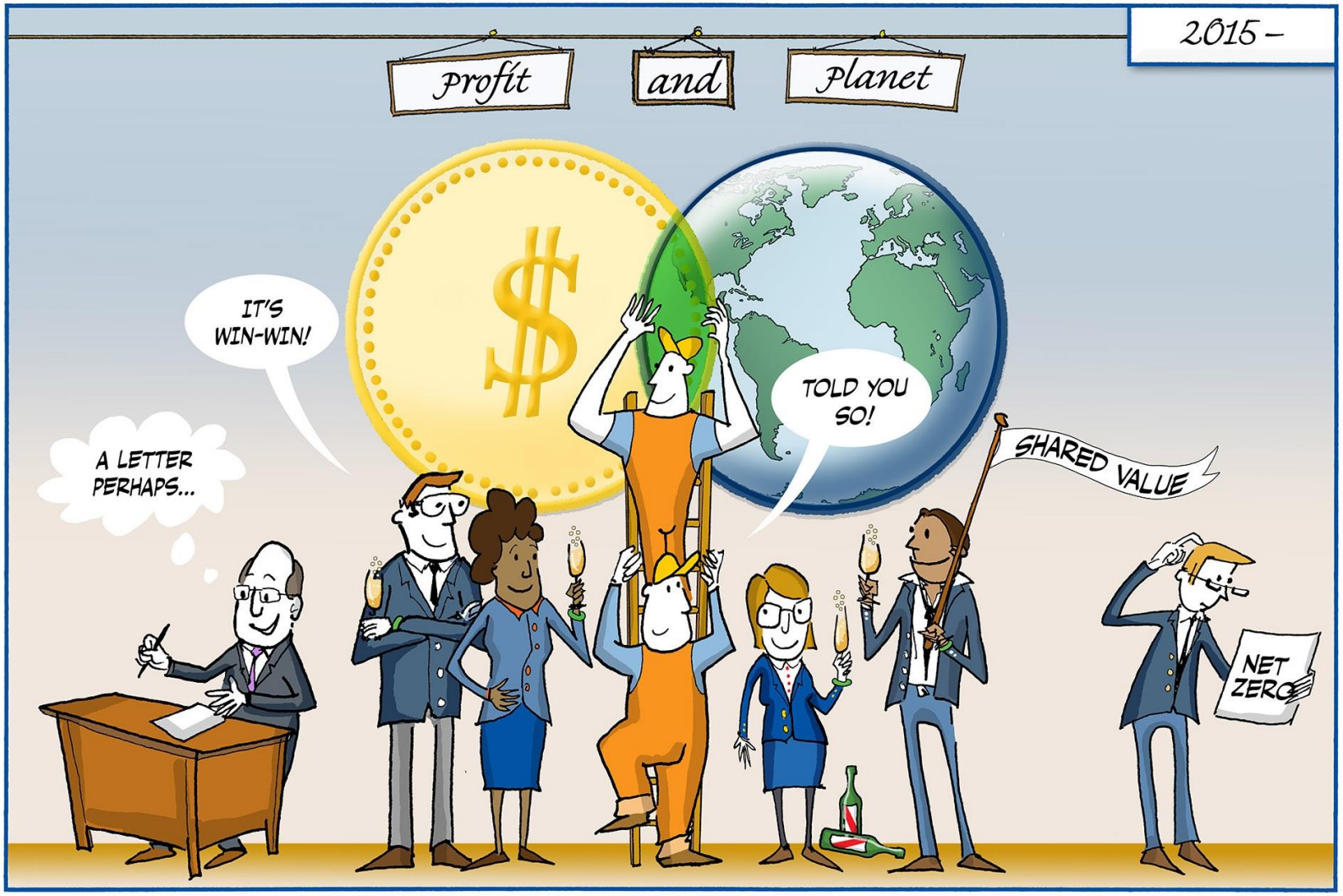
'Sideways' learning – or 'unlearning to relearn' - adapting to new contexts when technological innovation is insufficient.

- These two directions of movement represent fundamental, much observed, alternatives in human attitude:
  - Techno-optimism (or 'eco-modernism') versus behavioural change
  - Economic versus ecological thinking.
  - 'Growth' versus 'harmony' etc.
- VML has largely been the attempt to become sustainable through 'upward' movement of identifying and accelerating technology solutions that can be 'added on top' of established structures.
- Change the world or adapt to it…?
  - *"Life can either be accepted or changed. If it is not accepted, it must be changed. If it cannot be changed, it must be accepted."* **Winston Churchill**
  - *"God, grant me the serenity to accept the things I cannot change, Courage to change the things I can, And wisdom to know the difference."* **Reinhold Niebuhr**

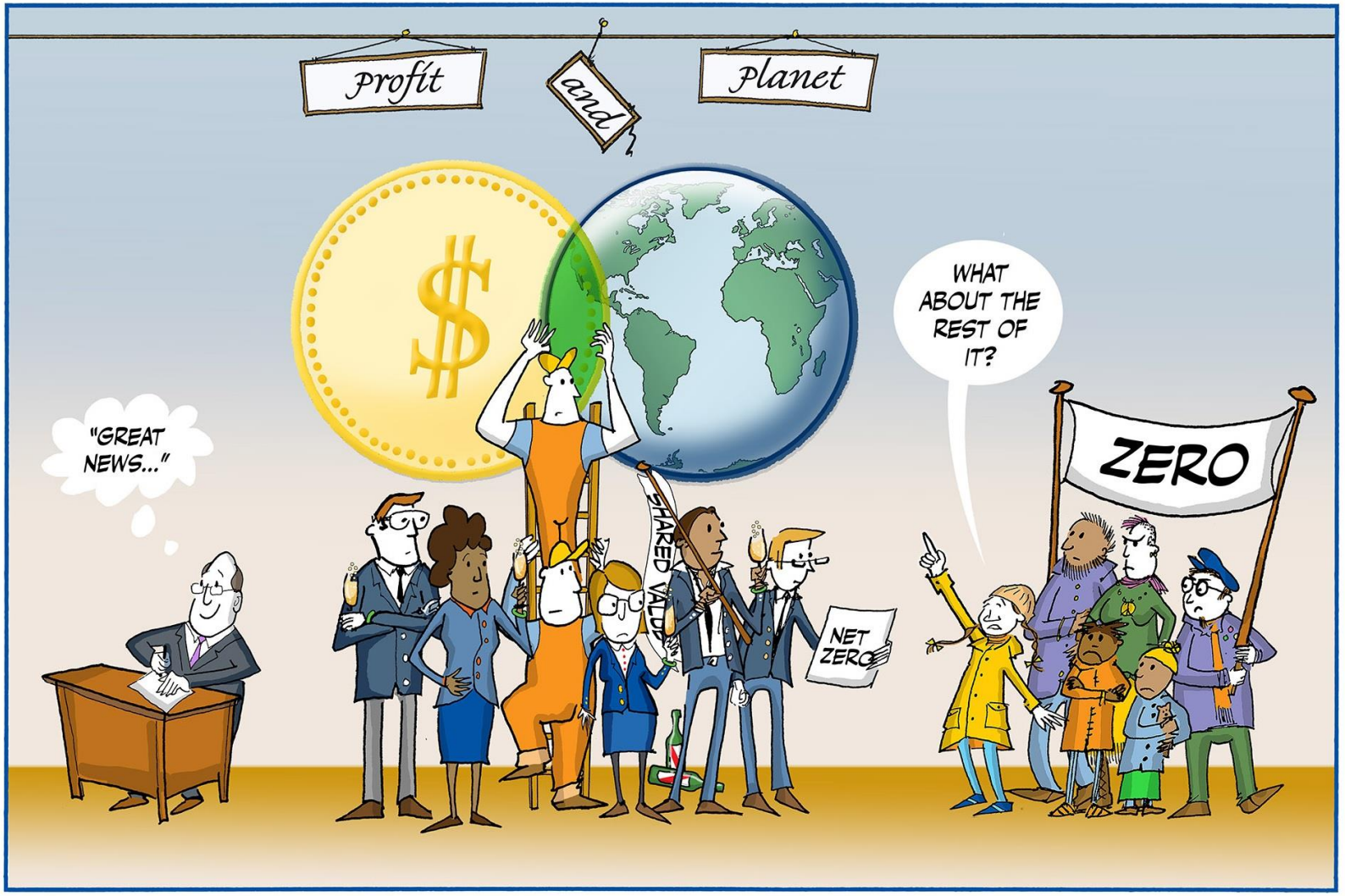
Building the ‘Win-Win’ Case



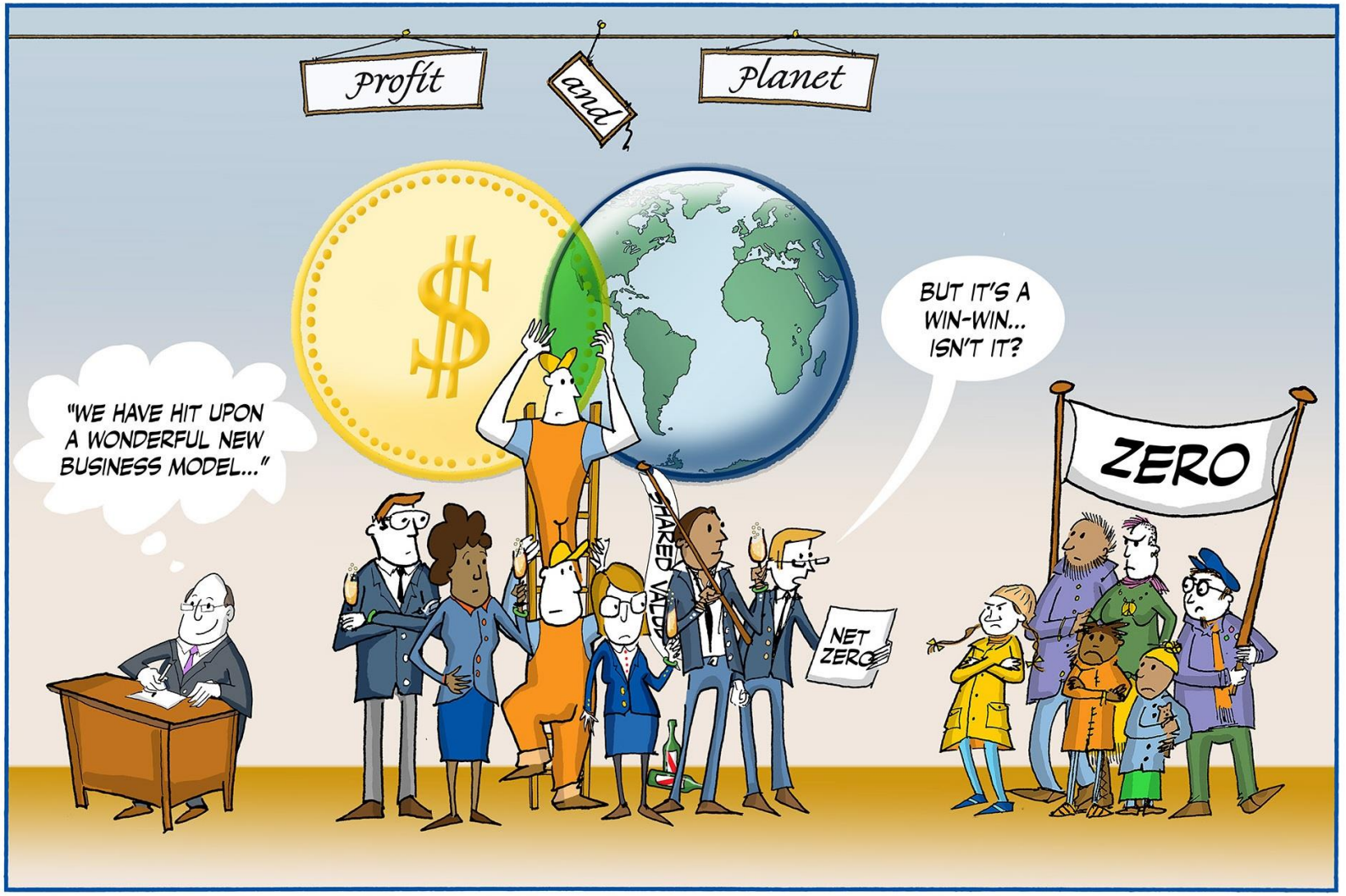
‘Win-Win’ Becomes Mainstream and Catalytic



Limits to ‘Win-Win’



‘Win-Win’ as Constraint on Necessary Action



A Different Perspective: A Limits-Respecting Economy