



32nd Annual **INCOSE**
international symposium

hybrid event

Detroit, MI, USA
June 25 - 30, 2022

Stop beating up on complexity



Outline

1. Welcome and introduction of panelists	~10 mins
2. Position statements	~35 mins
3. Open discussion	~35 mins
4. Summary and closing remarks	~10 mins



Suja's narrative

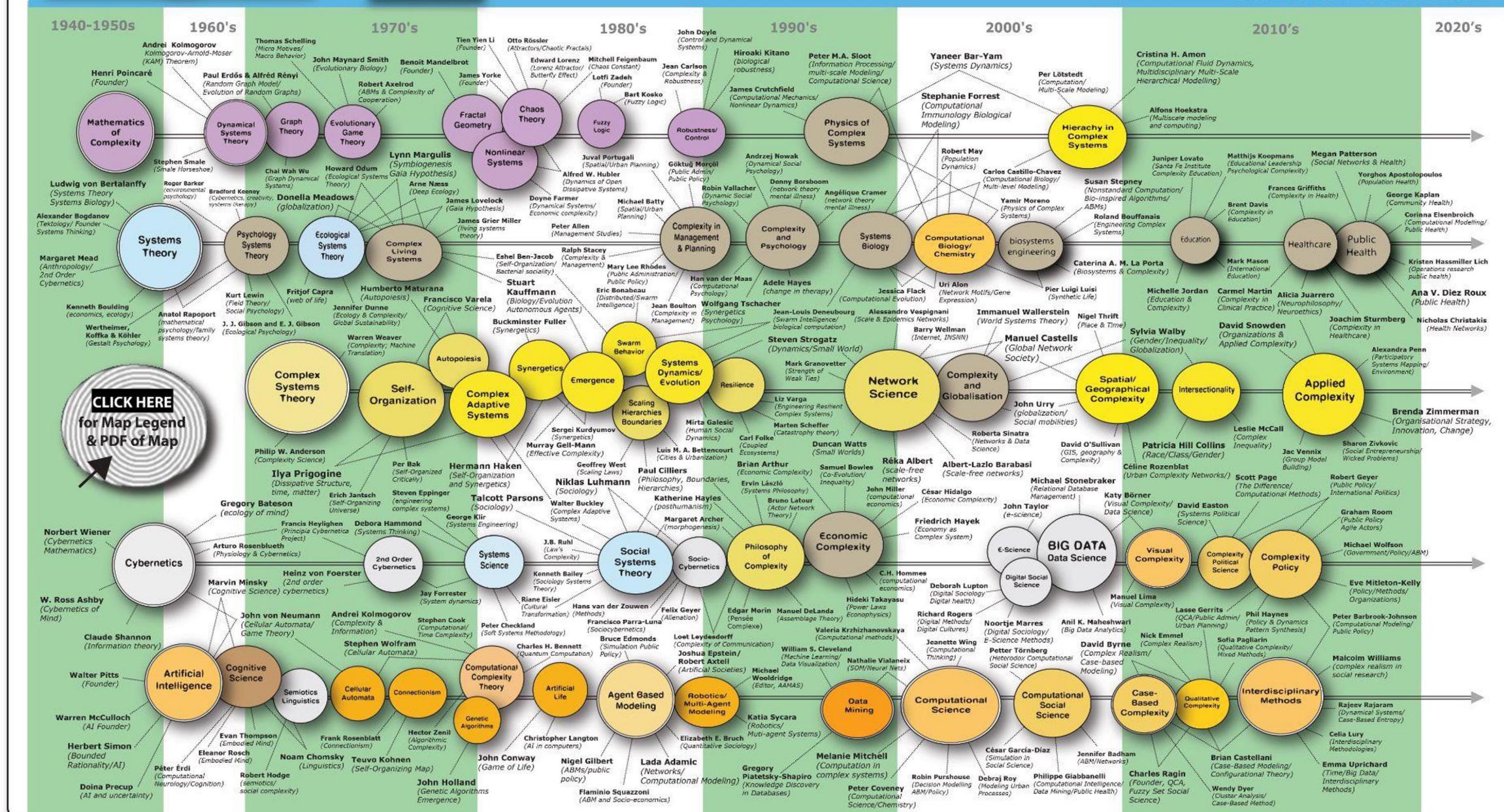
what? why?



what is complexity?

technology?
interconnectedness?

uncertainty?
because we
don't know?





our current challenge

“...organisation of knowledge, an organisation that is incapable of recognising and apprehending the complexity of reality.”

-Edgar Morin



why do we need to embrace it?

what's the
opposite of
embrace?



exclude, reject, repudiate,
release, shun, disbelief,
distrust, let go, turn away,
renounce





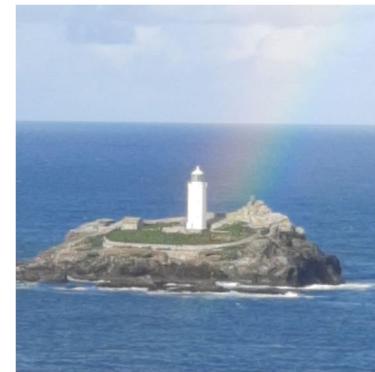
what are some of the first steps we can take?

- Don't fall in love with your model
- Be humble
- Be childlike

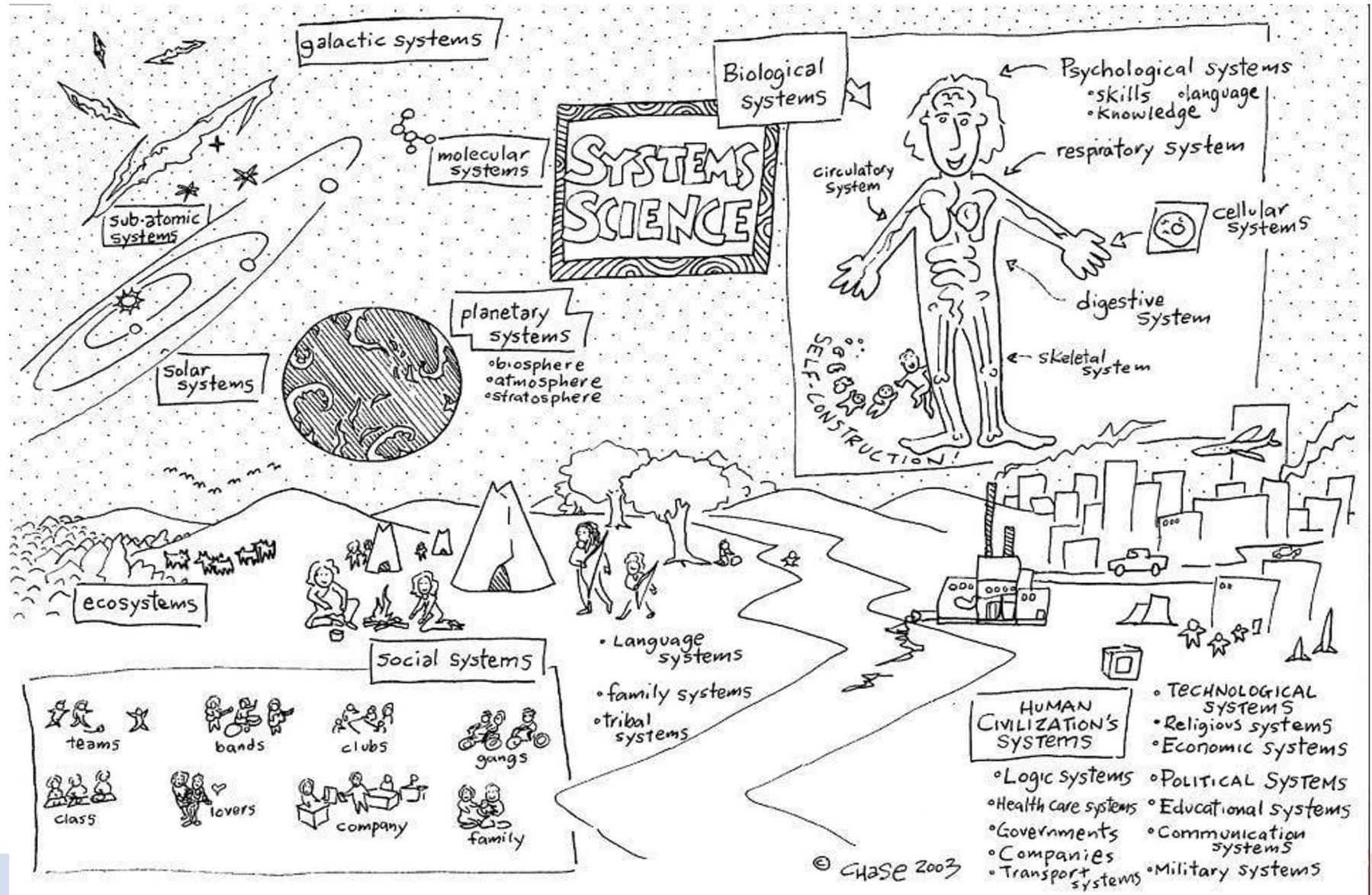


Gary's Story

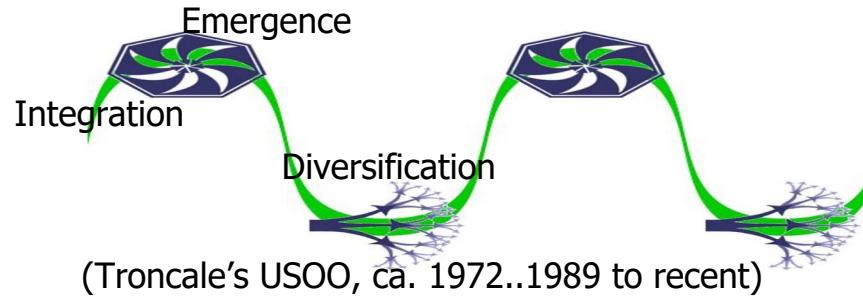
..appreciate complexity



Life, the universe and every “thing” is complex



Universal concepts, patterns, principles and assets that are transdisciplinary across all complexity



• Grand Sequence:

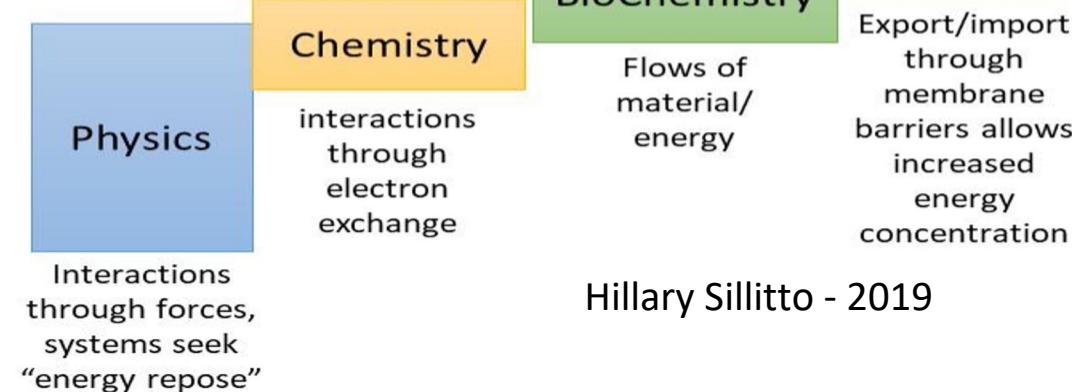
Maintained by exchange of information, sharing of resources, division of labour, power structures

Energy needed to maintain

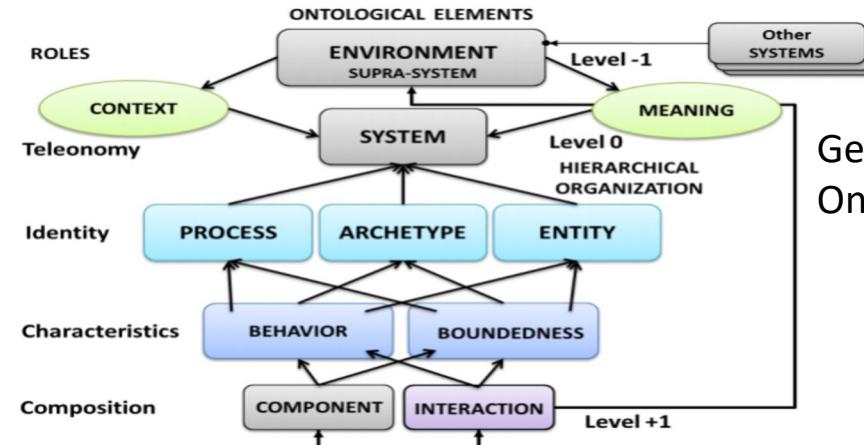
Energy needed to break up

- Geopolitical states
- Agro Villages
- Human Tribal Metagroups
- Animal social groups
- Multi cellular organisms
- Cells (Eukaryotic)
- Cells (Prokaryotic)
- Molecules
- Atoms
- Nuclei
- Nucleons
- Quanta

Increasingly information rich



Volk's "Grand Sequence" - 2018

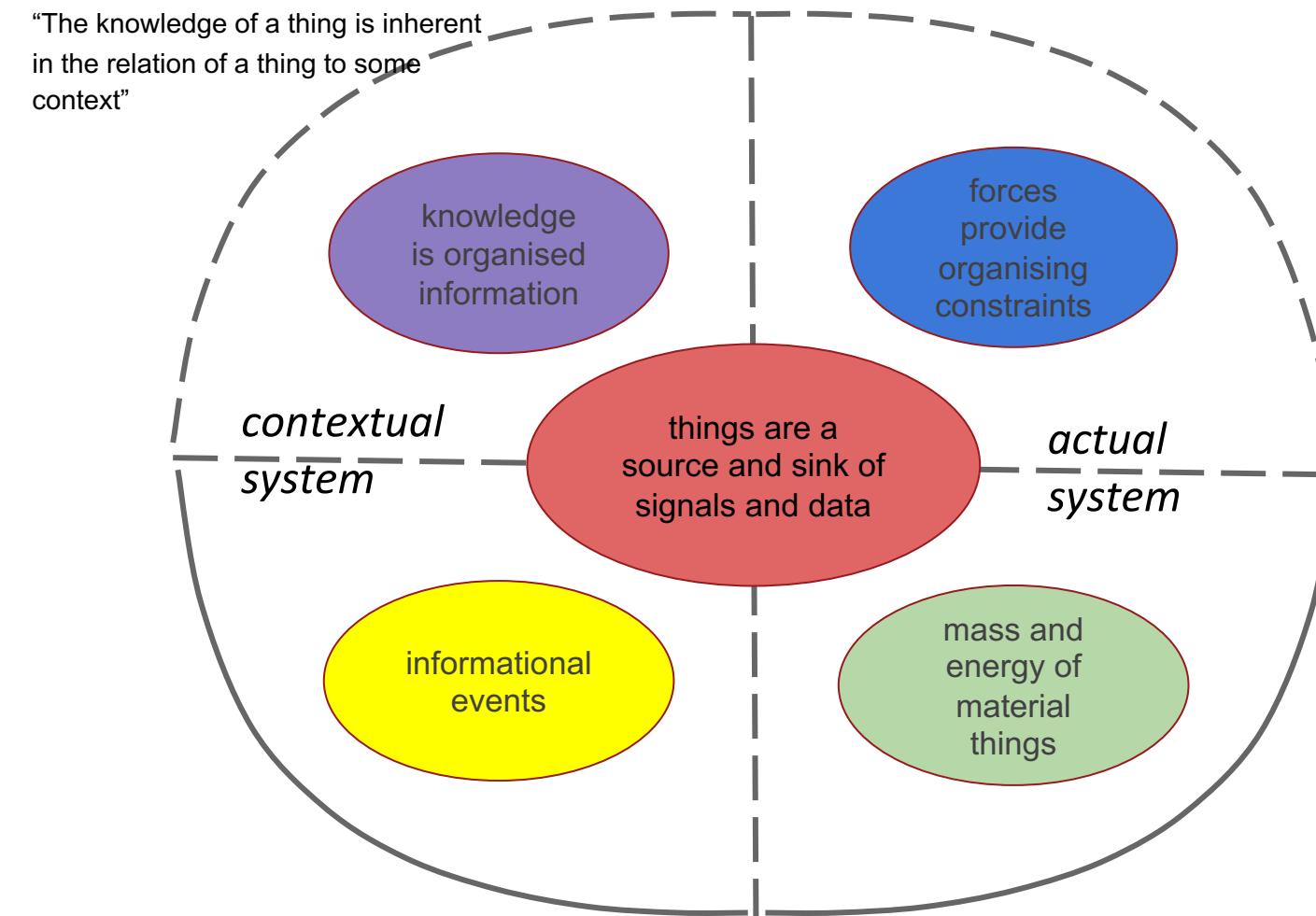


George Mobus "General Systems Ontology" - 2019

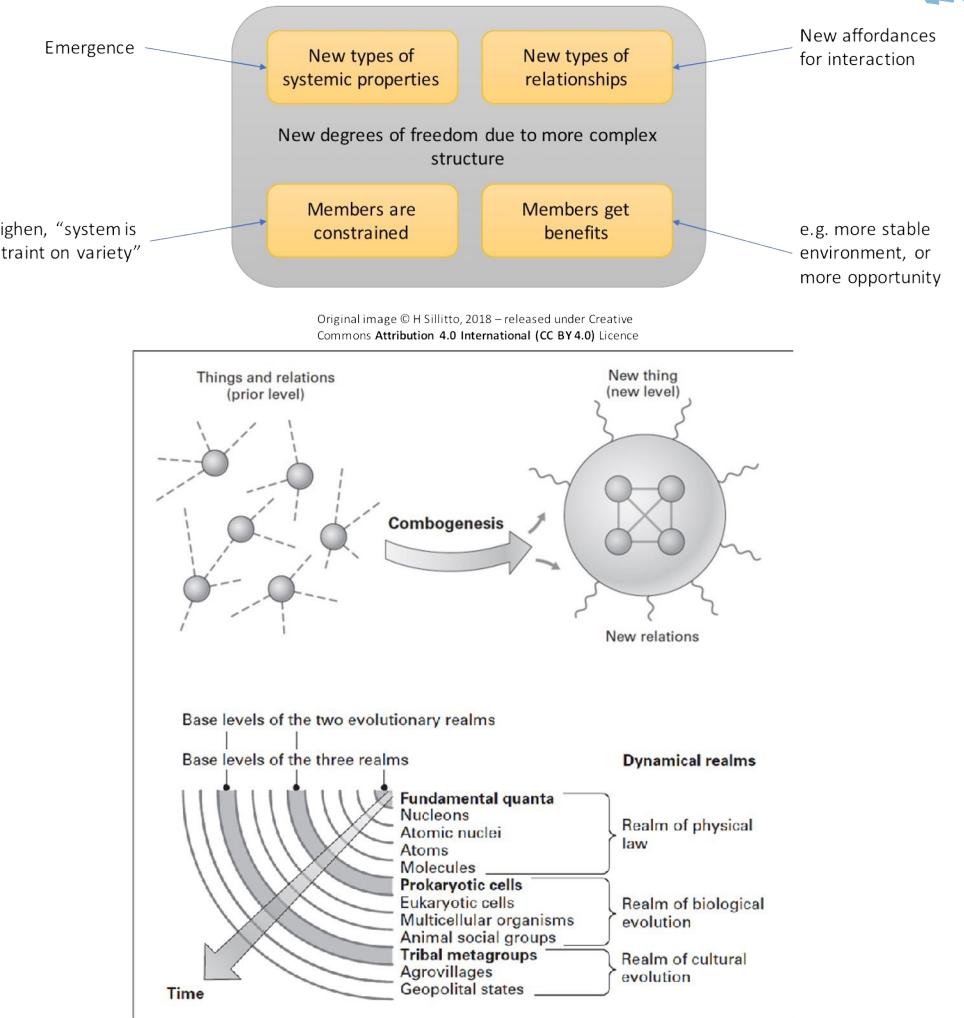
Hillary Sillitto - 2019



The source of complexity - the R-Holon



“Information is the language nature uses to convey its messages and this information comes in discrete units”



The Metapattern of General Evolutionary Dynamics and the Three Dynamical Realms of Big History
T. Volk. Published 28 December 2020

How we perceive and can appreciate complexity





Charlotte's Story





thesis

complexity is an enabler of innovation



Innovate

to think or do something in a new way

components are **imagination**

+ sometimes **implementation**

+ sometimes **business success**

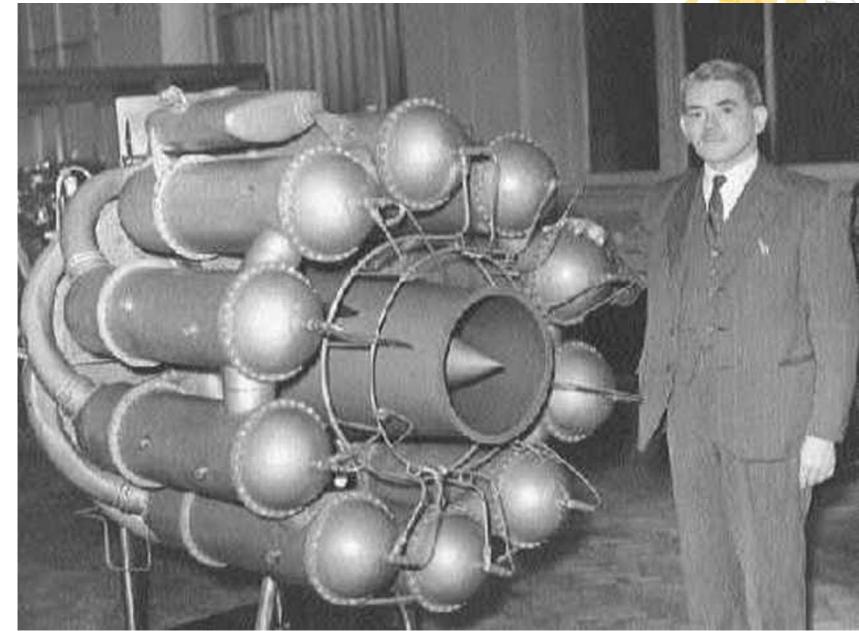
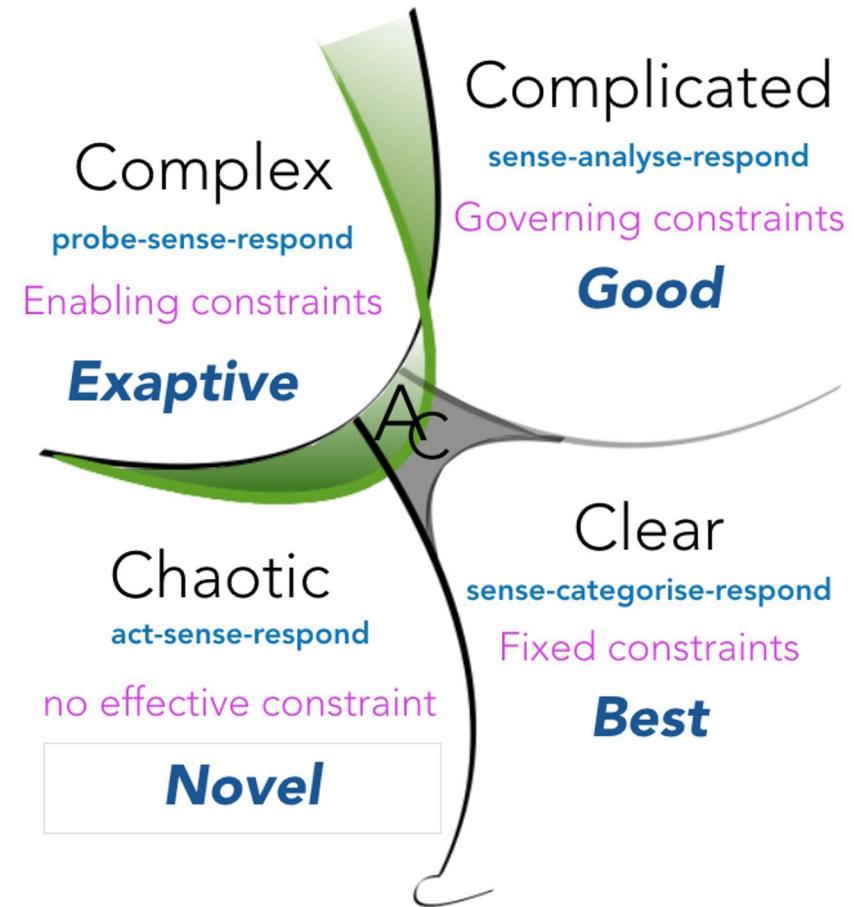
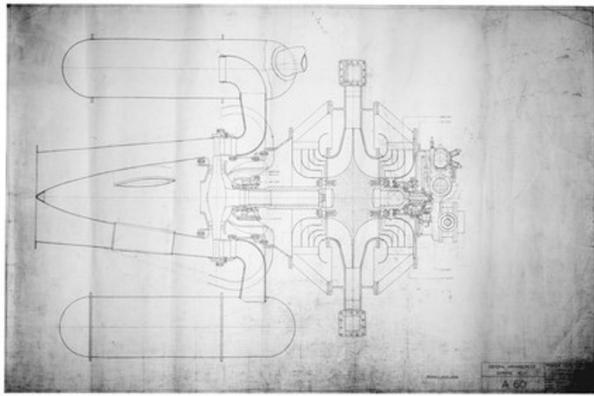
Literature

lots! but ...

an increase in some kinds of complexity increase innovation and others decrease it ¹

the innovating process is more "disorderly" for innovations that are more complex. The hypothesis was supported for a measure of technical complexity but not for one of organizational complexity. ²

Identify your company's innovation fulcrum—the number of offerings that would optimize both revenues and profits. Ask, "What would my company look like if it made and sold just one product?" Then add variety back into your business, product by product: Gauge customer interest and incremental revenues—and estimate the new costs that would come with heightened complexity. The point where costs start outweighing revenues is your innovation fulcrum.³



(a)



(b)



AND



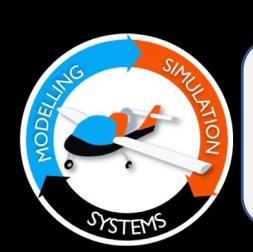
the art of harmonisation





JB's Story





Complexity

A Personal Journey...



UNSW



Systems, Sub Systems & Interdependence

HDH



Systematic Approach to development

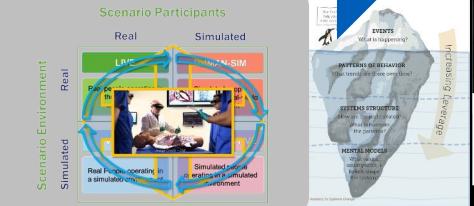
EASAMS



MDA



CAE



Modelling & Simulation

JBES



Systems Thinking & Systemic Approaches



Carl Philipp Gottfried von Clausewitz

18th century Prussian soldier and German military theorist

...it is of immense importance that the soldier should not have to encounter in War those things which, when seen for the first time, set him in astonishment and perplexity;

...if he has only met with them one single time before even by that he is half acquainted with them...



Complexity

A Personal Journey...



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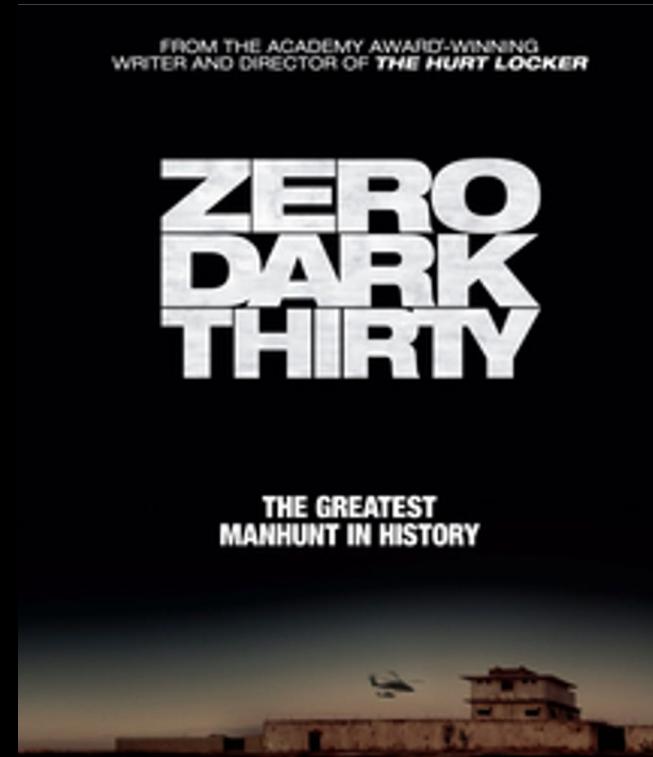
Complexity



Safety Critical MR...



FROM THE ACADEMY AWARD-WINNING
WRITER AND DIRECTOR OF *THE HURT LOCKER*





Complexity

Safety Critical MR...



Military

160th SOAR Inaugurates MH-47G Simulator

By [James T. McKenna](#) | August 21, 2007

[Send Feedback](#)

[Attack](#), [Heavylift](#), [Utility](#)

The U.S. Army's [160th Special Operations Aviation Regiment \(Airborne\)](#) is training with a new Boeing MH-47G Chinook combat mission simulator. Built by CAE, the simulator is at Fort Campbell, Ky., home of the [160th SOAR\(A\)](#), also known as the Night Stalkers. It is part of the [Army's Special Operations Forces Aviation Training and Rehearsal Systems \(ASTARS\) program](#). CAE says it has the largest vertical field-of-view ever delivered on a full-motion simulator. [For related news](#)

Image – Rotor & Wing International

INNOVATION IN HISTORY





Complexity

Safety Critical MR...



State of the Environment

Performance of Action

Decision

Common Situational Awareness is Key

SITUATION AWARENESS (Mica Endsley)

Perception of Elements In Current Situation
Level 1

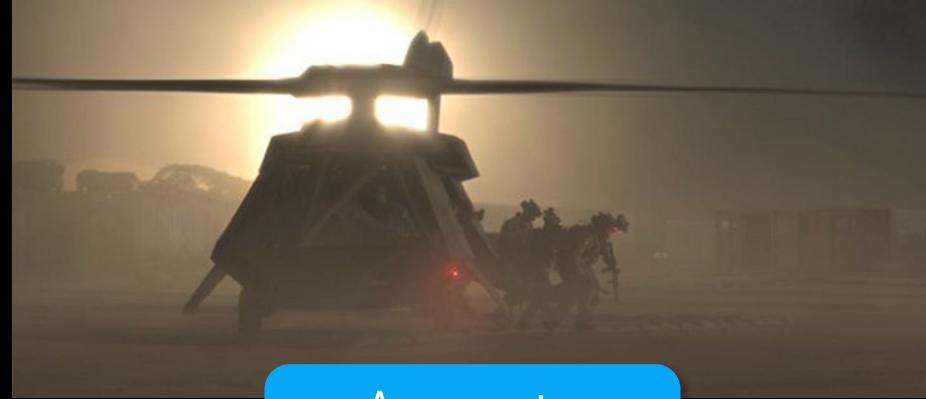
Comprehension of Current Situation
Level 2

Projection of Future States
Level 3



Complexity

$$\text{Complexity} = f(\text{Contextual SA})$$



State of the Environment

Agency to Effect

Decision

Common Situational Awareness is Key

SITUATION AWARENESS (Mica Endsley)

Ability to Sense / Perceive

Ability to Comprehend

Ability to Project



Complexity

$$\text{Complexity} = f(\text{Contextual SA})$$



“Sensors”



“Mental Models”

“Simulations”



Common Situational Awareness is Key

Ability to
Sense / Perceive

Ability to
Comprehend

Ability to
Project



Complexity

Mental Models



Santiago theory of cognition

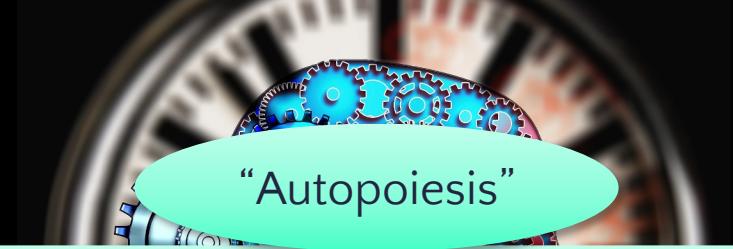
“The living system reacts with its environment to bring forth a sense of awareness.....” — Humberto Maturana



Only love expands intelligence. To live in love is to accept the other and the conditions of his existence as a source of richness, not as opposition, restriction or limitation.

— Humberto Maturana —

AZ QUOTES



Autopoiesis

“We don't perceive the world we see, we see the world we perceive” — Humberto Maturana

Mental Models

Common Situational Awareness is Key

Ability to Sense / Perceive

Ability to Comprehend

Ability to Project



A learning organization is an organization that is continually expanding its capacity to create its future.

— Peter Senge —

AZ QUOTES



Complexity

Flight Sim “Generations”...



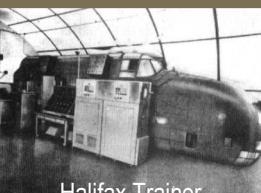
A Personal Categorisation of Simulator Generations

Manual /
Mechanical



GEN-0

Analog
Computers



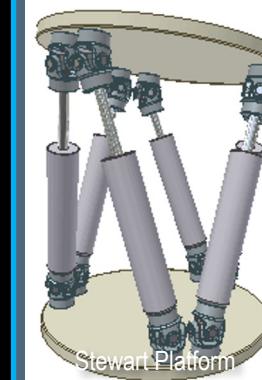
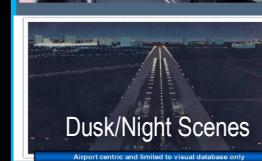
GEN-1

Digital
Computers



GEN-2

Visual, Sound &
Motion



GEN-3

“Level D” Flight &
Mission Training



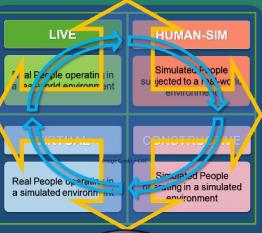
GEN-4

Interconnectivity of
State Information



GEN-4.5

Common
Synthetic Env's



GEN-5

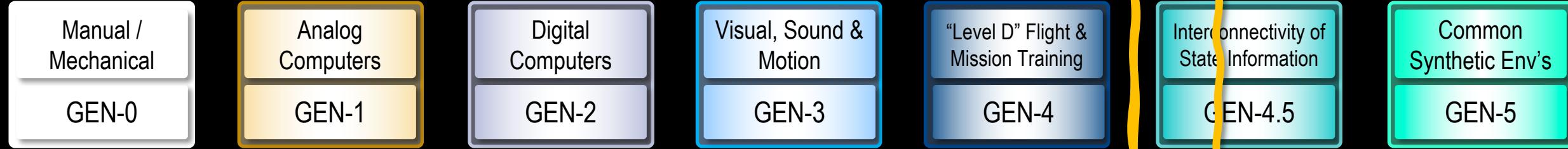


Complexity

Increasing Interdependence



Personal Experience Based Categorisation of Simulator Generations



Increasing Technological & Environmental Interconnectivity

Increasing Env Connectivity

Energy on Enabling Outcomes

Energy on Outcomes

Energy on Outcomes

Existing Architectures Increasingly Unable to cope
Architectural Improvement is primarily "Reductionist" (Analysis/looking-In)

"Synthesis" driven Architectural
Paradigm shift (efficiency &
effectiveness)

Complexity

The SE Opportunity Context

G A S
(ST-M&S)

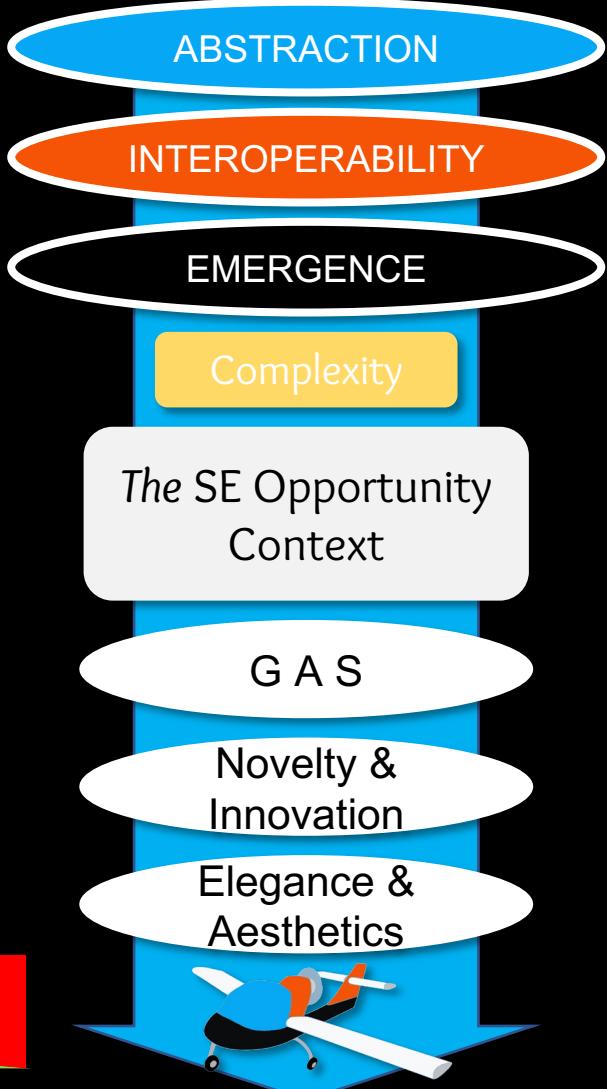
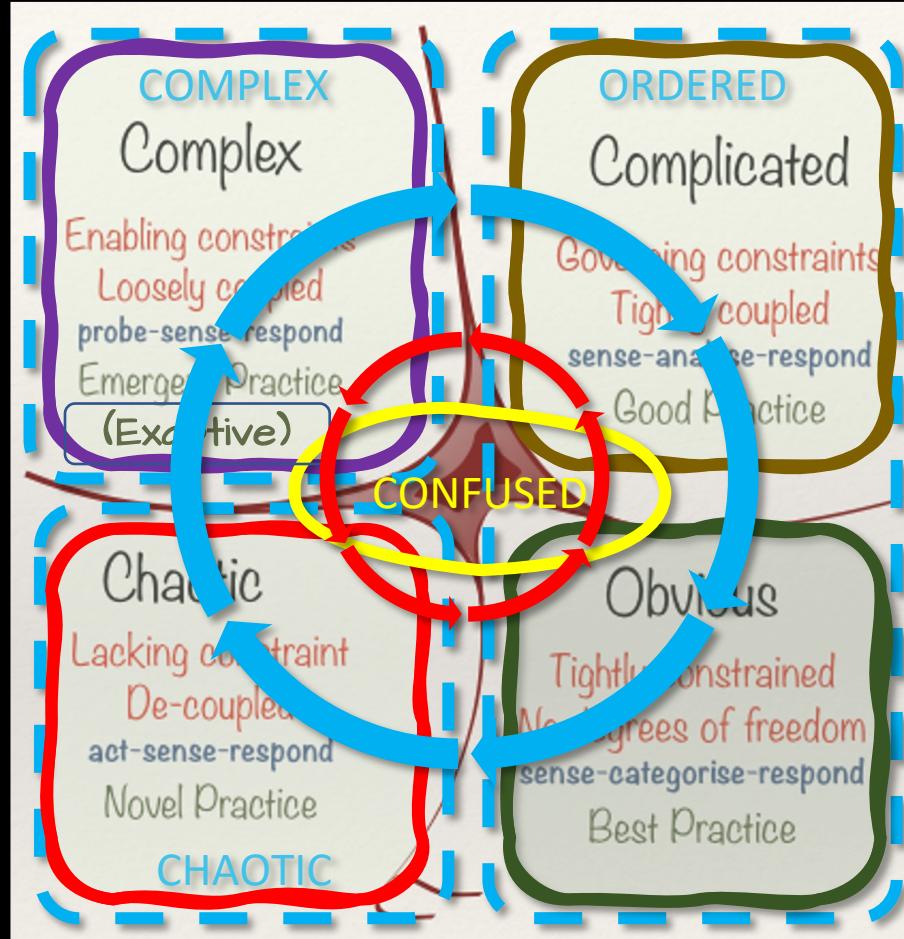
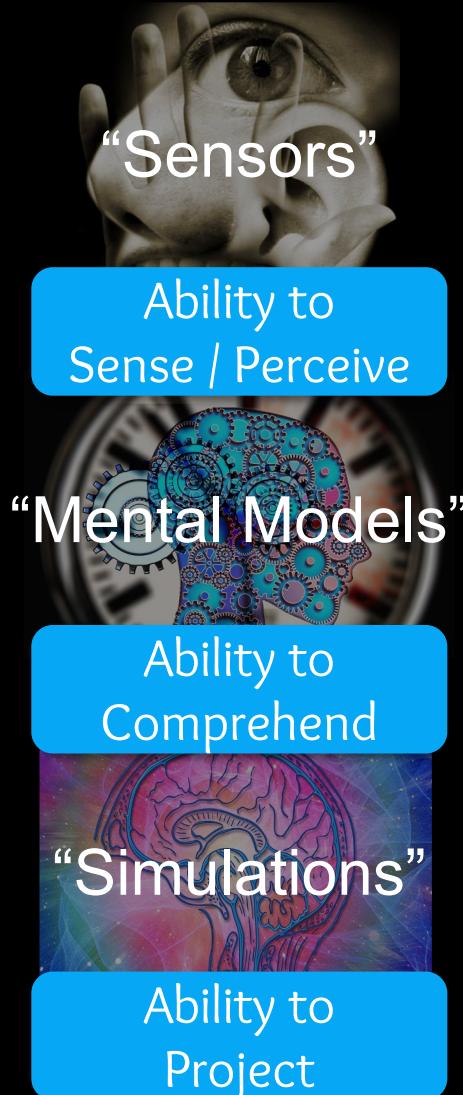
Novelty &
Innovation

Elegance &
Aesthetics



Complexity

The SE Opportunity Context





Patrick's Story

...to engineer is human

...to engineer is human - its about **people**



Engineers are people

- part of nature

People are **complex** AND **creative** AND **naturally risk averse**
AND risk takers

- cause and effect can be entangled

We have learned that Problems are **context** dependent

- **Purpose** needs to be clear
- Recognise what we **do not** know

It requires engineering **judgement** and **hope** is essential

Not just about risk - appreciate the positive - **opportunities**



People living with Uncertainty

Complexity



Uncertainty

Natural
Inevitable
&
Can be Useful

Complexity is increasing – Living with uncertainty



A cultural example from Eastern Asia:



Crisis:

The harmonious combination of Danger and Opportunity

Fig 4

David Blockley, Gary Smith,
Patrick Godfrey, John Jay Kineman
Proof copy (2022)
"Relational Holon Science and
Popper's 3 Worlds in
Engineering Practice" *Systems*
Research and Relational Science
Journal

Creating a new hospital

Why: Delivering healthcare
How: Diagnosis & treatment
Who: Client: R-Hospital Trust
Who: Design:
What: Infrastructure
Where: Location
When: Dates
Viability: 

Identity hospital

Italian Flag



Do not Know
Evidence for success Evidence for failure

Blockley D, Godfrey P, (2017)
"Measuring evidence using the Italian flag"
p103-107 *Doing it Differently Systems for
rethinking Infrastructure* 2nd Ed. ICE Publishing,
London, UK

Level 0



Level 1



Living with Uncertainty

Humans **evolved** by controlling fire (technology). We can:

- cook, energise machines, explore the oceans, communicate globally,
- use it to create or destroy
 - **People** choose
 - **AND** it can have unintended consequences.
- **People:**
 - create meaning from concept systems **AND** behaviour from physical systems
 - adapt, 'learn together', cooperate, collaborate,
 - act **proactively** to live with uncertainty

Helping us to:

Create a better world through a systems approach



References

- David Blockley, Gary Smith, Patrick Godfrey, John Jay Kineman Proof copy (2022) “**Relational Holon Science and Popper's 3 Worlds in Engineering Practice**” *Systems Research and Relational Science Journal*
- Blockley D, Godfrey P, (2017) “**Measuring evidence using the Italian flag**” p103-107 *Doing it Differently Systems for rethinking Infrastructure 2nd Ed. ICE Publishing, London, UK*
- Website: Italian Flag: <http://myengineeringsystems.co.uk/italian-flag/>

Patrick.Godfrey@systems-thinking.co.uk



Open discussion





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www.incose.org/symp2022