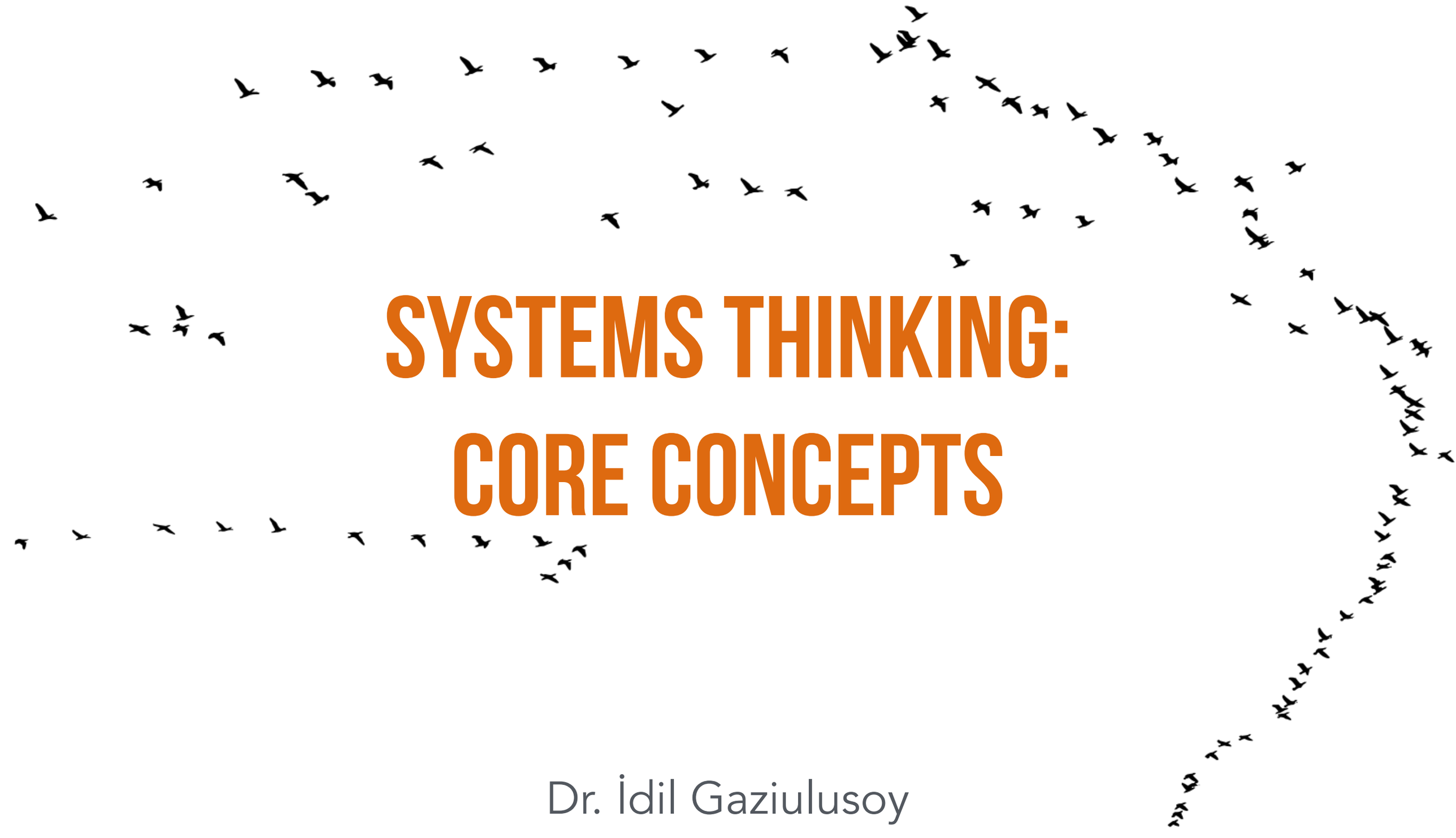

SYSTEMS THINKING: CORE CONCEPTS

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Sustainable Design Research

TEACHING & LEARNING OBJECTIVES

My teaching objective:
inspire students to become competent systems thinkers (i.e. induce curiosity to learn more beyond this lecture & practice learning)

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inspire students to become competent systems thinkers (i.e. induce curiosity to learn more beyond this lecture & practice learning)

Learning objectives for students:
Understand systems thinking as a specific type of analytical and creative perspective
Identify “threads of knowledge” to pull for further learning about systems thinking

INTRODUCTION: SYSTEMS THINKING AS MINDSET

SYSTEMS THINKING IS NOT ANOTHER DISCIPLINE IN THE ZOO OF SCIENTIFIC DISCIPLINES

IT IS A SPECIFIC WAY OF THINKING ABOUT, OBSERVING, ANALYSING AND WORKING WITH PHENOMENA

SYSTEMS THINKING - SYSTEMS THEORY(IES)

HAS BEEN USED IN A VARIETY OF DISCIPLINES AND HAS MULTIPLE MEANINGS

Basic Theory	Main Proponent(s)
General Systems Theory	Von Bertalanffy, Boulding
Living Systems Theory	Miller
Mathematical Systems Theory	Mesarovic, Wymore, Klir
Cybernetics	Rosenblueth, Wiener & Bigelow, Wiener, Ashby, Forrester
Social Systems Theory	Parsons, Buckley, Luhmann
Philosophical Systems Theory	Laszlo, Bunge
Critical Systems Theory	Midgley

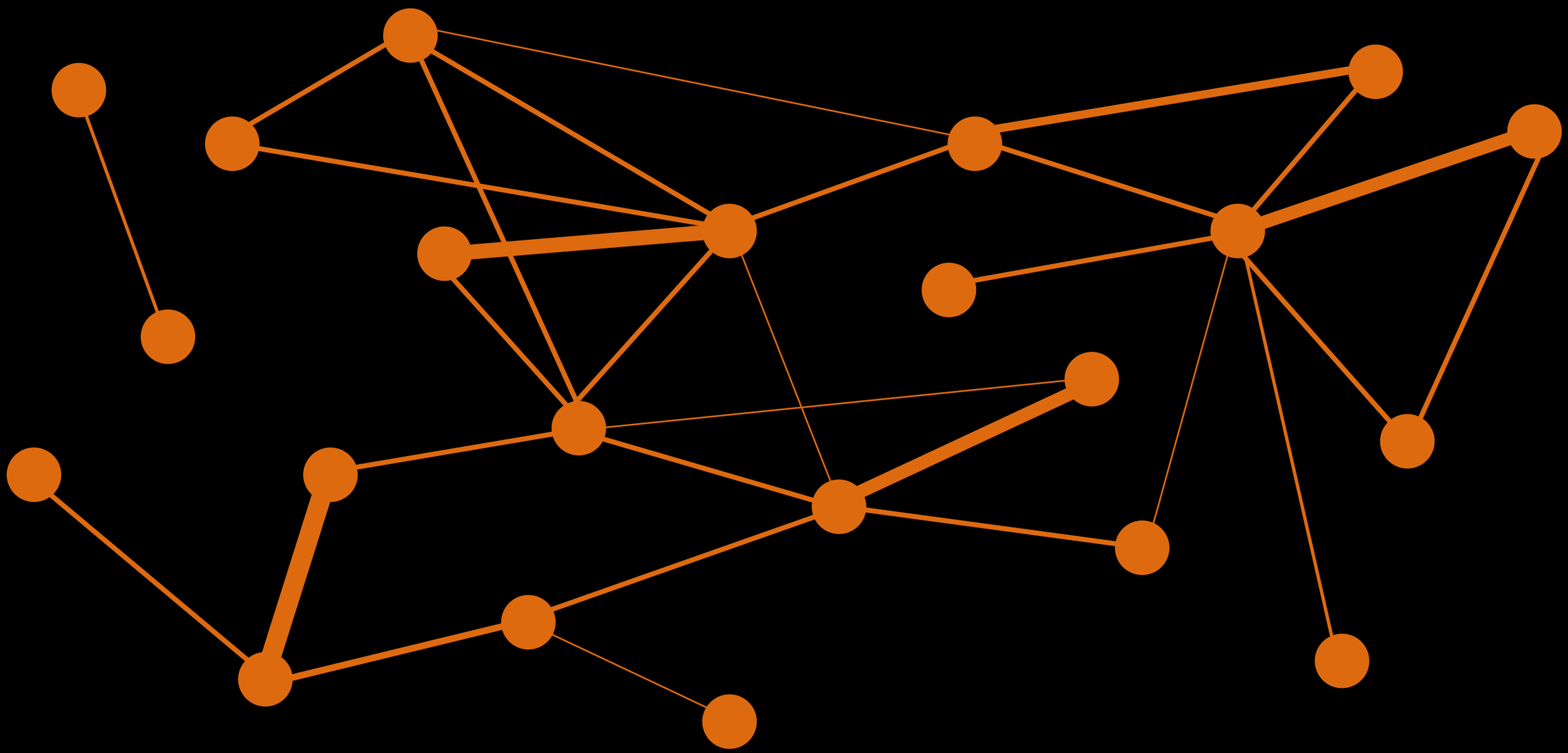
LOOKING AT THE WORLD THROUGH A SYSTEMS LENS CAN BE LIFE CHANGING

LOOKING AT THE WORLD THROUGH A SYSTEMS LENS CAN BE LIFE CHANGING

The world of things & disciplines

LOOKING AT THE WORLD THROUGH A SYSTEMS LENS CAN BE LIFE CHANGING

The world of relations, networks, “real-life” & inter-disciplines



BASICS: DEFINITIONS AND TYPES

WHAT IS A SYSTEM?

"A system is an interconnected set of elements that is coherently organised in a way that achieves something."

(Meadows, 2008)

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Components of a System

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elements

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"A system is an interconnected set of elements that is coherently organised in a way that achieves something."
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relationships between elements

elements

Components of a System

WHAT IS A SYSTEM?

"A system is an interconnected set of elements that is coherently organised in a way that achieves something."
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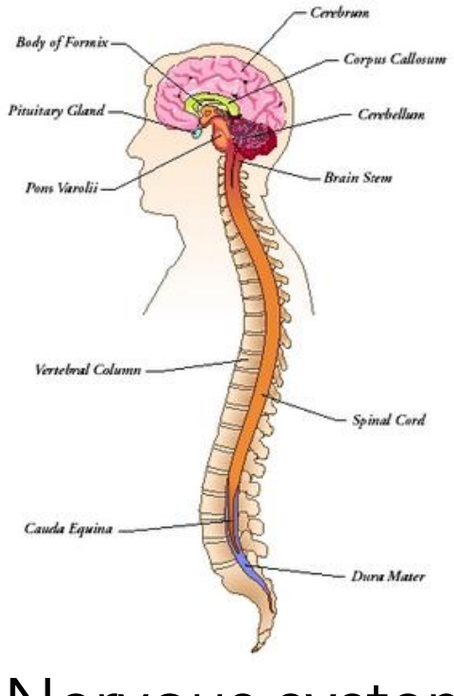
purpose

relationships between elements

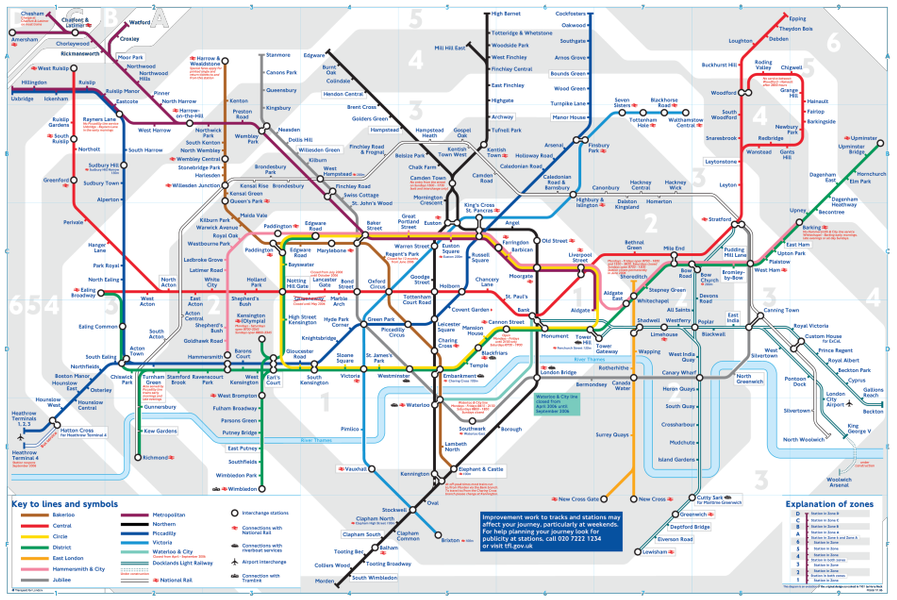
elements

Components of a System

EXAMPLES OF SYSTEMS



Nervous system

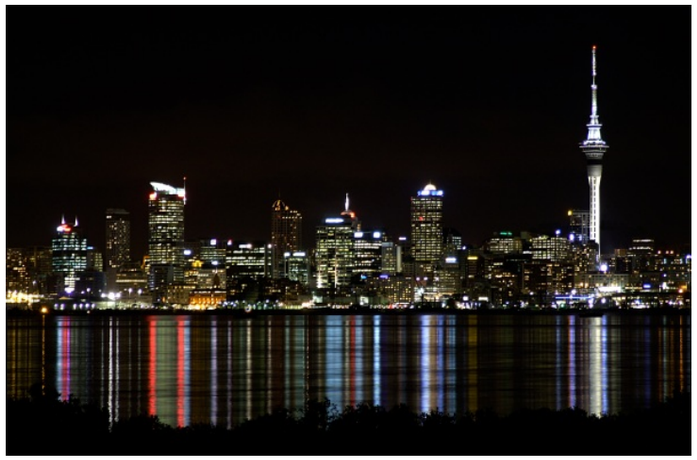


London metro

Andromeda galaxy

A Frog

A Bicycle



A City

WHAT IS A SYSTEM?

"A system is an interconnected set of elements that is coherently organised in a way that achieves something."
(Meadows, 2008)

purpose

relationships between elements

elements - human and non-human

Components of a System

WHAT IS A SYSTEM?

"A system is an interconnected set of elements that is coherently organised in a way that achieves something."
(Meadows, 2008)

purpose - differs based on perspective

relationships between elements

elements - human and non-human

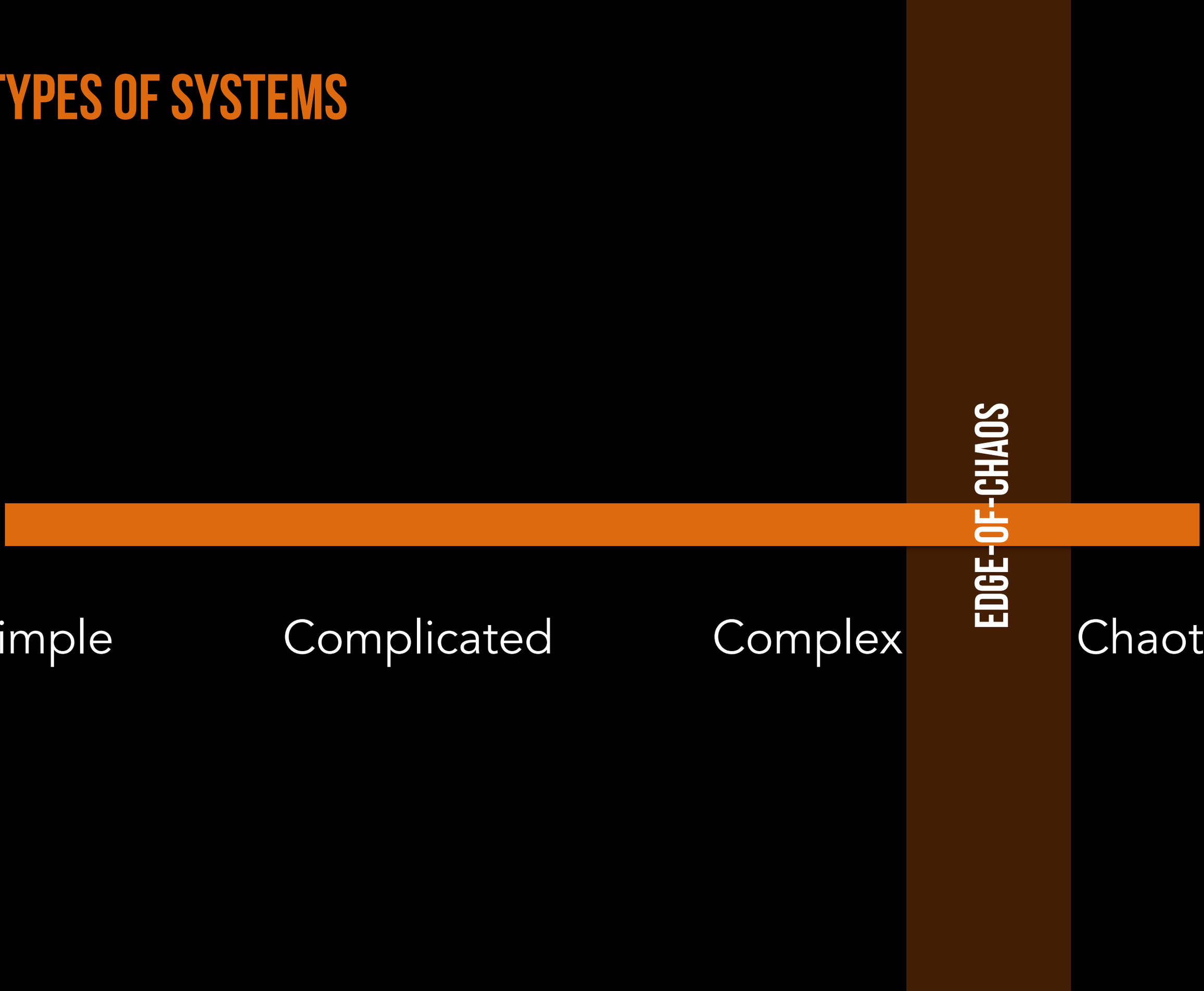
Components of a System

CIRCLES IN THE AIR.....

CIRCLES IN THE AIR.....

WHAT DID YOU OBSERVE?

TYPES OF SYSTEMS



TYPES OF SYSTEMS

TYPES OF SYSTEMS

A complex system

A simple system

TYPES OF SYSTEMS

A complex system

A simple system

In design/engineering/planning we deal with both and mostly at the same time as components of larger (highly-complex) systems.

TYPES OF SYSTEMS

A complex system

A simple system

So, what are some of the differences between these two?

TYPES OF SYSTEMS

A complex system

unpredictable behaviour

large number of components

many interactions

decentralised decision making

limited or no reducibility

A simple system

predictable behaviour

small number of components

few interactions

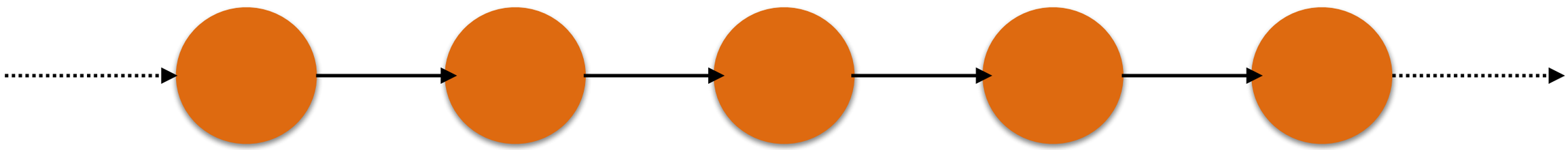
centralised decision making

reducibility

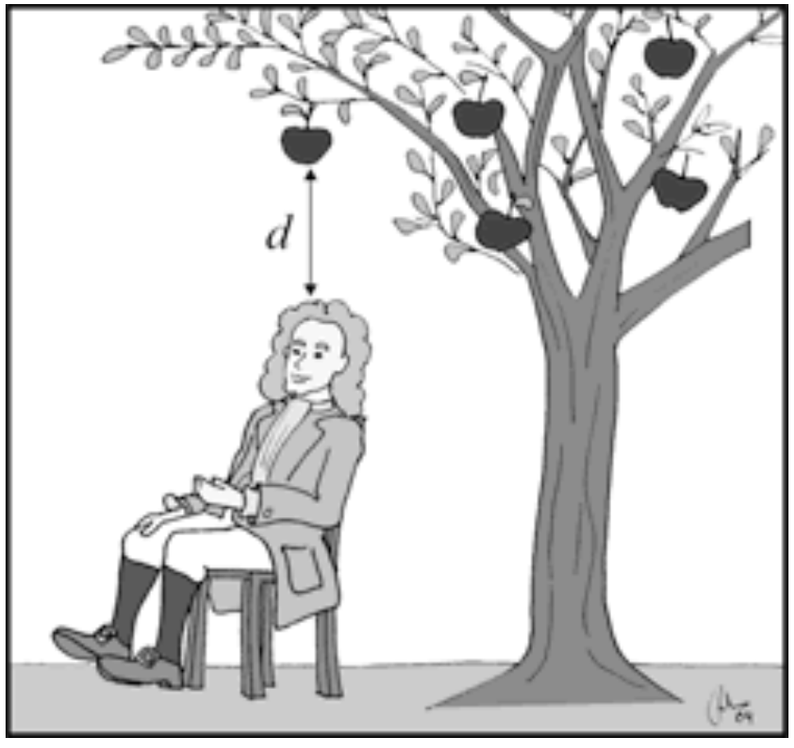
(Casti, 1996)

UNDERSTANDING SYSTEMS: CORE CONCEPTS

UNDERSTANDING SYSTEMS - CAUSALITY



Mechanistic (linear) thinking of cause and effect chains

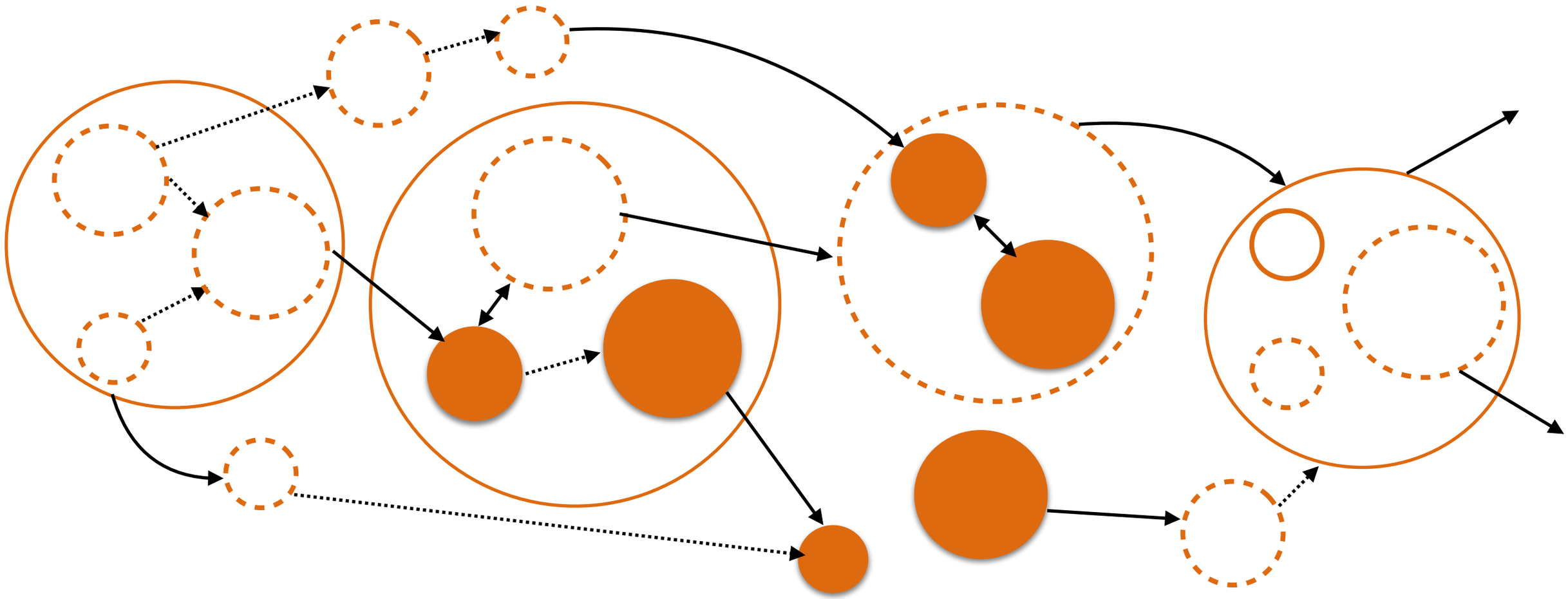


What did cause the apple to fall?

A causes B

"Gravitational force caused the apple to fall."

Only partially true.



Systemic thinking of cause and effect chains

Multiple Causes (or more precisely, Multiple Influences)

The apple is denser than air - The material cause
The apple broke apart from the branch - The formal cause
The gravitational force pulled the apple towards the centre of the earth - The efficient cause
The apple was ripe - The final cause

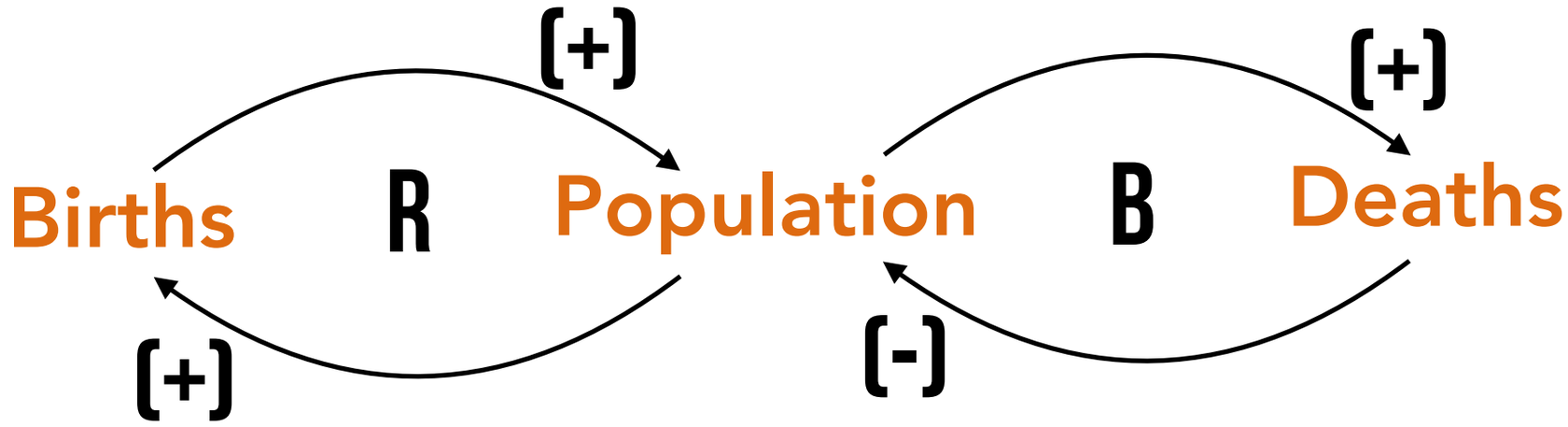
UNDERSTANDING SYSTEMS - FEEDBACK LOOPS

If A causes B, is it also possible that B causes A?

Feedback is the situation when output from an event in the past will influence an occurrence or occurrences of the same event in the present or future.

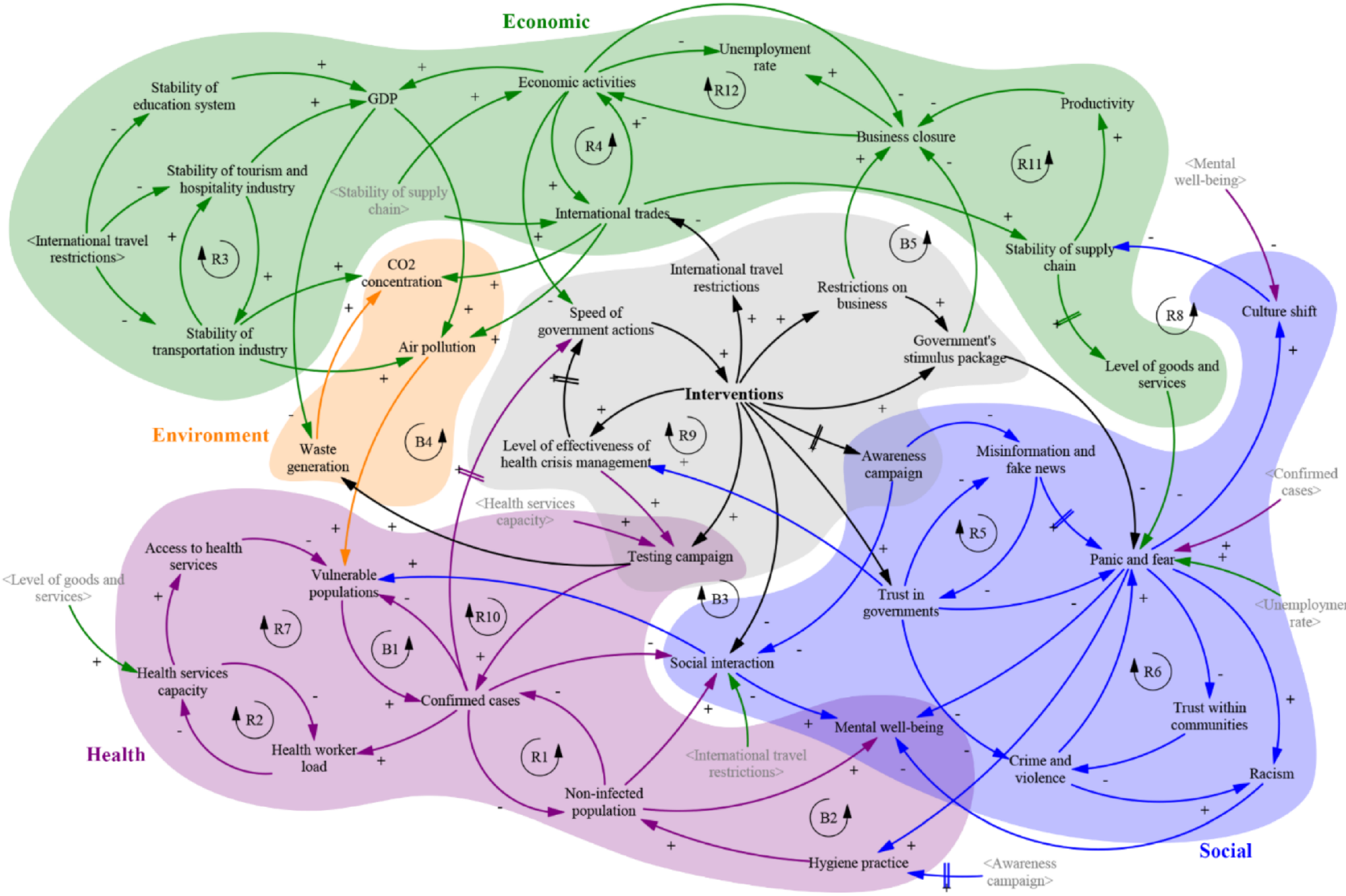
Reinforcing feedback loops – amplifies, increases, moves in the same direction

Balancing feedback loops – decreases, moves in the opposite direction



Depending on which loop dominates the population will either decline or increase. If neither of the loops dominate than the population will not change.

CAUSAL LOOP DIAGRAMS



Sahin, O.; Salim, H.; Suprun, E.; Richards, R.; MacAskill, S.; Heilgeist, S.; Rutherford, S.; Stewart, R.A.; Beal, C.D. Developing a Preliminary Causal Loop Diagram for Understanding the Wicked Complexity of the COVID-19 Pandemic. *Systems* **2020**, *8*, 20.

UNDERSTANDING SYSTEMS - SHIFTING THE BURDEN

Shifting the burden arise when a solution to a systemic problem reduces (or disguises) the symptoms, but does nothing to solve the problem

Exporting waste
Drug abuse for psychological relief
Symptomatic relief medicines
More roads to combat congestion
ETC.

Shifting the burden is a result of either reductionism or short-termism or both

UNDERSTANDING SYSTEMS - CAUSAL LAYERS

Events

(who does what to whom?)
Reactive
What happened?

Patterns

(reoccurring patterns over time)
Adaptive
What is happening over time?

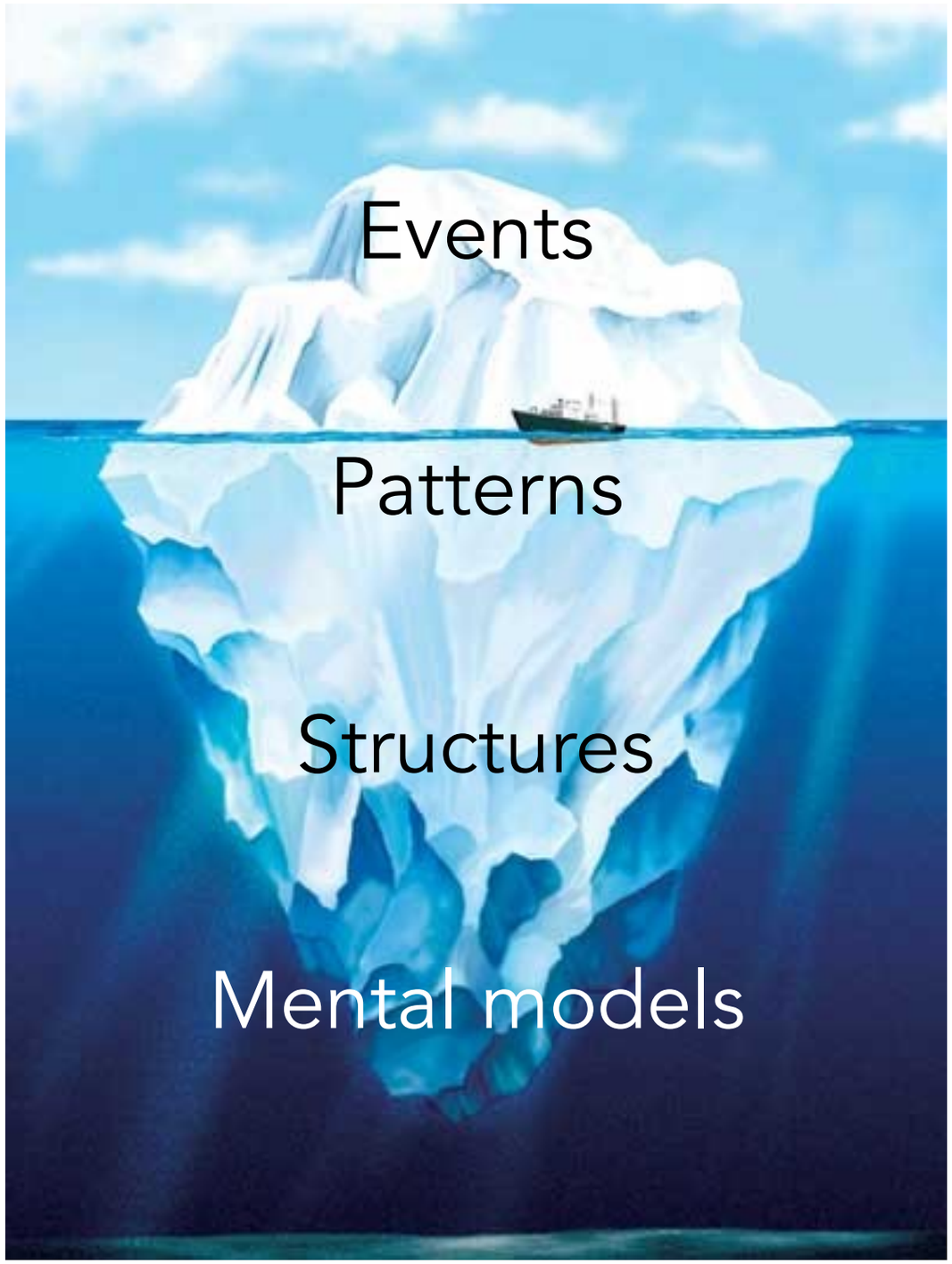
Structures

(how the parts of the system organised)
Creative
Why is this happening?

Mental models

(mental models and assumptions)
Generative
In what ways our mental models
created and sustained
the structures in place?

UNDERSTANDING SYSTEMS - CAUSAL LAYERS



increasing poverty

rich gets richer, poor gets poorer

current economic paradigm results in assets to be accumulated in nodes

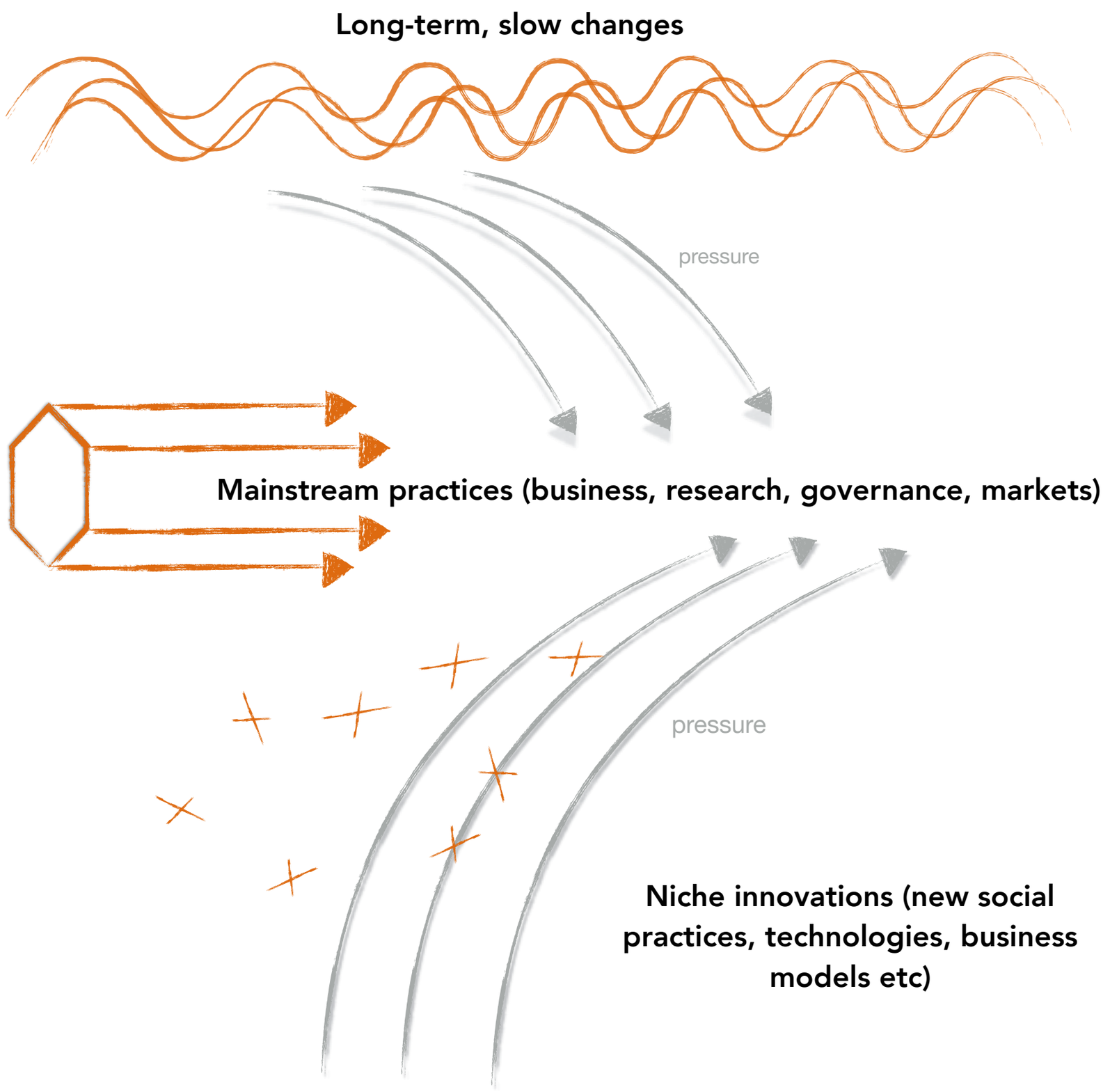
wealth=financial wealth; it's ok to have a lot of disposable income; inequality is ok; my wellbeing is independent from the wellbeing of others

ANY QUESTIONS?

THEORIES OF SYSTEMIC CHANGE AND SUSTAINABILITY

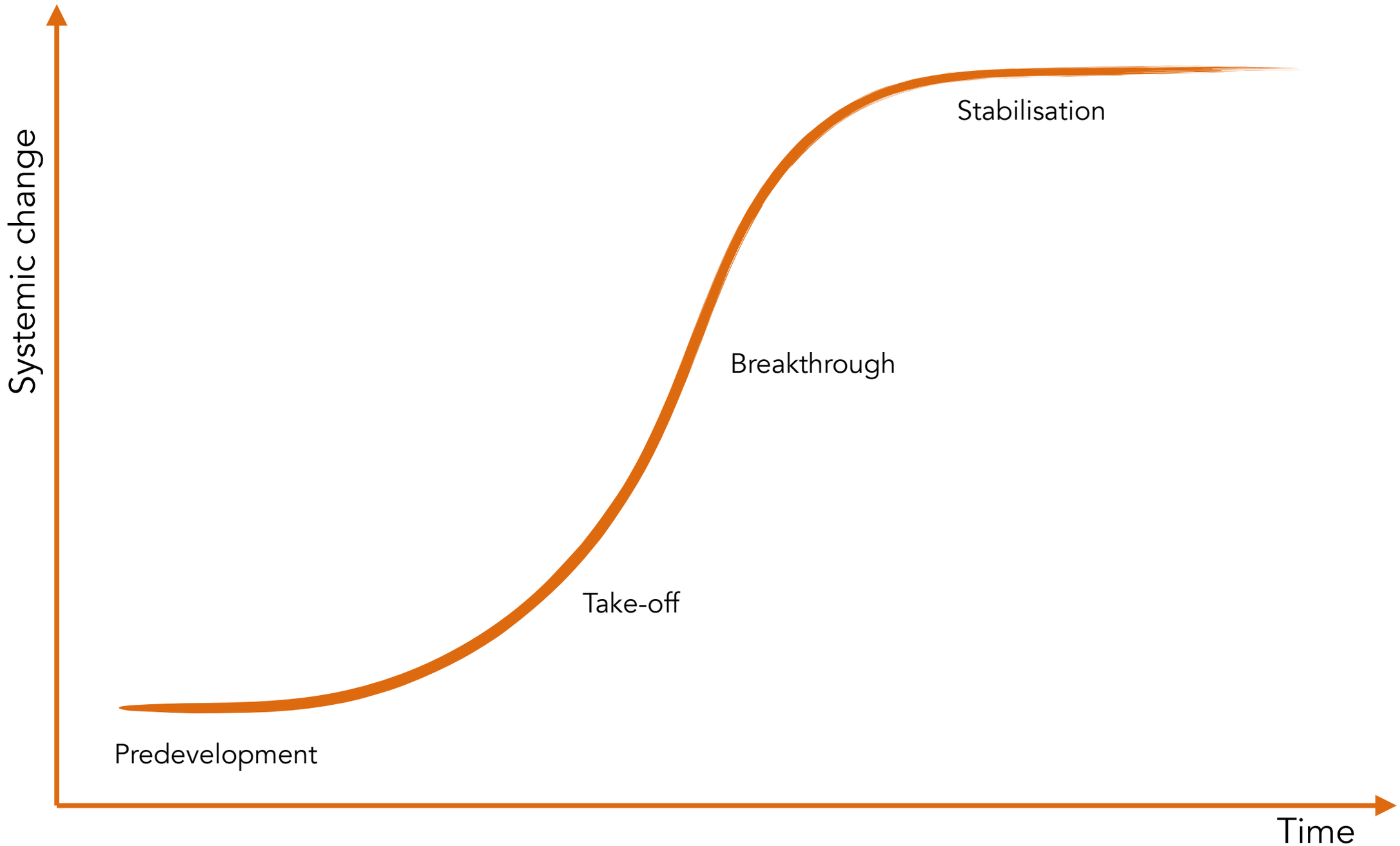
MULTI-LEVEL PERSPECTIVE OF SYSTEM INNOVATION

(Geels, 2005; Geels & Schot, 2007)

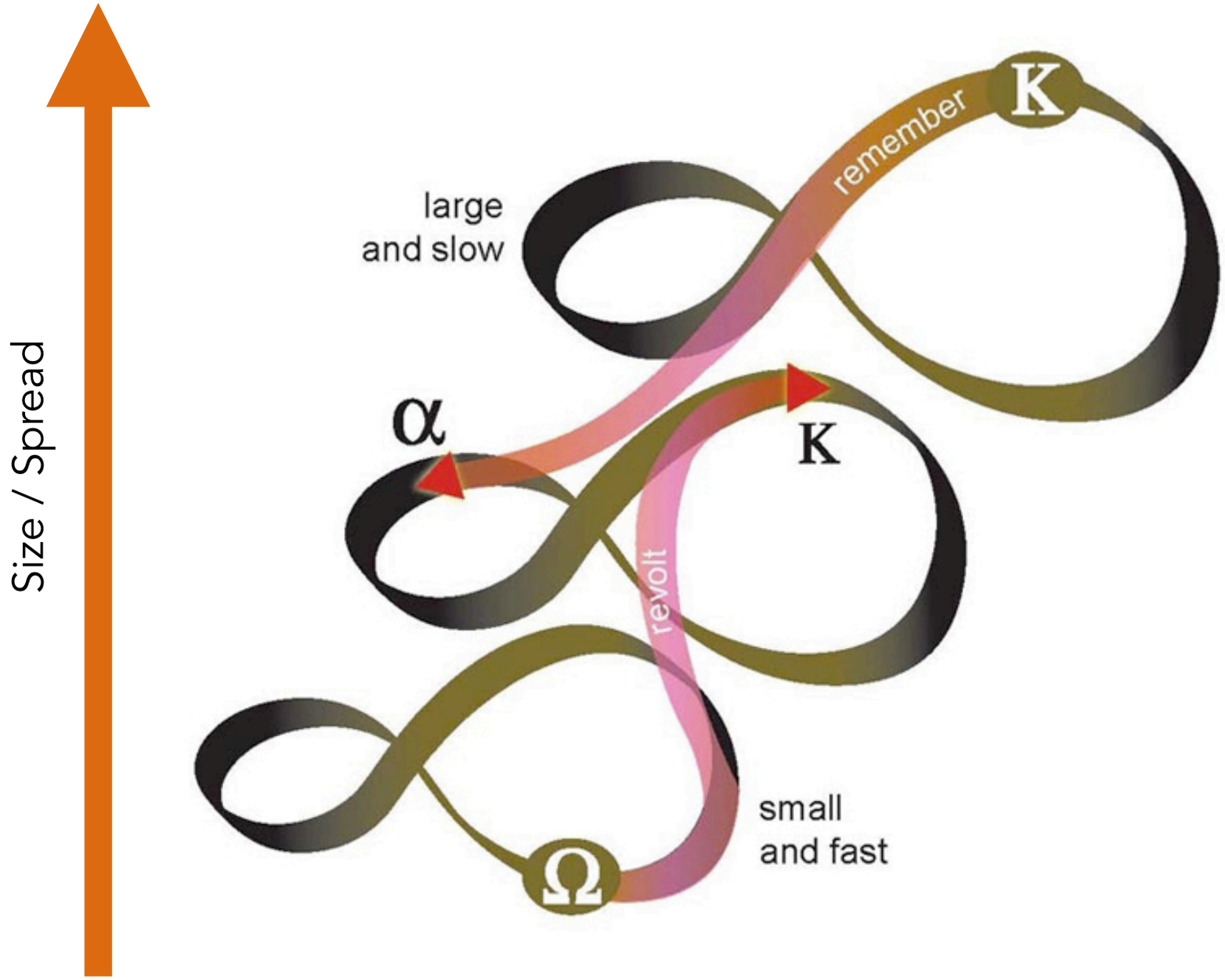


MULTI-PHASE MODEL OF SYSTEM INNOVATIONS

(Rotmans et al., 2000)



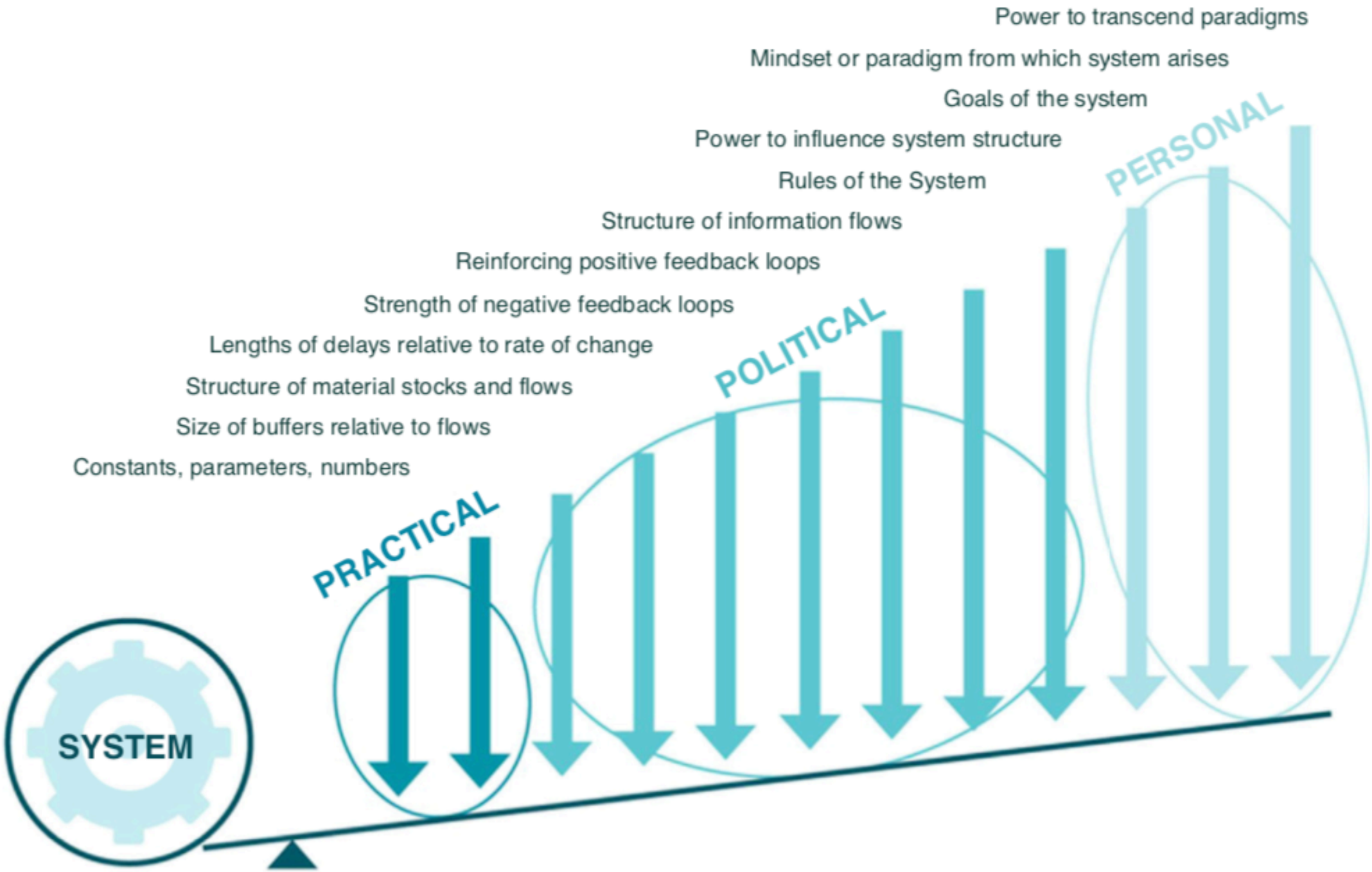
PANARCHY & ADAPTIVE GOVERNANCE OF SYSTEMIC CHANGE



Adapted from Gunderson and Holling (2002)

WHAT I LIKE AND USE MOST THESE DAYS?

LEVERAGE POINTS TO INTERVENE IN SYSTEMS



(Meadows, 1999)

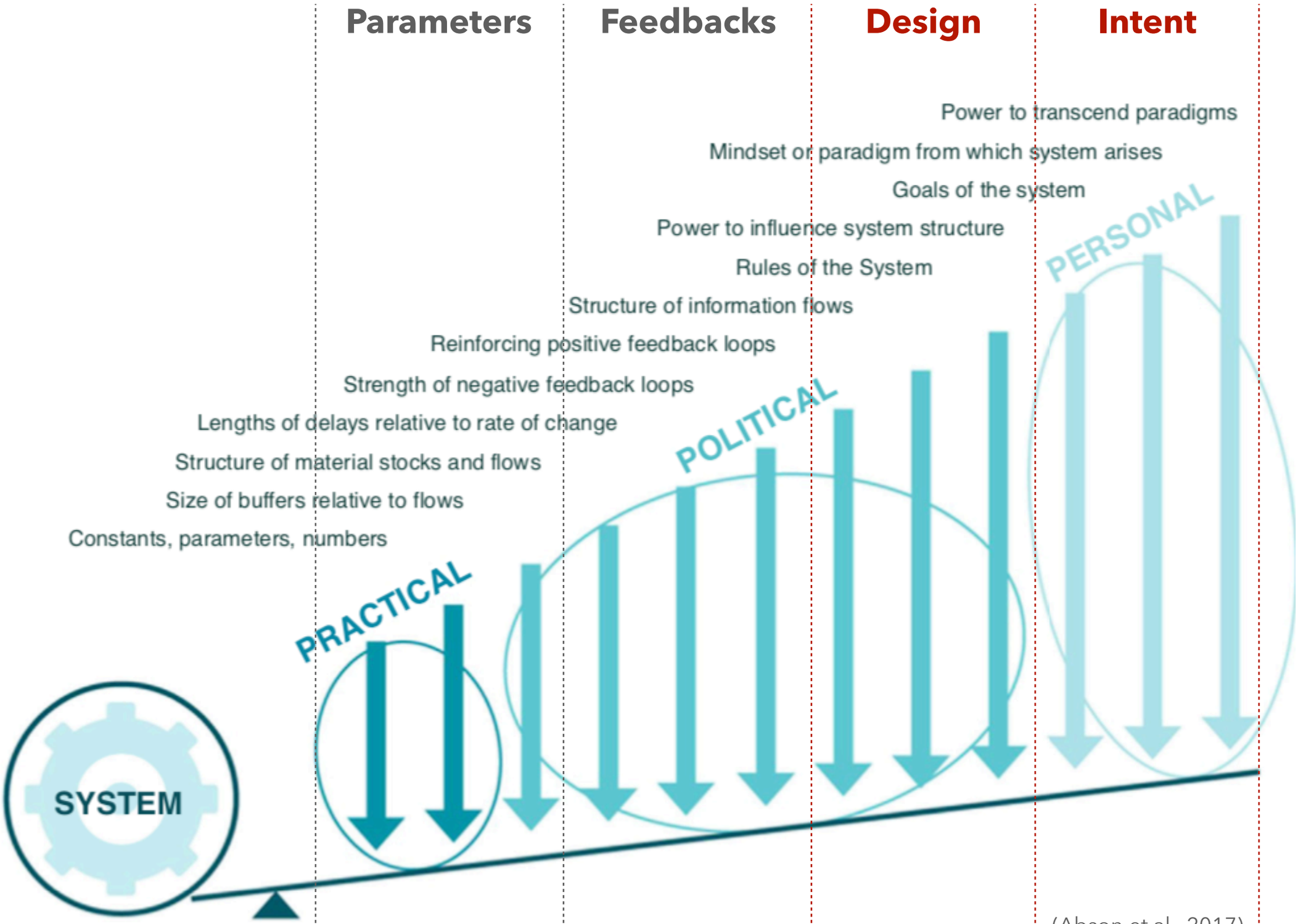
DEEP LEVERAGE POINTS

e.g. Average fuel consumption of a car

e.g. The extent to which poverty leads to population growth, which may further exacerbate poverty

e.g. Ability of farmers to organize the sustainable use of a communal pasture

e.g. The conscious shift from a growth–based economy to a steady–state economy



(Abson et al., 2017)

KEY ADVANTAGES OF LEVERAGE POINTS PERSPECTIVE

First advantage: A leverage points perspective **can bridge causal and teleological explanations of system change** – that is, change is seen to arise from variables influencing one another, but also from how human intent shapes the trajectory of a system.

Second advantage: A leverage points perspective **explicitly recognizes influential, 'deep' leverage points** – places at which interventions are difficult but likely to yield truly transformative change.

Third advantage: A leverage points perspective **enables the examination of interactions between shallow and deep system changes** – sometimes, relatively superficial interventions may pave the way for deeper changes, while at other times, deeper changes may be required for superficial interventions to work.

Fourth advantage: A leverage points perspective **can function as a methodological boundary object** – that is, providing a common entry point for academics from different disciplines and other societal stakeholders to work together.

(Fischer & Rieher, 2018)

THANK YOU!

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