SYSTEMS THINKING

INTRODUCTION

Hella Hernberg | Aalto University | Design for Government | 15 Mar 2023

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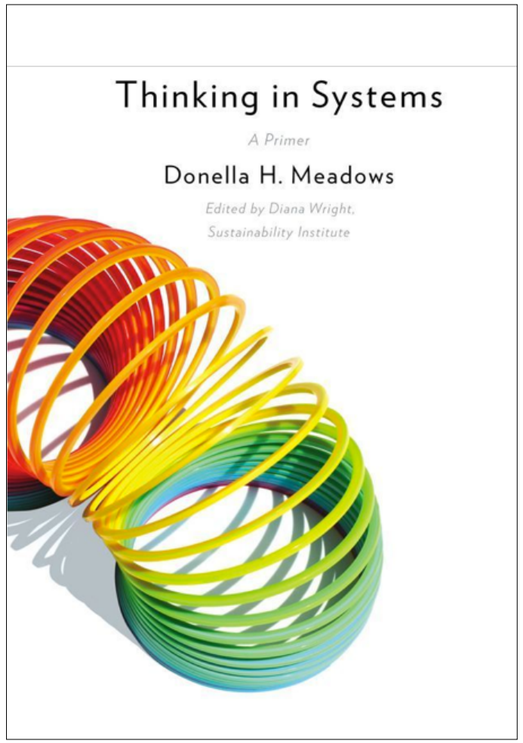
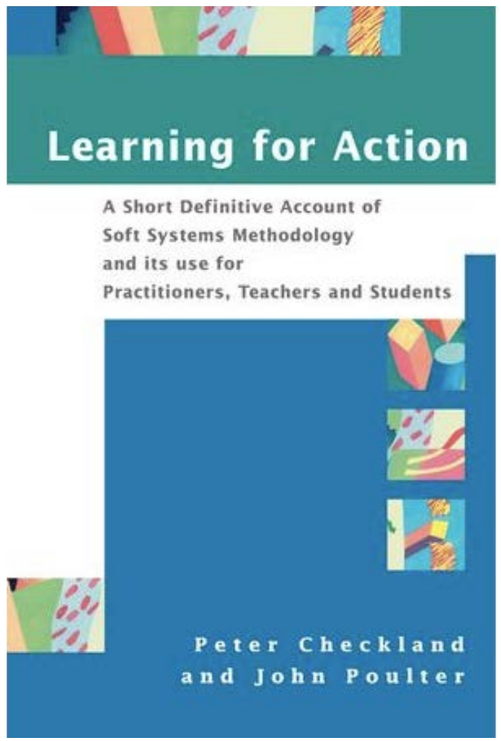
Today's schedule:

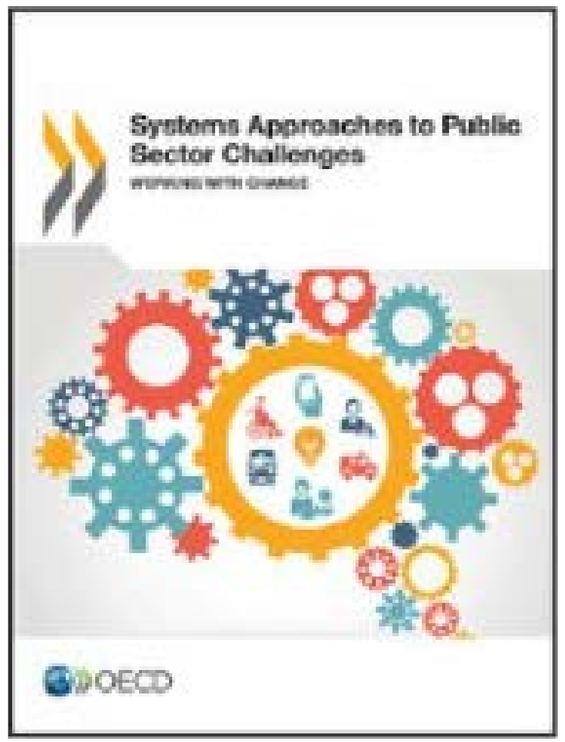
9:15-10:00	Lecture: Introduction to systems thinking
	Break (5 mins)
10:05-10:20	Introduction to systems maps
10:20-11:50	Systems maps: group excercises
11:50-12:00	Sharing and discussion

Afternoon:

13:15-14:15	Reading discussion: Systems Thinking
14:30-16:00	Group tutorials







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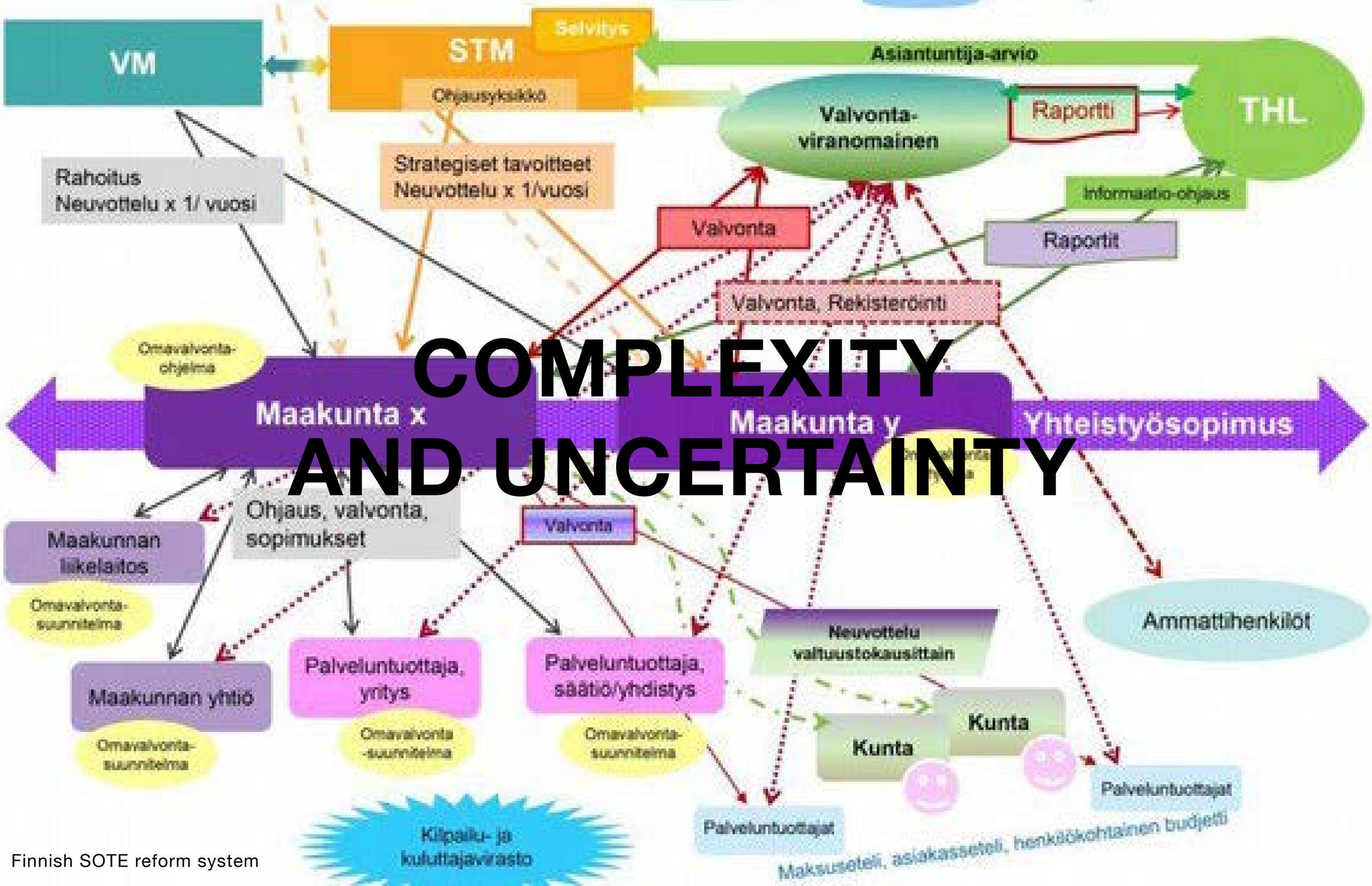

Finnish SOTE reform system

"One key concern is how best to account for uncertainty while managing greater complexity and still deliver effective services."

– OECD (2017)

Primary problems of the 21st Century are ‘wicked problems’

Healthcare, education, social services, welfare state, climate change, sustainability and resiliene, economic development, immigration, democracy, etc.

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Some key aspects of wicked problems:

- **Multiple stakeholders,** each acting to a certain extent within their own norms.
- **Complete diagnosis or understanding is not possible.** Each perspective from which the problem is viewed provides a different understanding of its nature.
- **There are no optimum solutions** to wicked problems. Long-term options are often discounted in favour of short-term agreements.
- Because wicked problems are **impossible to observe directly,** they are **unpredictable** and their **behaviour is uncertain.**
- **The efficacy of solutions is difficult to determine.**

OECD (2017)

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"A systems-oriented view of problems challenges the idea that healthcare, say, is the responsibility of a Department of Health."

–Dan Hill

Image from arvato.com

WHY SYSTEMS THINKING AND DESIGN?

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Design and systems thinking share a common orientation to complex problems:

to effect highly-leveraged, well-reasoned, and preferred changes in situations of concern.

Systems thinking promotes the **analytical** understanding of complex **problem** situations.

Design disciplines demonstrate an **action-oriented** approach toward creative **solutions**.

Jones, 2014

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WHAT IS THE PROBLEM?

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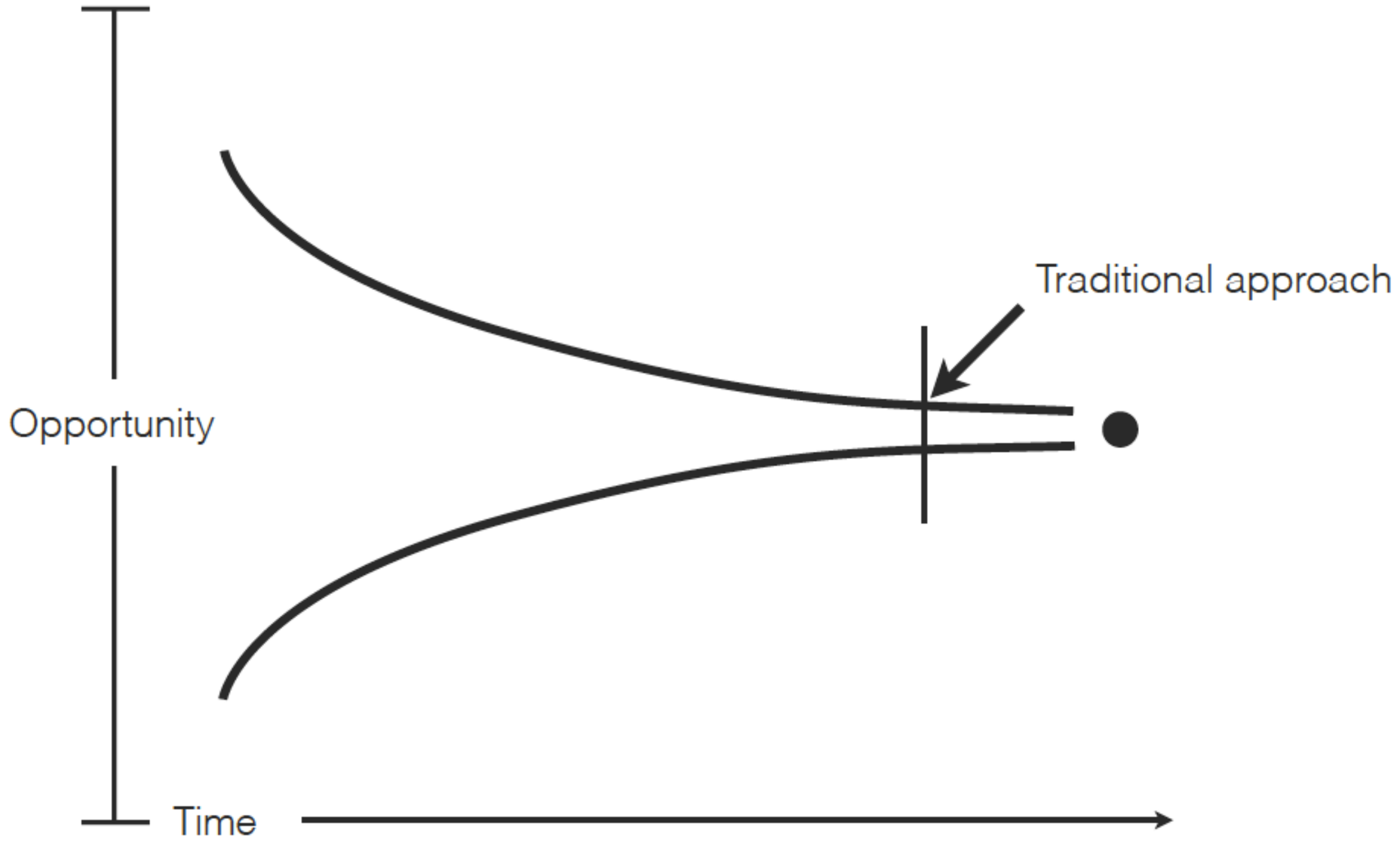
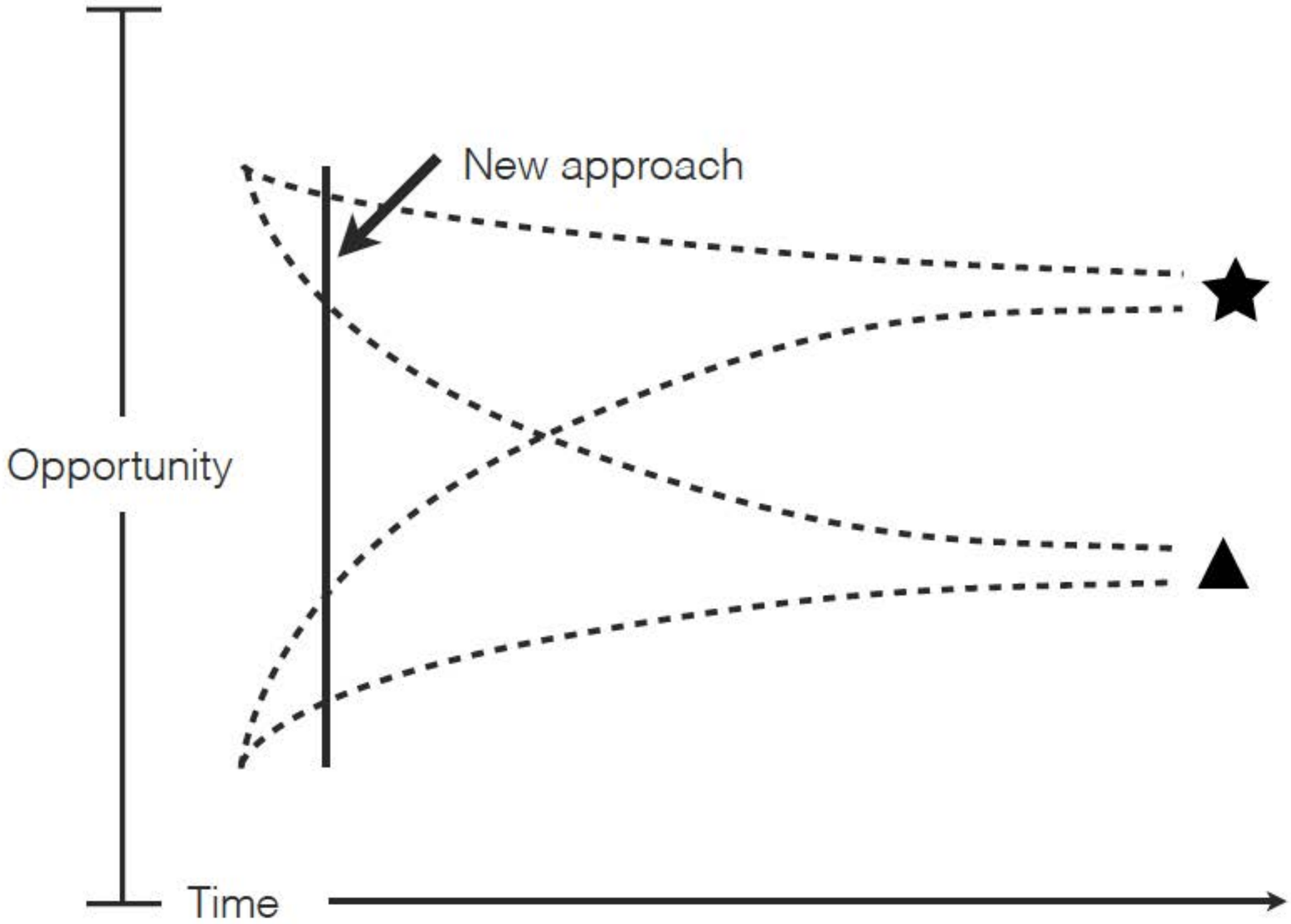


Attribution: Marco Steinberg, Sitra



Attribution: Marco Steinberg, Sitra

WHAT IS A SYSTEM?

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*A system is a **set of things** – people, cells, molecules, or whatever – **interconnected** in such a way that they produce their own **pattern of behavior over time**.*

– Donella H. Meadows (2008)

In other words,
A system has at least:

- a set of elements or entities
- links between them
- a purpose

A System is more than the sum of its parts.

It may exhibit adaptive, dynamic, goal-seeking, self-preserving, and sometimes evolutionary behavior.

Meadows, 2008

SYSTEM STRUCTURE AND BEHAVIOR: THE BASICS

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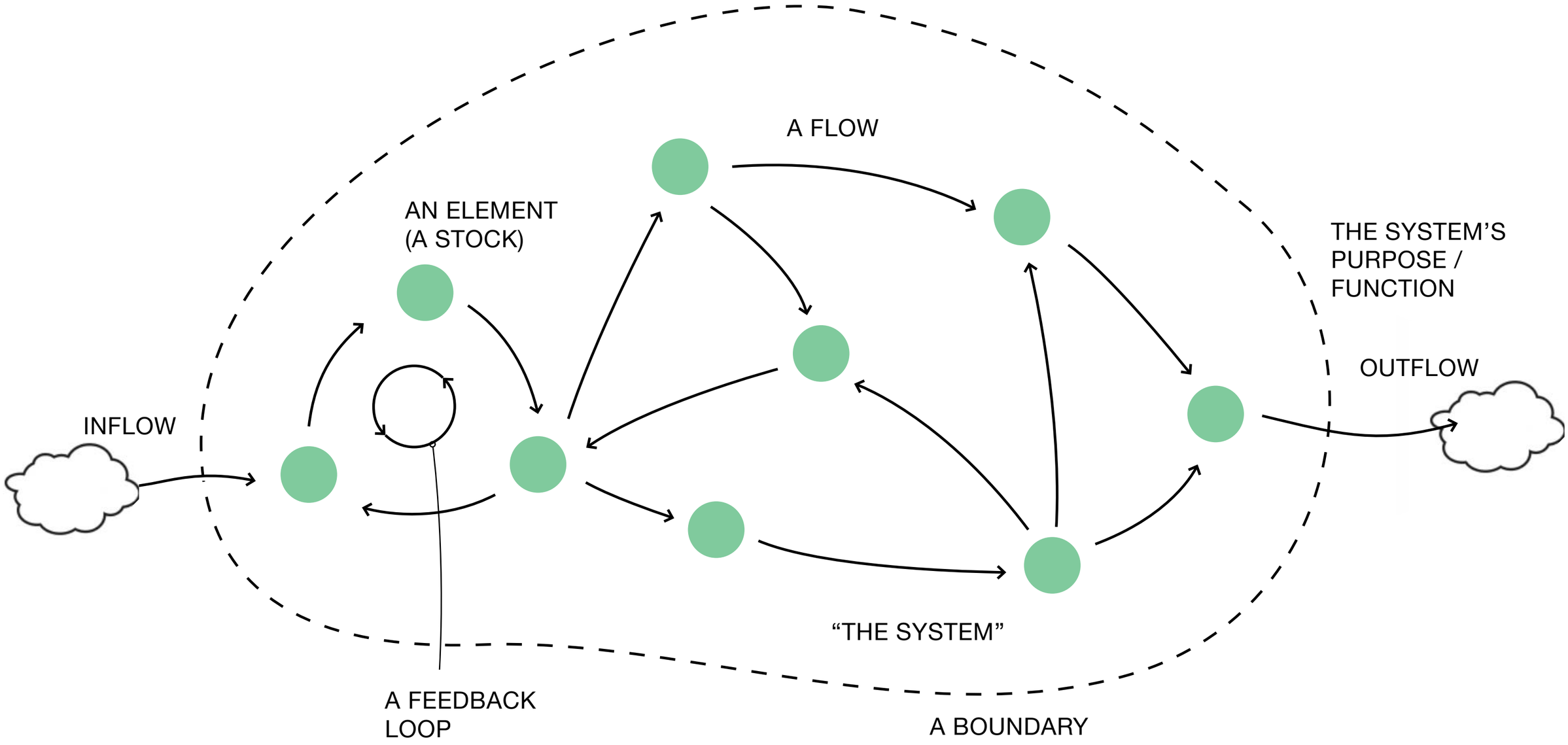
A GENERAL CONCEPTION OF “SYSTEM”



After Flood & Jackson, 1991

EXAMPLES OF A SYSTEM ELEMENT (STOCK)?

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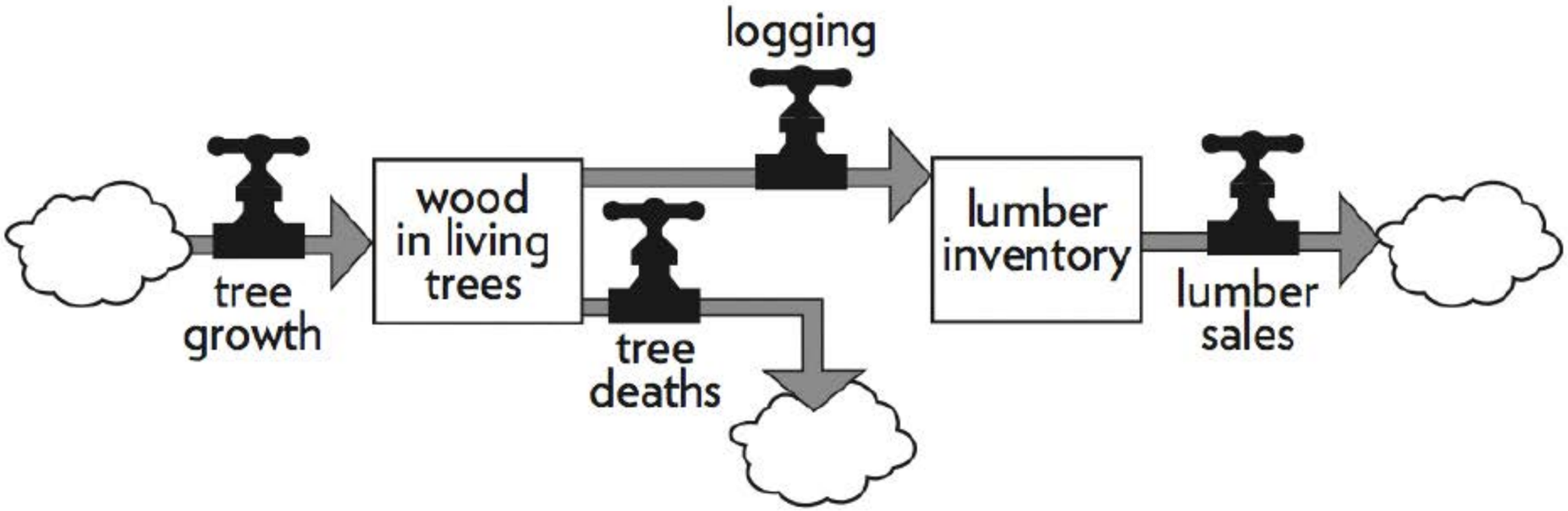
EXAMPLES OF A SYSTEM ELEMENT (STOCK)

A bird population

Producers, suppliers or transporters in a supply chain

An organisation or organisational unit

STOCKS (System elements) AND FLOWS



A stock is the foundation of any system: elements you can see or measure. For example: trees in a forest.

Stocks can be non-renewable or renewable. They can also be non-physical.

Stocks change over time through flows. Examples: inflow/outflow, birth/death, growth/decay, deposit/withdrawal

A stock takes time to change, because flows take time to flow.

Meadows, 2008

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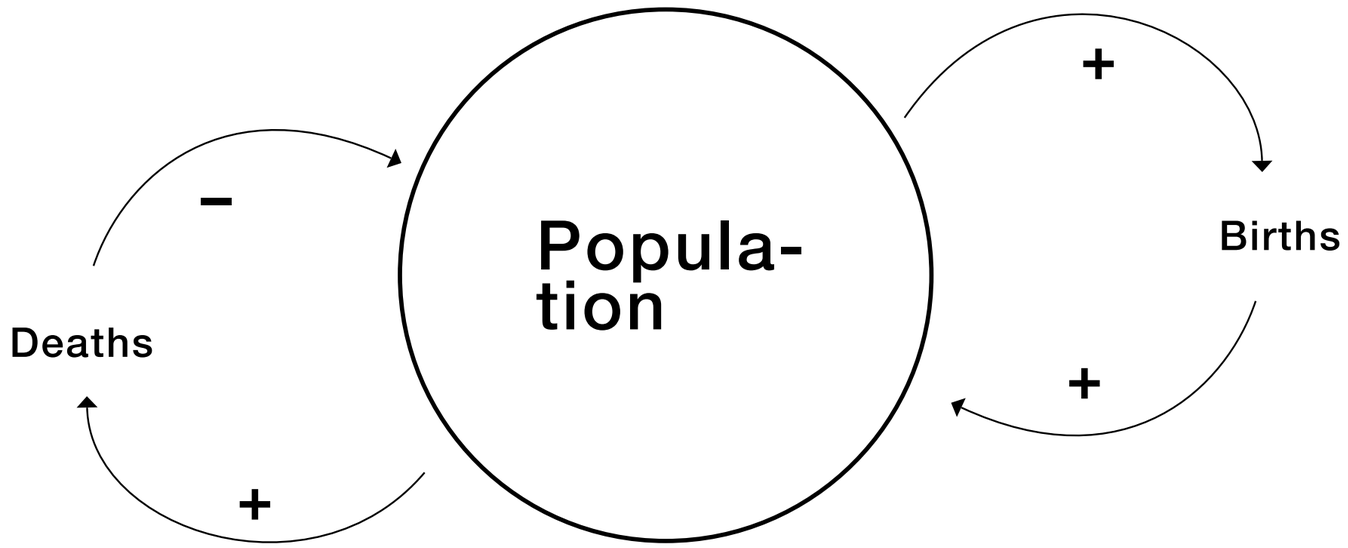
Examples of flows:

- Resource flows (materials, money, energy, etc.)
- Information flows
- Document flows
- Traffic
- etc

FEEDBACK LOOPS

A Feedback loop is a control mechanism that creates consistent behavior over a long period of time.

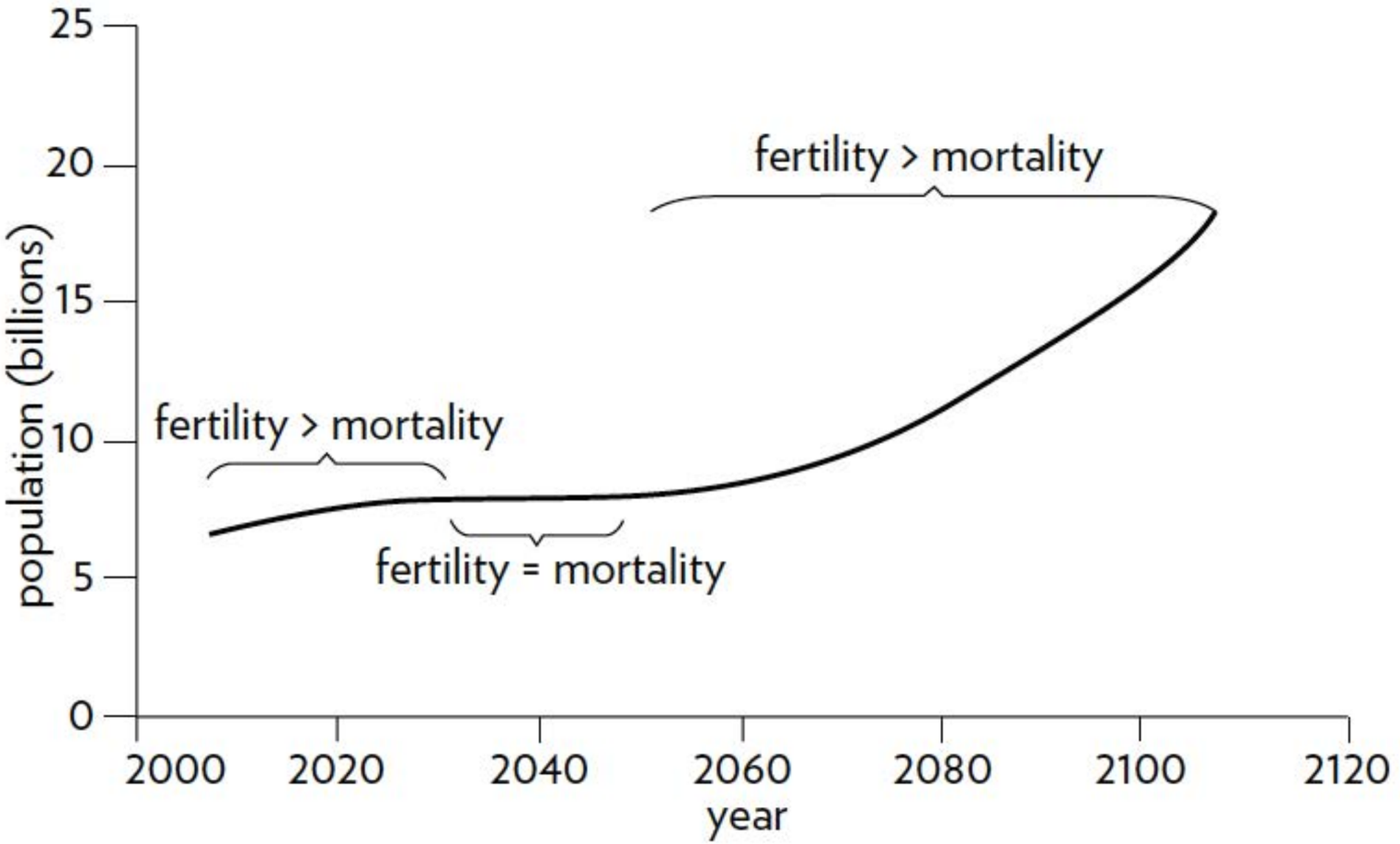


A balancing / negative feedback loop
- stabilizing, goal-seeking
- change to opposite direction

A reinforcing / positive feedback loop
- amplifying, self-muiltiplying, exponential
- More gets more / less gets less

Meadows, 2008

FEEDBACK LOOPS



Balancing feedback loops are necessary in physical, exponentially growing systems as there are always limits to physical growth.

Meadows, 2008

Feedback loops are important intervention points in a system

- They are essential tools in policymaking:
  - Laws, regulations, taxation, incentives, KPI’s, etc.

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Discussion:

What kinds of feedback loops can you identify regarding your project brief?

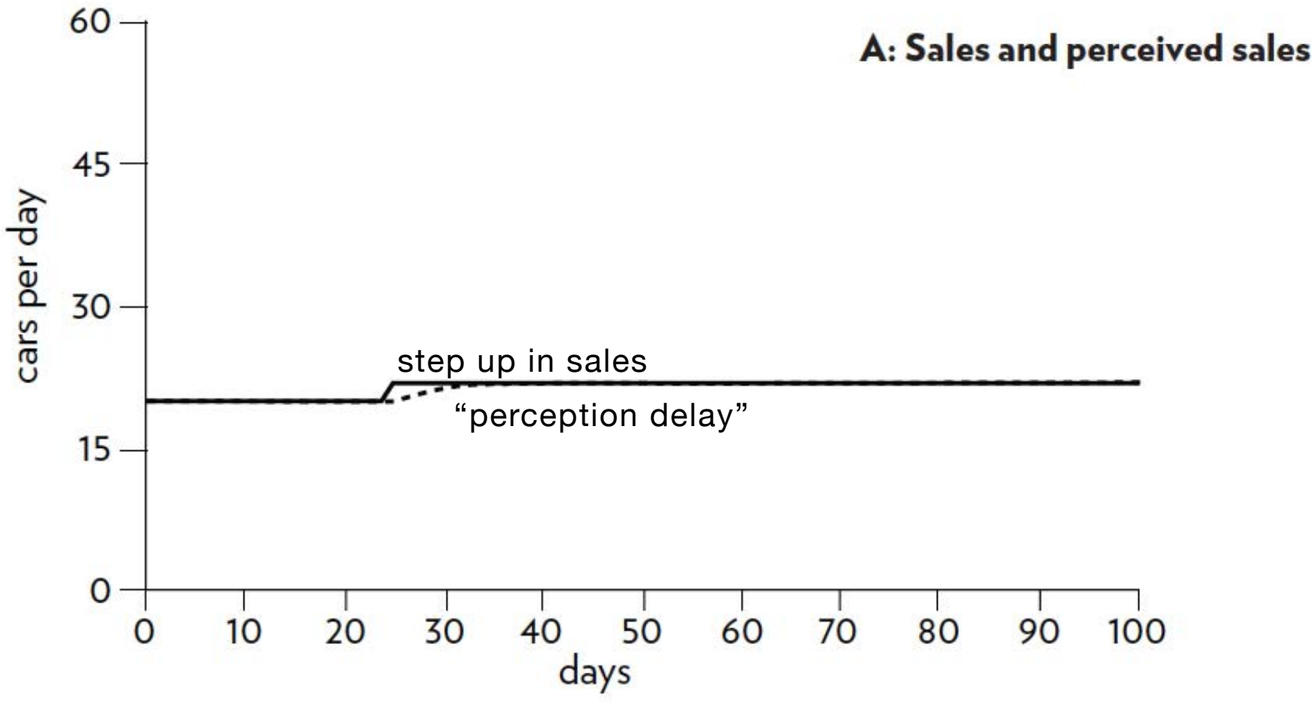
- reinforcing (positive) loops?
- balancing (negative) loops?

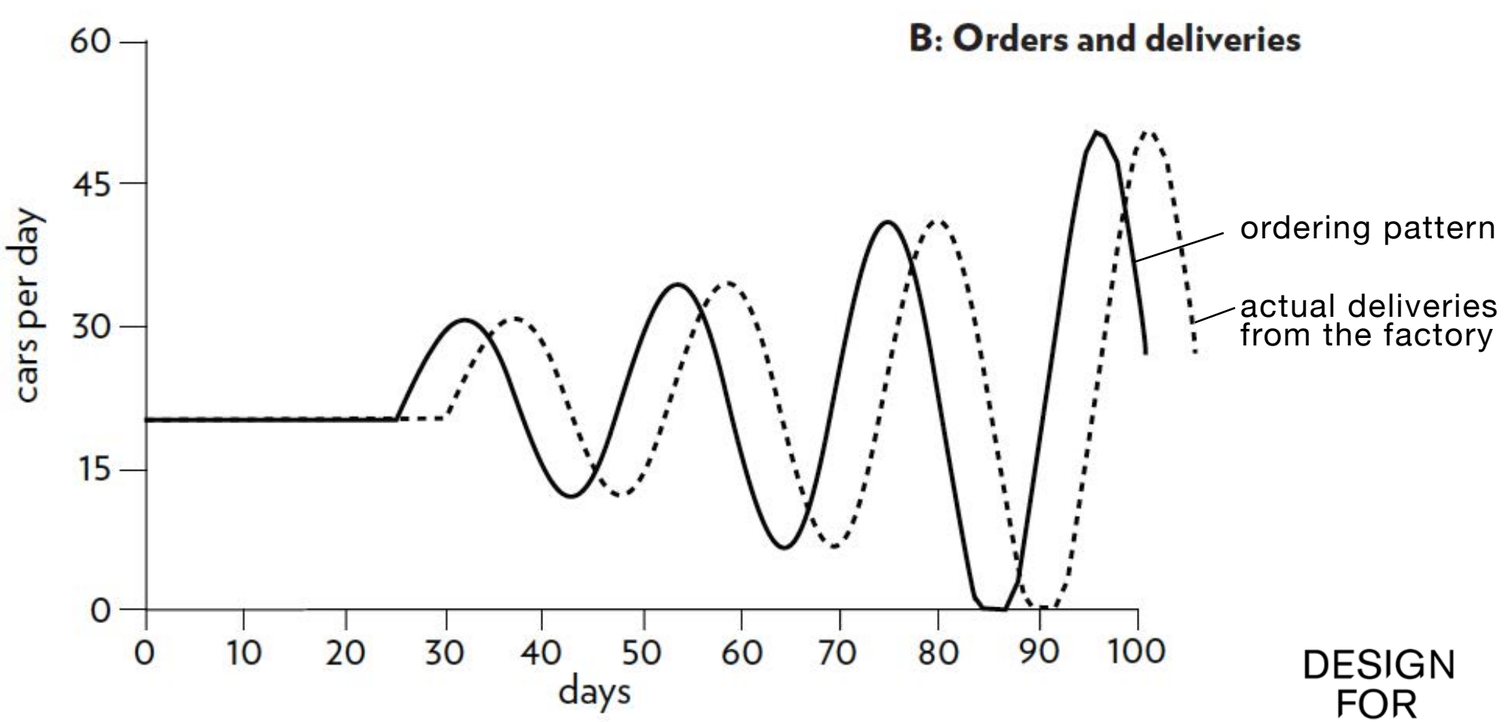
DELAYS

Delays are critical determinants of system behavior.

A delay in a balancing feedback loop makes a system likely to oscillate.

Changing the length of a delay can make a **large change in the behavio**r of the system.
However, usually delays are not easily changeable.





Meadows, 2008

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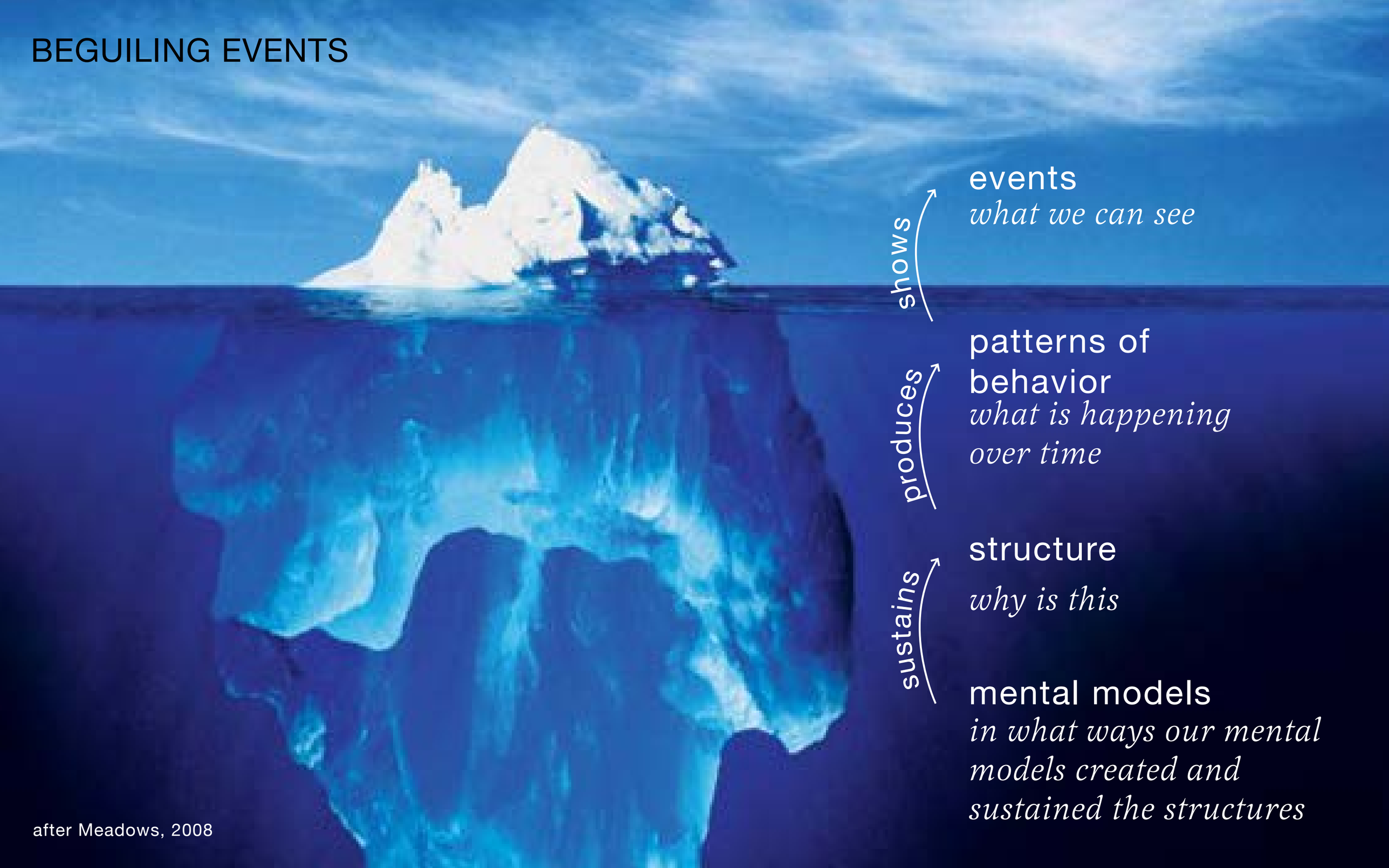
BEGUILING EVENTS



shows

events
what we can see

produces

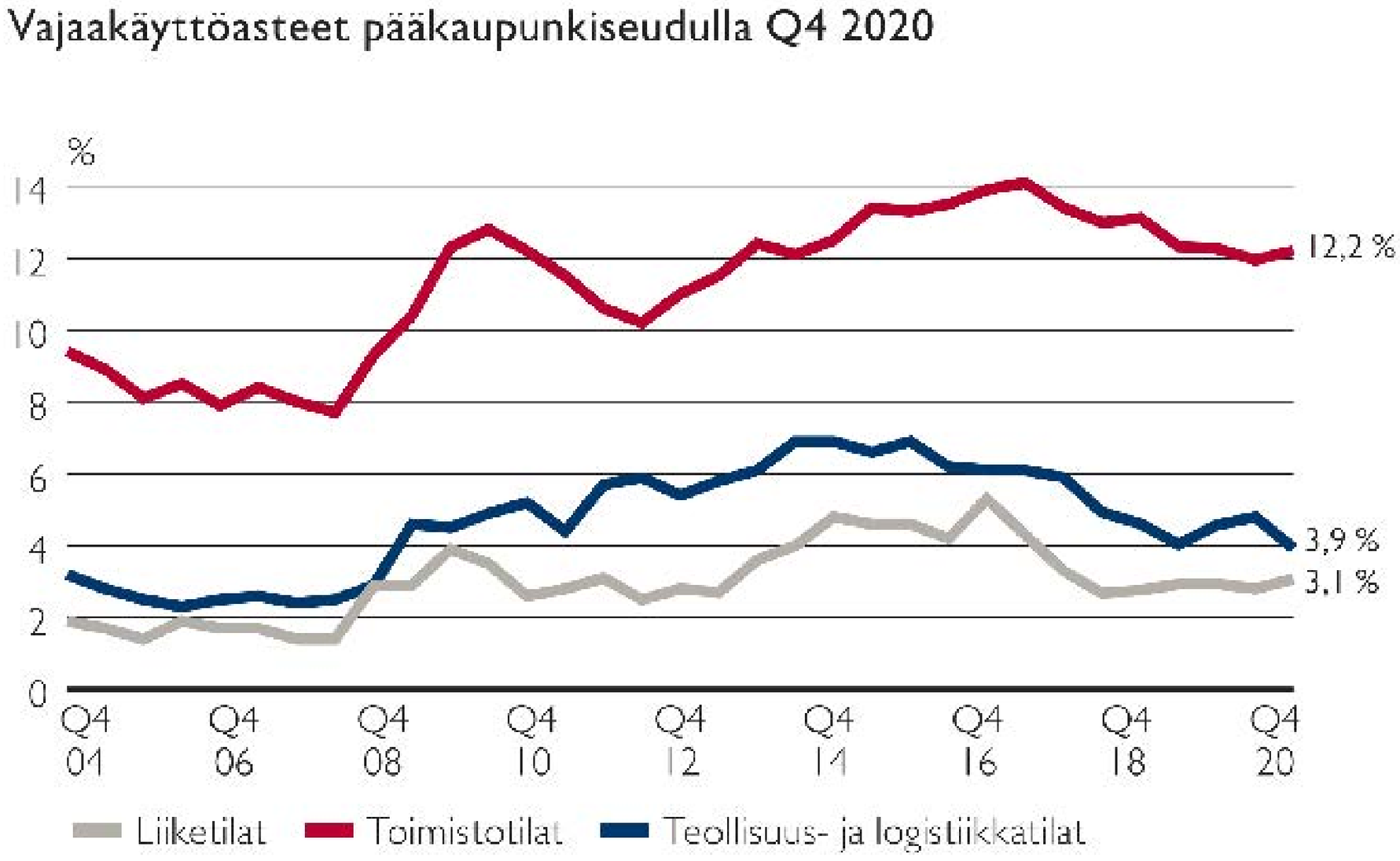
patterns of behavior
what is happening over time

sustains

structure
why is this

mental models
in what ways our mental models created and sustained the structures

after Meadows, 2008



Vacancy rates of office, retail and industrial buildings
in the Helsinki metropolitan area
Source: Catella, 2021

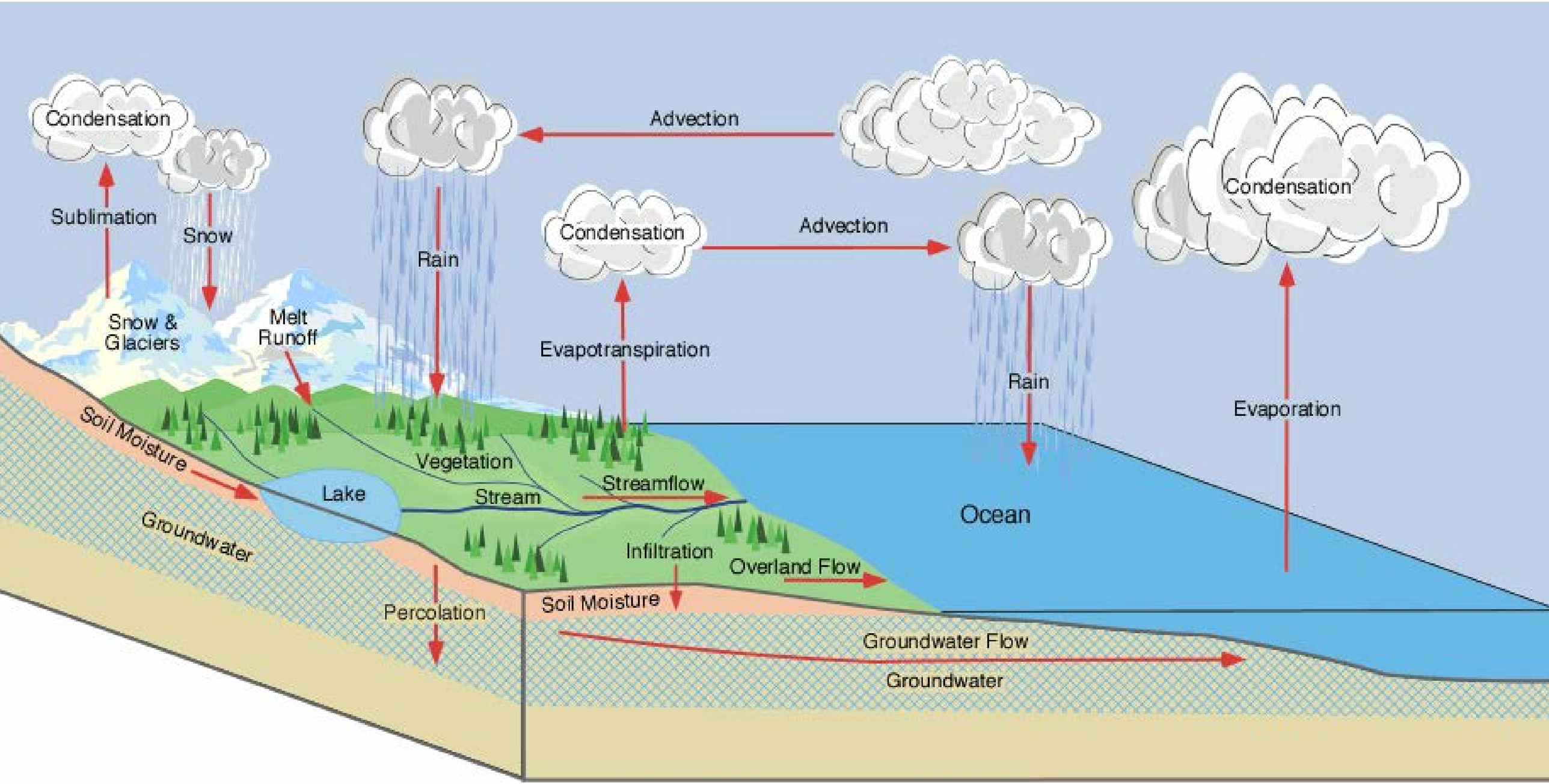
System boundaries:

- Where do you choose to draw the boundary around your system?

System boundaries:

- Where you *choose* to draw the boundary around your system influences how you think about the system.
- It depends on the purpose of the discussion and the questions you want to ask.
- A matter of inclusion and exclusion
- It is necessary to maintain an awareness of things outside your system boundaries.

BOUNDARIES?



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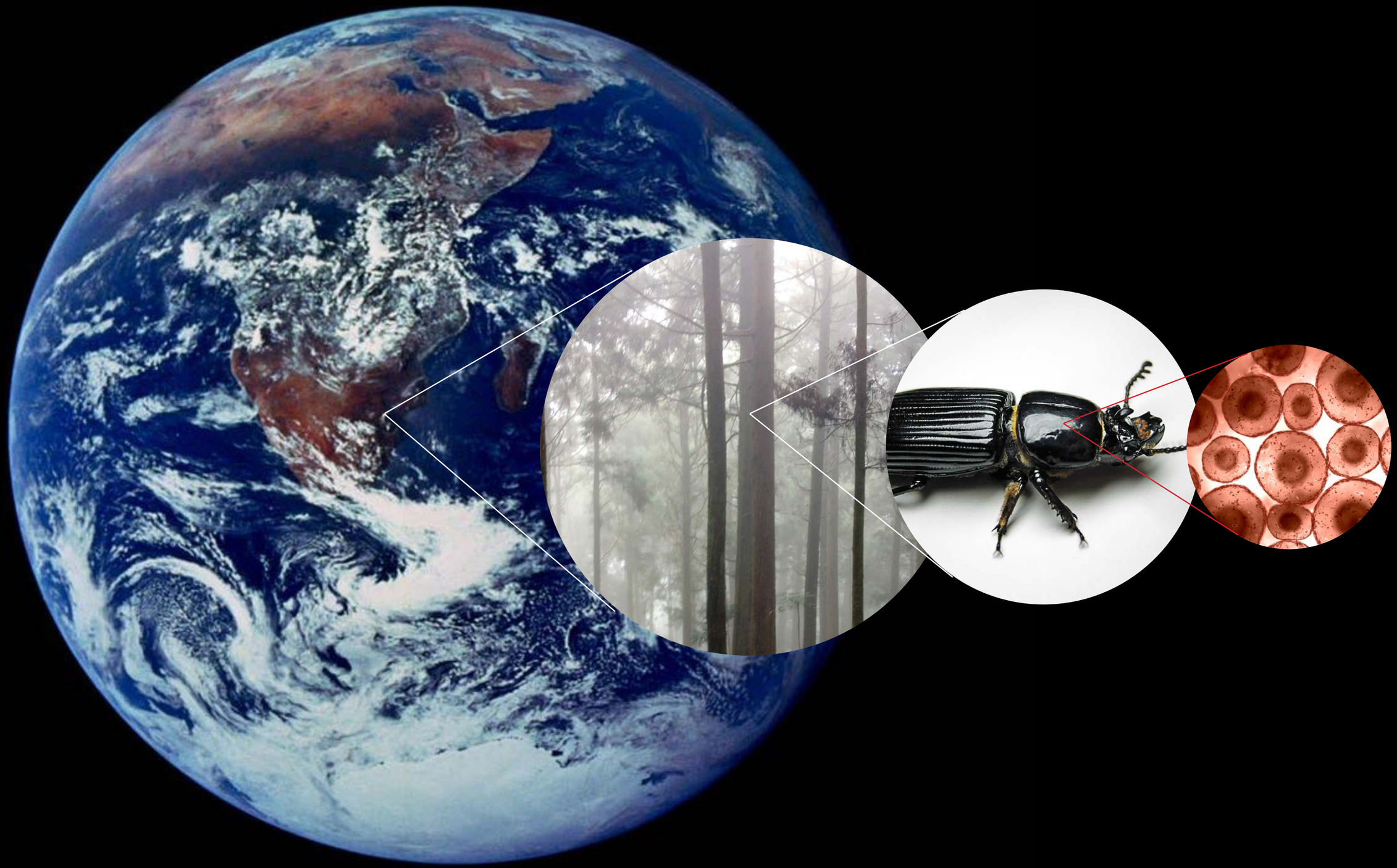
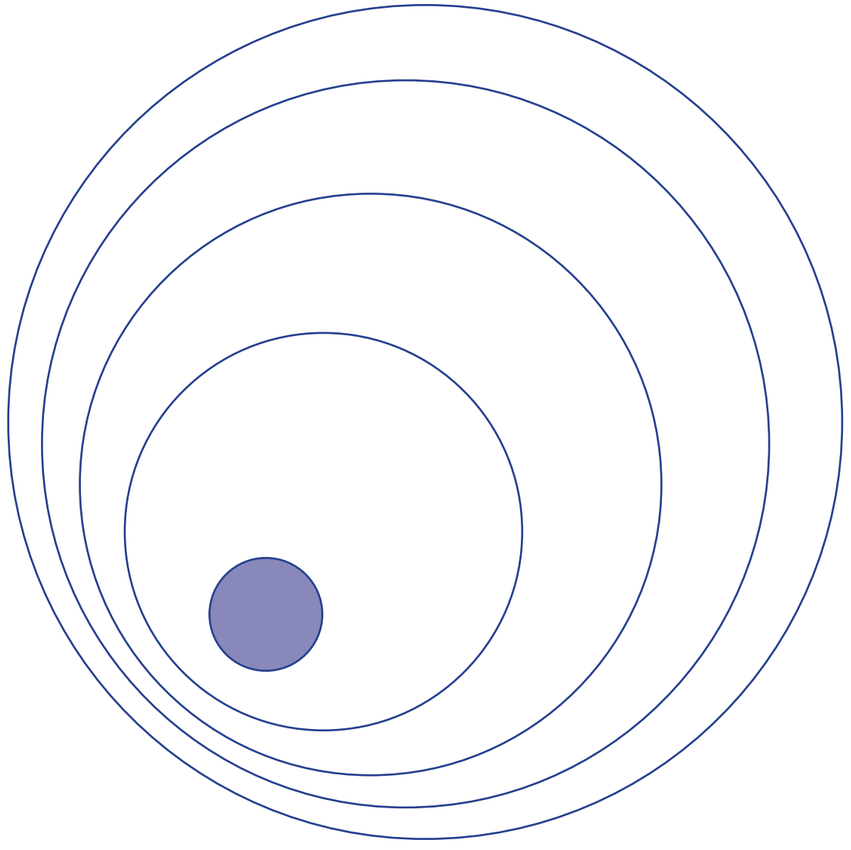
BOUNDARIES: MICRO TO MACRO



"Always design a thing by considering it in its next larger context – a chair in a room, a room in the house, a house in an environment, an environment in a city plan."

–Eliel Saarinen



The purpose of the system

- One of the most powerful ways to influence the behavior of a system is through its purpose or goal.
- The purpose or goal sets the direction of the system, it outputs and how its performance is measured.
- How the system’s purpose is understood depends on the perspective of those looking at the system.

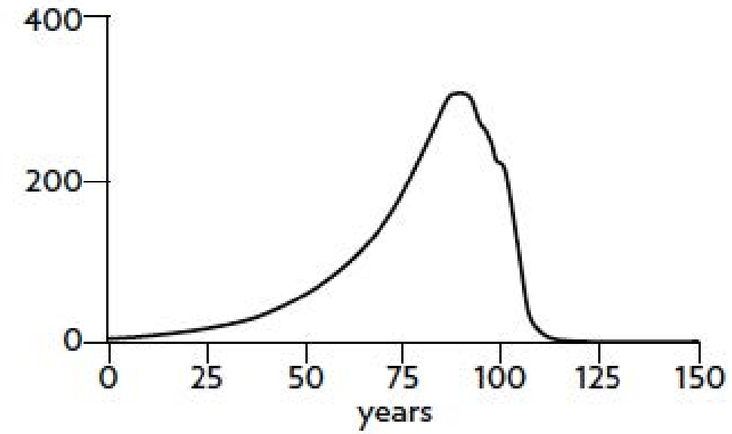
Meadows, 2008

RESILIENCE

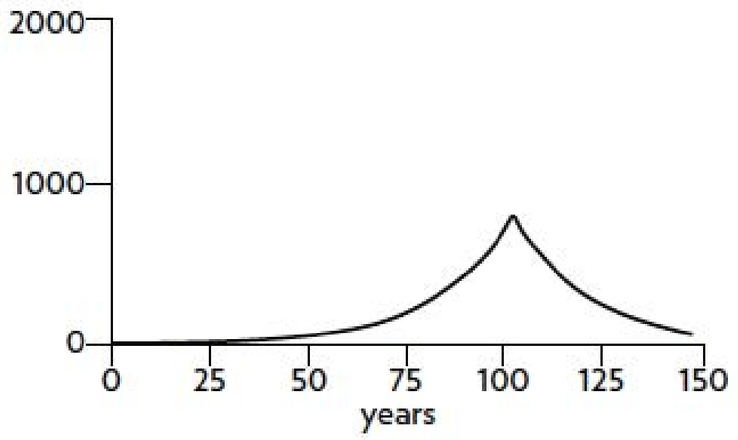
Resilience is the ability of a system to cope with change – to recover from perturbation, the ability to restore or repair themselves.
Systems need to be managed not only for productivity or stability.

NON-LINEARITY

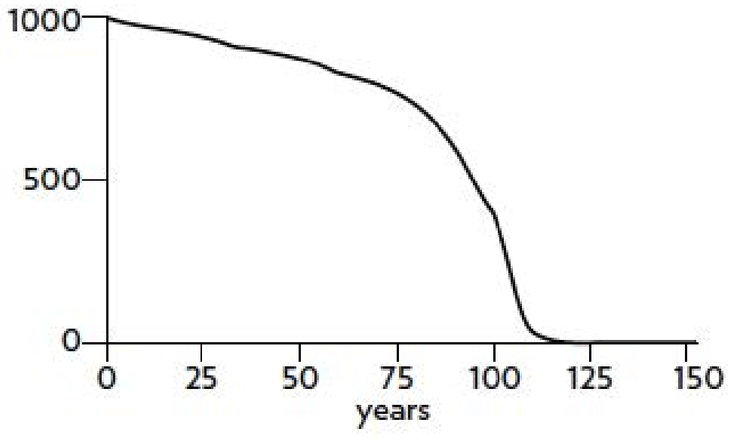
A: Harvest rate
(fishing industry)



B: Capital stock
(fishing boats)



C: Resource stock
(fish in the ocean)



A great increase in yield per unit of capital creates a pattern of overshoot and collapse in the harvest (A), the economic capital (B), and the resource (C).
Meadows, 2008

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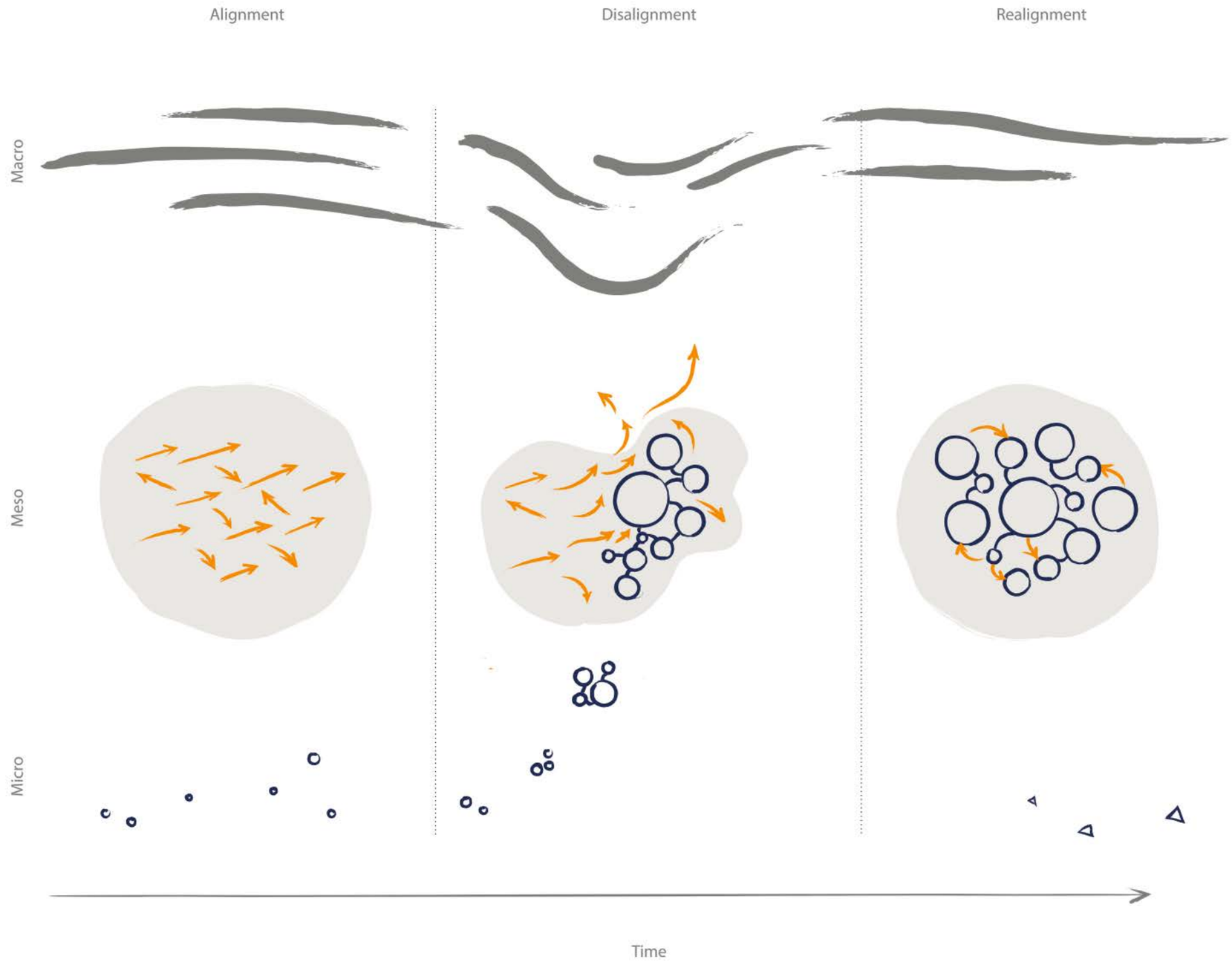
Levels in a system

Macro
The 'landscape': values, ideologies, demographics and economic context

Meso
The 'regime': frameworks, rules and norms embedded in infrastructure, institutions and markets

Micro
'Niche' innovations: new practices, technologies and lifestyles



From Leadbeater & Winhall, 2020 'Building Better Systems'
See also, Geels, 2004, 2011, 2020

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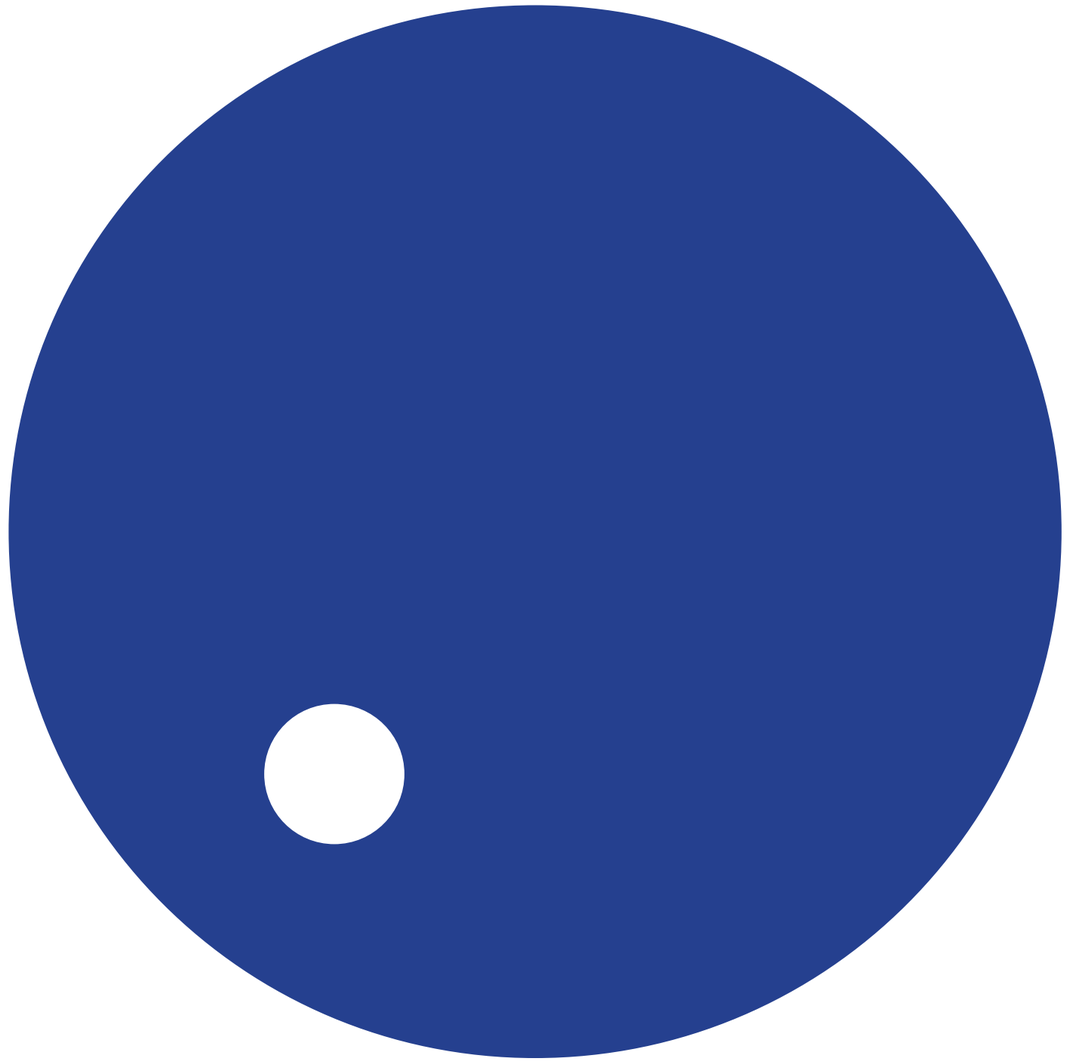
“DARK MATTER”

In theoretical physics, dark matter is believed to constitute 83% of the matter in the universe.



83%

after Dan Hill, 2011

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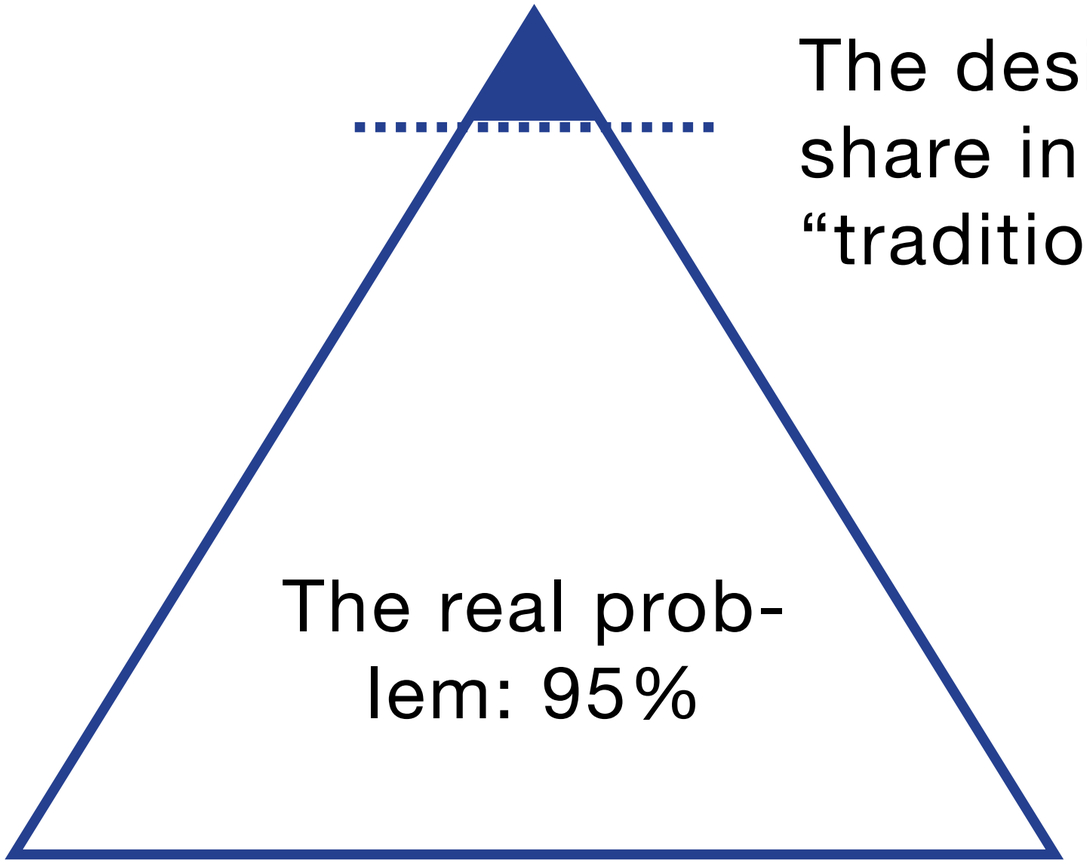

The designer's share in a "traditional" design

Strategic design recognizes that the "dark matter" is part of the design challenge.

Viktor Papanek, 1984

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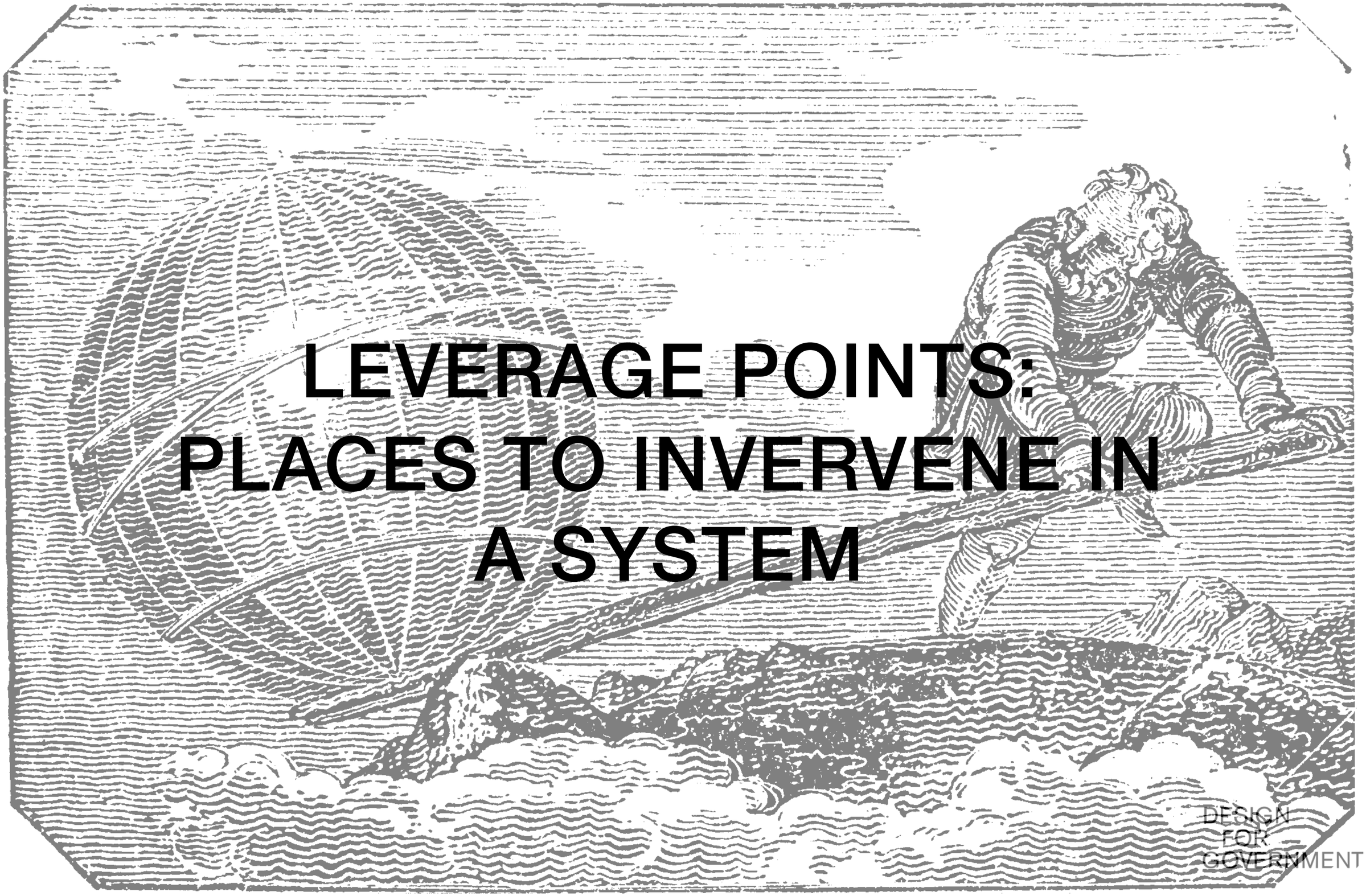
LEVERAGE POINTS: PLACES TO INVERVENE IN A SYSTEM



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Leverage points:

Places in the system, where a small change could lead to a large shift in behavior

Where to look for leverage points?

Where can you find points with high impact or high potential for changing the system?

Are these points easy to change?

For example:

- Purpose
- Power
- Resource flows
- Relationships
- Feedback loops

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SYSTEMS MAP

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The purpose of systems mapping at DfG:

- Getting a holistic view of the challenge, making sense of the problem
- Identifying relations between elements/ entities
- Revealing leverage points for intervention design
- Communicating and storytelling

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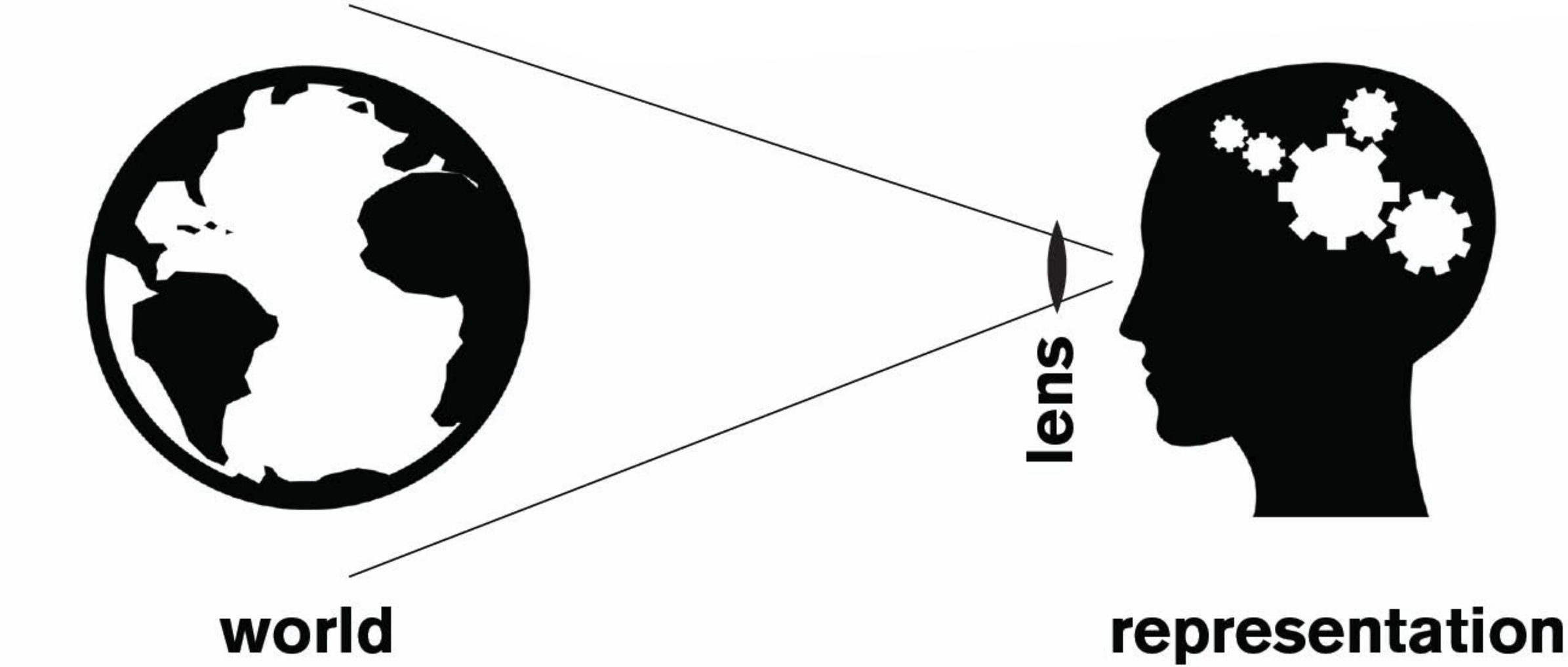
OUR INTERPRETATION



“Everything we think we know about the world is a model. Our models do have a strong congruence with the world. Our models fall short of representing the world fully. “

– Meadows, 2008

A systems map can include:

- **Elements** in the system, including their roles
- Their **relations**, such as:
    - Power relations
    - Contracts
- **Flows**, such as:
    - Decision flows
    - Communication
    - Knowledge transfer
    - Resource flows
- **Feedback loops**
    - Reinforcing (positive) or balancing (negative)

DIFFERENT TYPES OF SYSTEMS MAPS

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Some existing models that you may apply:

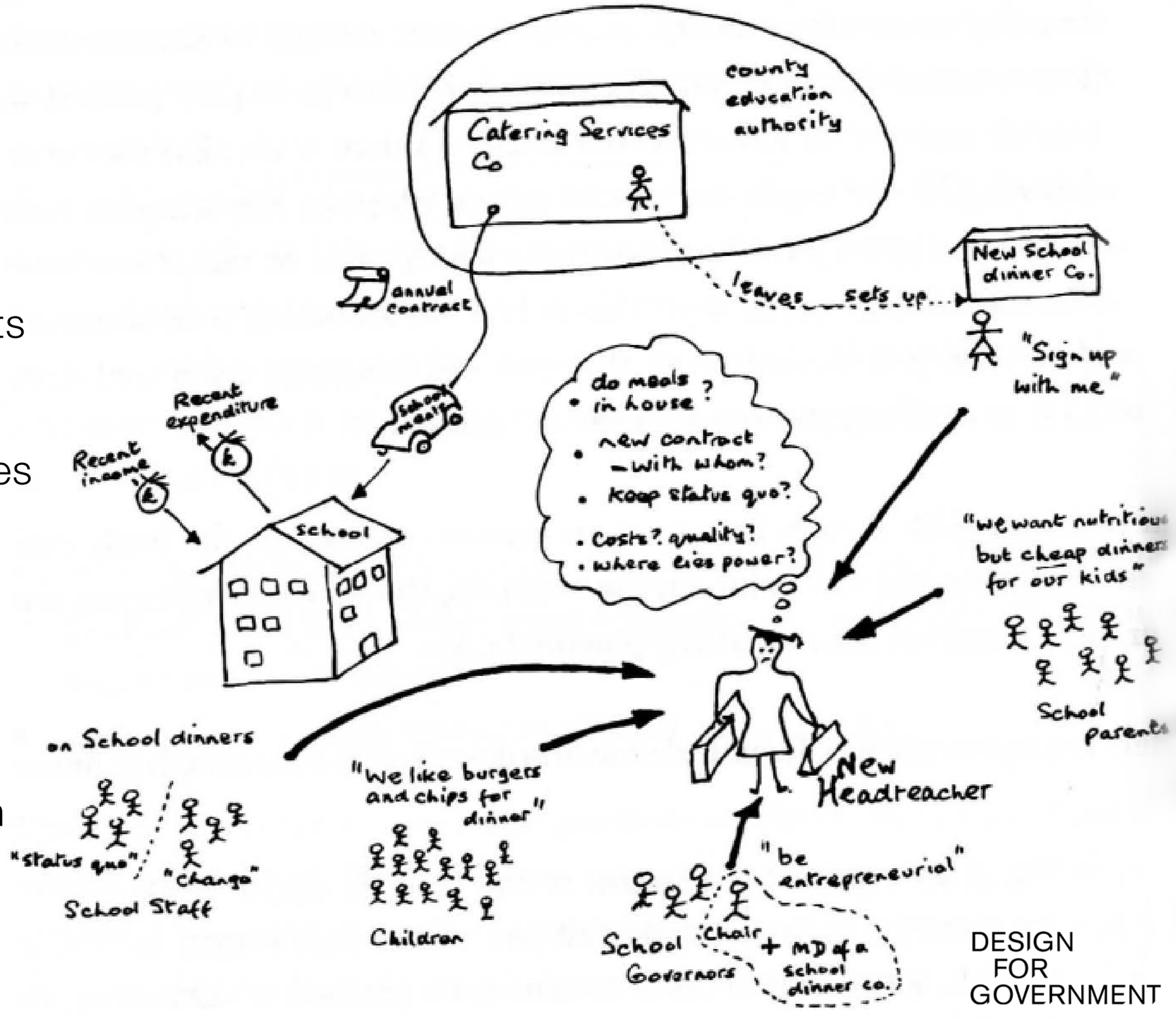
- **The Rich Picture:**
  Process oriented, one-human perspective
- **CATWOE model:**
  Process oriented, organisational perspective
- **CAUSAL LOOP model:**
  Mapping of system elements and different types of causal relations
- **STEEP model:**
  Birds-eye view, a more general mapping of the different kinds of elements and relations

THE RICH PICTURE

A rich picture captures a one-human view of a situation:

- The main entities, structures and viewpoints
- Crucial relationships
- Processes going on
- Current recognized issues and any potential ones.

- The picture can be updated as the enquiry proceeds
- It can be used as a basis for discussion with stakeholders



Checkland & Poulter, 2006

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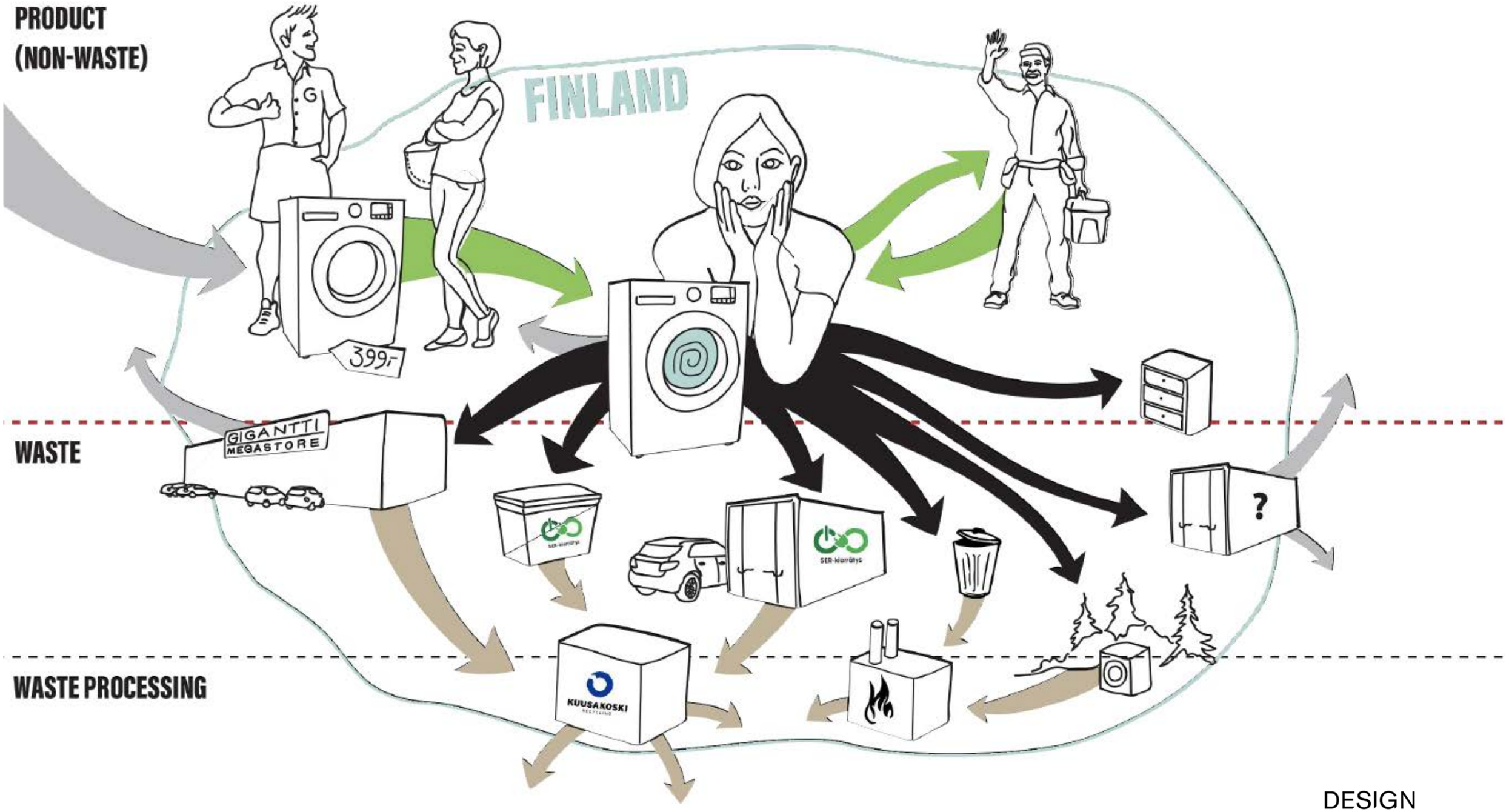
THE RICH PICTURE

Here is a real-world problematical situation described in a paragraph of prose:

> The newly appointed headteacher of an 11s-to-18s school, which has overspent its budget in the last year or two, finds herself, in her first term, facing an issue concerning the provision of school meals. Currently these are provided by the county education authority through their catering services company, the contract being renewed annually. A member of that company who is leaving to set up her own catering company urges the headteacher to make a contract with her instead of the county, suggesting the school could save money on this. Some staff members agree with this, others want to stick with the status quo. Some parents, alerted by a national debate about school meals, want more nutritious meals as long as they don't cost more. Pupils say: 'We like burgers and chips.' The school governors are discussing this issue; the Chairman, himself MD of a catering company, is urging the headteacher to be entrepreneurial and to take on responsibility for the provision of school meals, believing this could be profitable for the school.

Checkland & Poulter, 2006

EXAMPLES FROM DFG: RICH PICTURE-ISH



DfG 2016 Waste team 1: Suvi Kinnarinen, Merja Lang, Riikka Ylitalo

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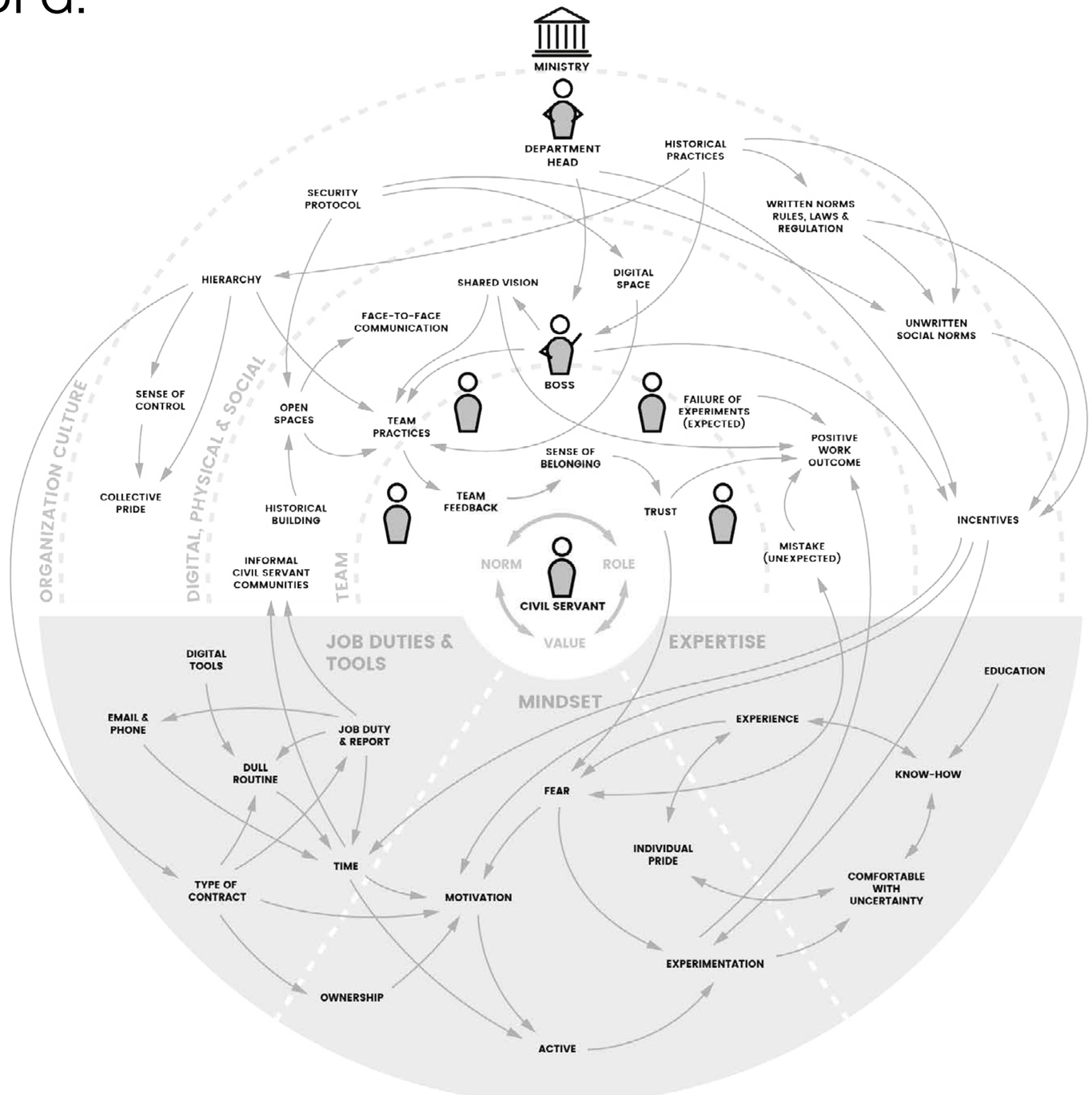

DfG 2017, Brad Mullen, Chinny Wong, Emilija Veselova, Vilma Hämäläinen, Yuri Fukamati

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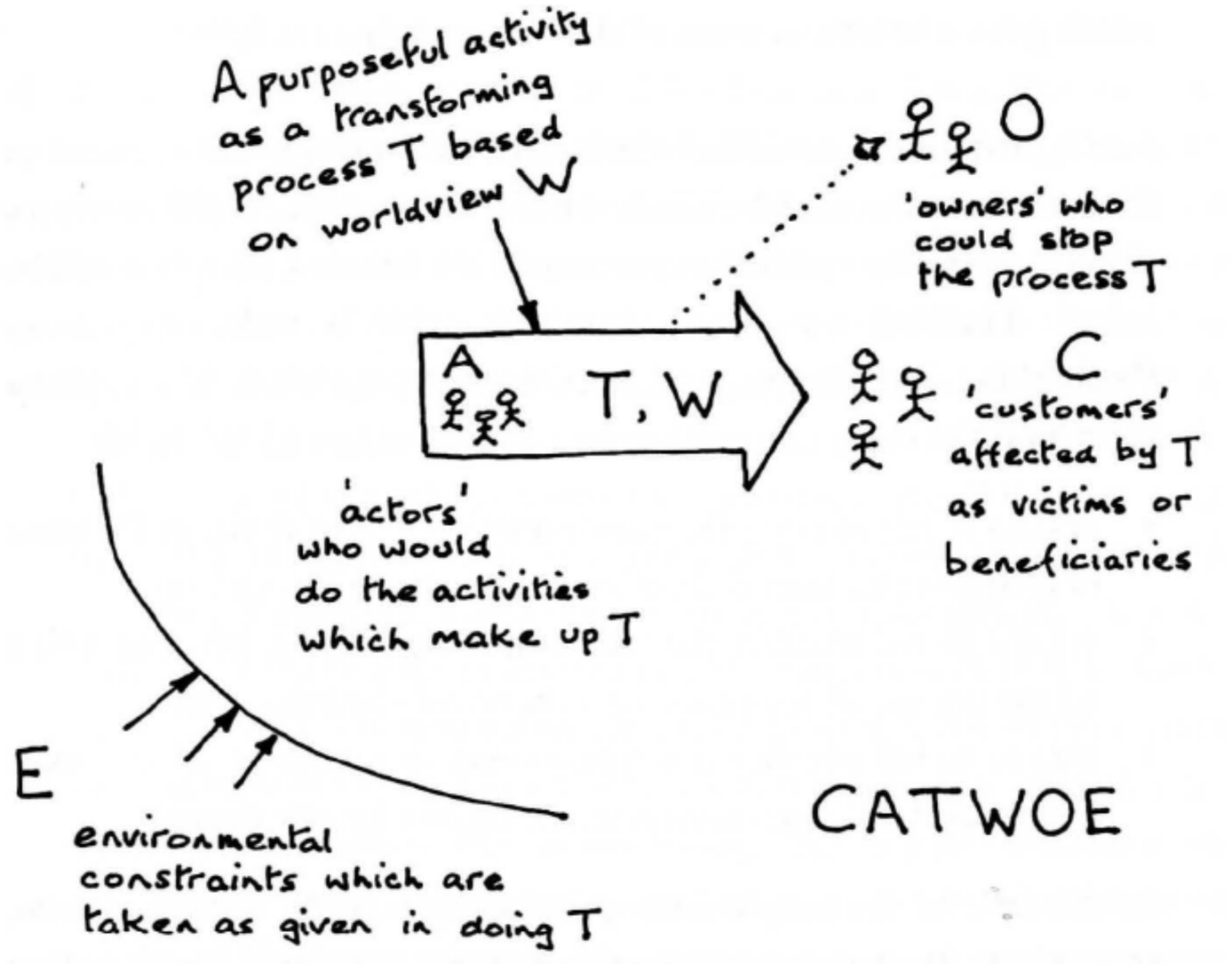
CATWOE ANALYSIS

“CATWOE” is part of the Soft Systems Methodology

Customers affected by the activity (beneficiaries or victims)
Actors performing the activity
Transformation process = the activity
Worldview that defines the activity
Owners, who could stop or change the process
Environmental constraints outside, which are taken as a given



Checkland & Poulter, 2006

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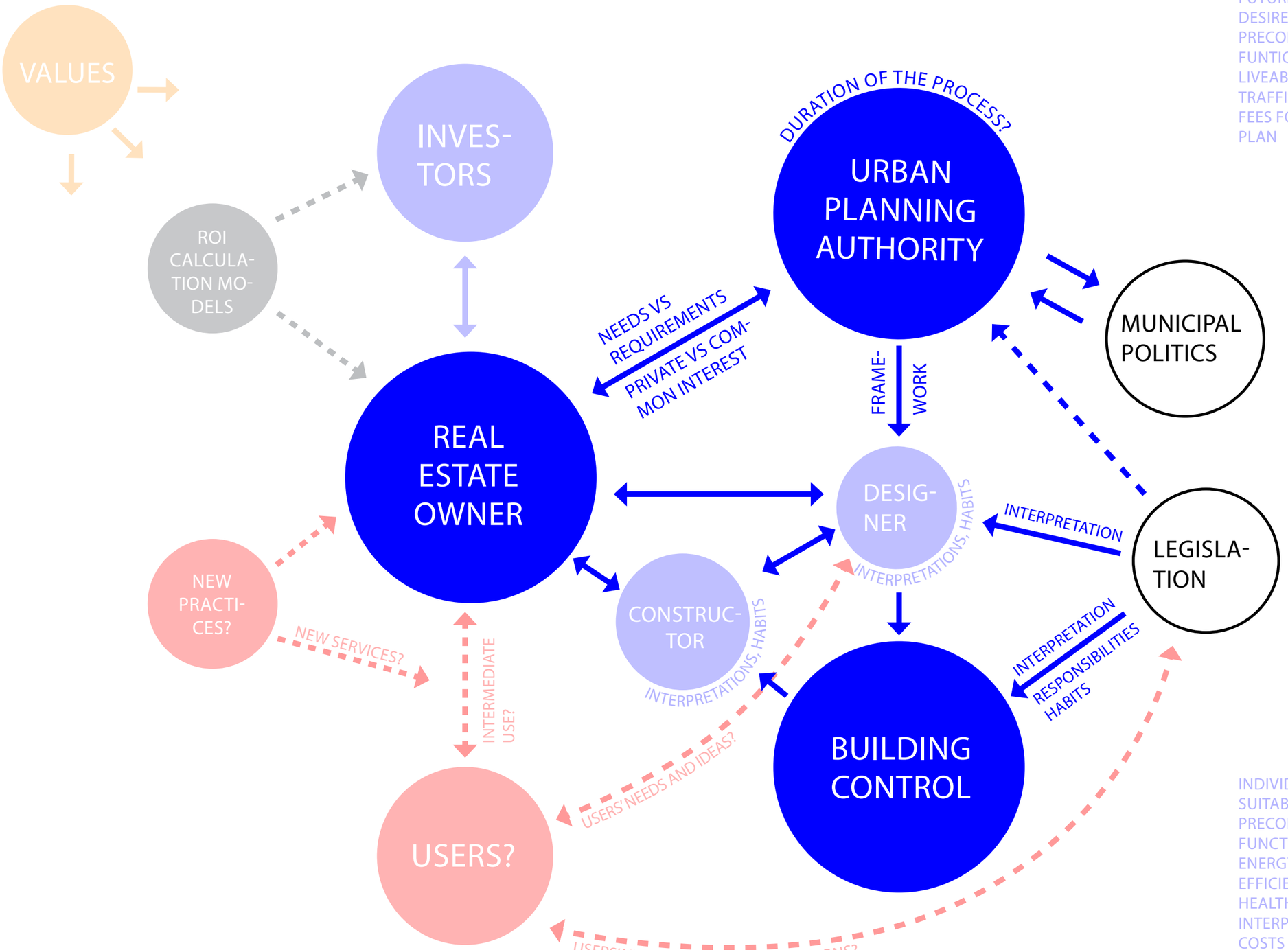
EXAMPLE: CATWOE-ISH



LOCATION
FUTURE PROSPECTS
DESIRED FUNCTIONS OF THE AREA
PRECONDITIONS FOR A NEW
FUNTION IN THE AREA
LIVEABILITY, NOISE, ETC
TRAFFIC, PARKING
FEES FOR CHANGING THE URBAN
PLAN

INDIVIDUAL BUILDING'S QUALITIES
SUITABILITY FOR A NEW PURPOSE
PRECONDITIONS FOR A NEW
FUNCTIONAL PURPOSE
ENERGY EFFICIENCY VS MATERIAL
EFFICIENCY
HEALTH AND SAFETY
INTERPRETATION OF NORMS
COSTS AND RETURN

From Vacant Spaces project at the Ministry of the Environment
Hella Hernberg, 2013

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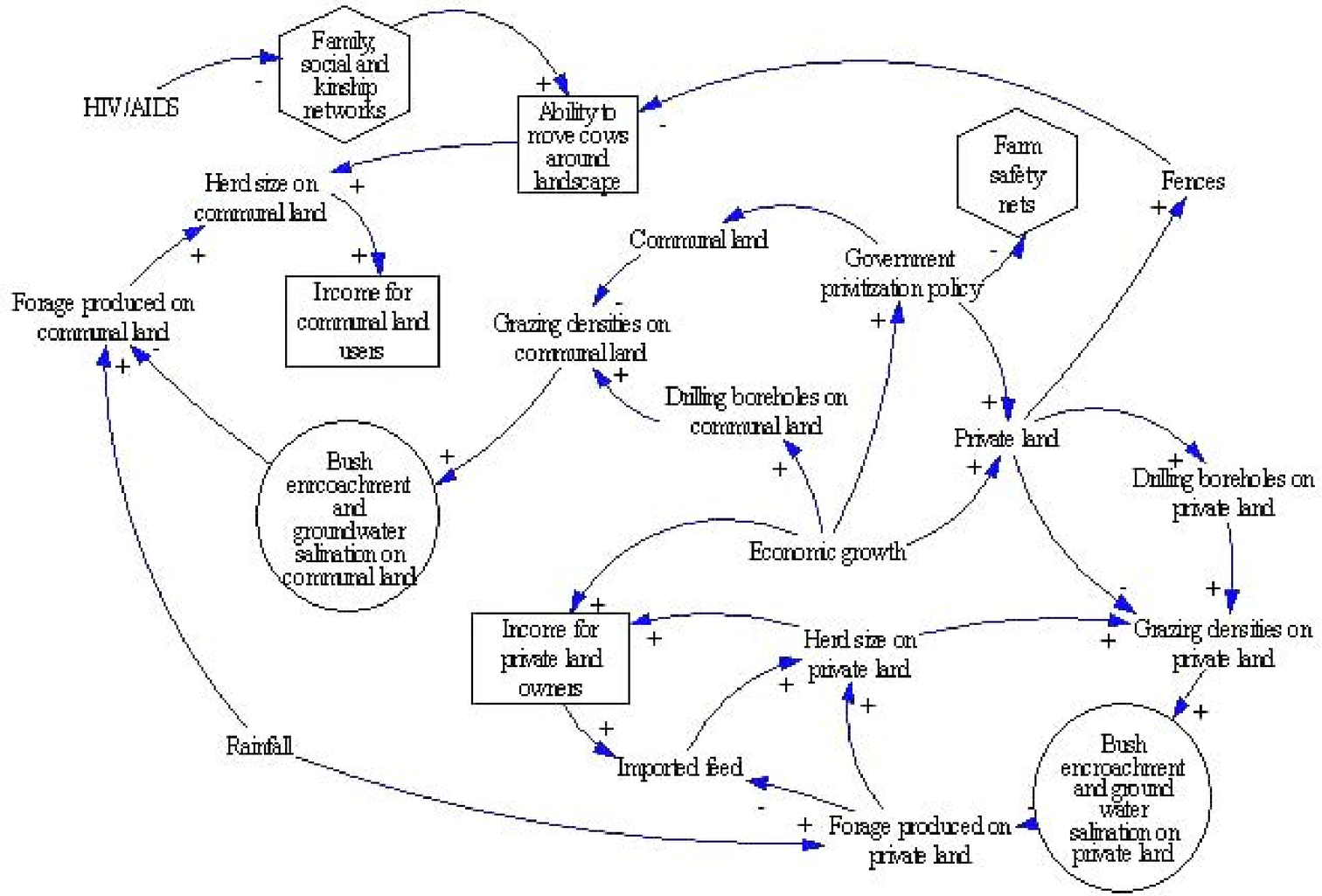
CAUSAL LOOP MODEL

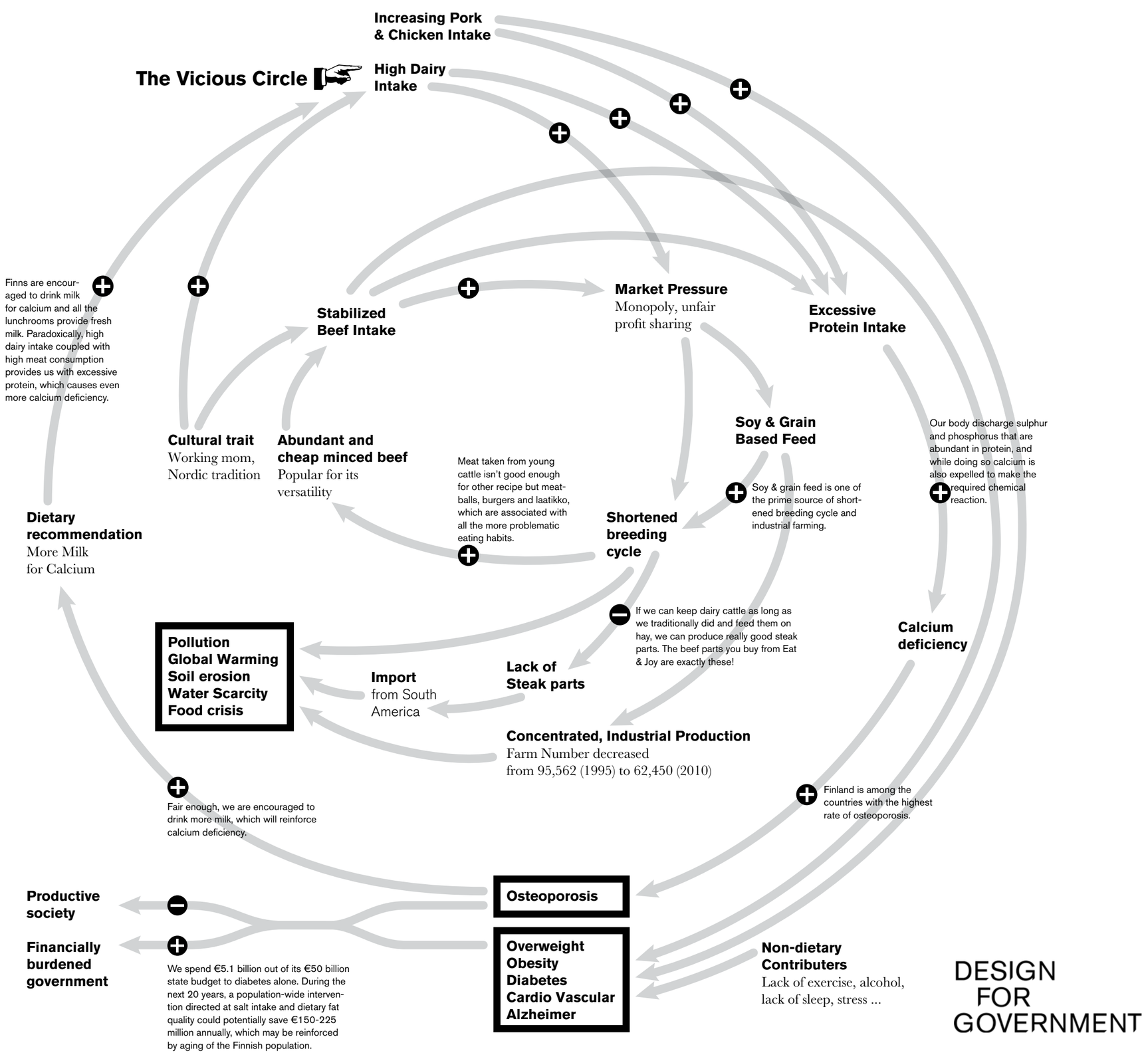
Mapping of

- **Key system elements** or variables (words and graphic elements)
- **Links/causal relations** between them (arrows)
- **Signs on the links** showing the type of relation or what type of behavior the system will produce



Dynamic systems model of the agropastoral food system of southern Botswana
Dougill, A., Fraser, E. and Reed, M. 2010

CAUSAL LOOP MODEL: EXAMPLE



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From Beef Finland project /Seungho Lee, 2012

STEEP MODEL

Political

Economical

Environmental

Technological

Social

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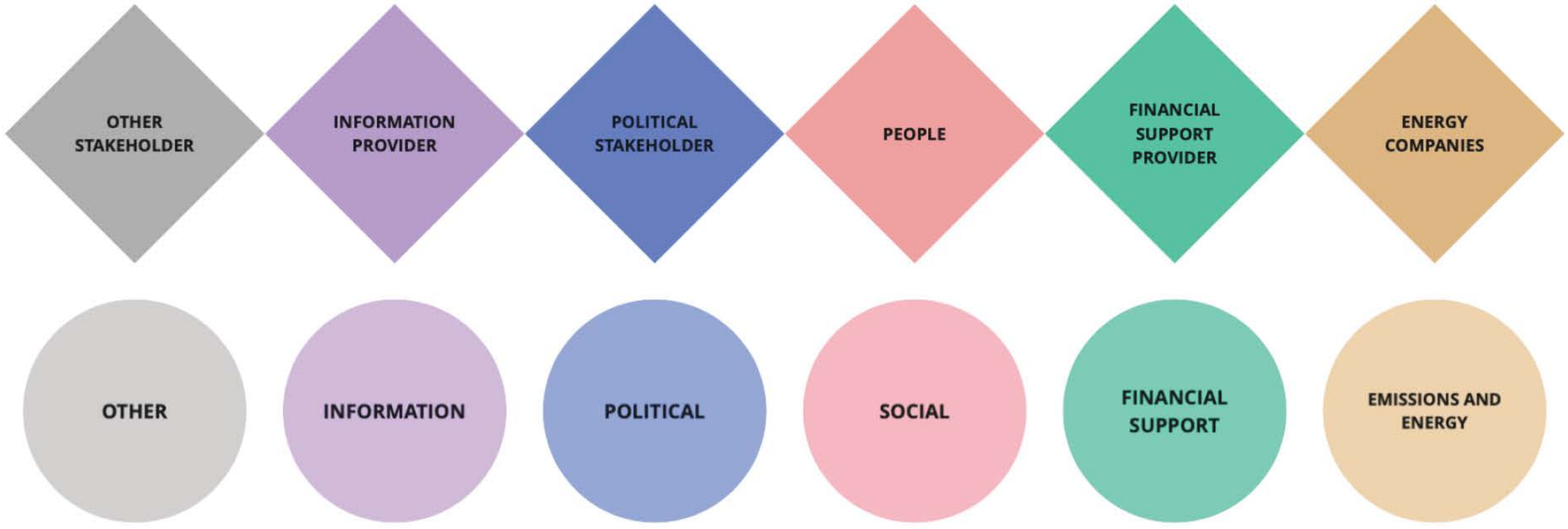
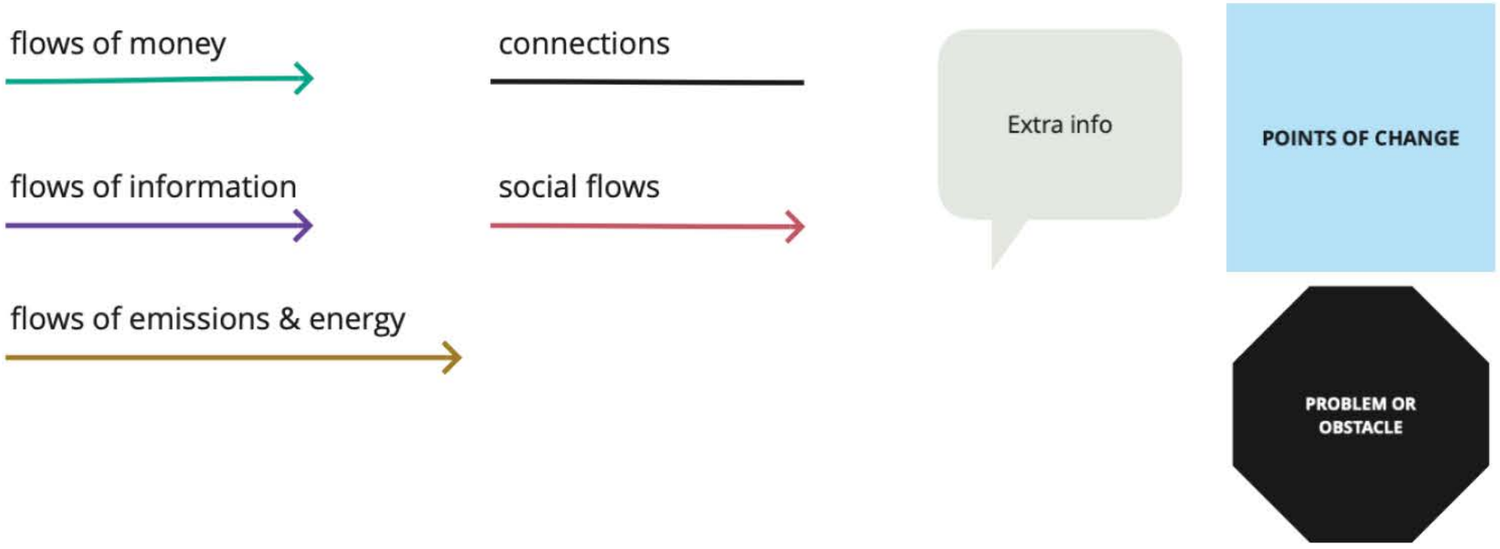
EXAMPLES FROM DFG: STEEP





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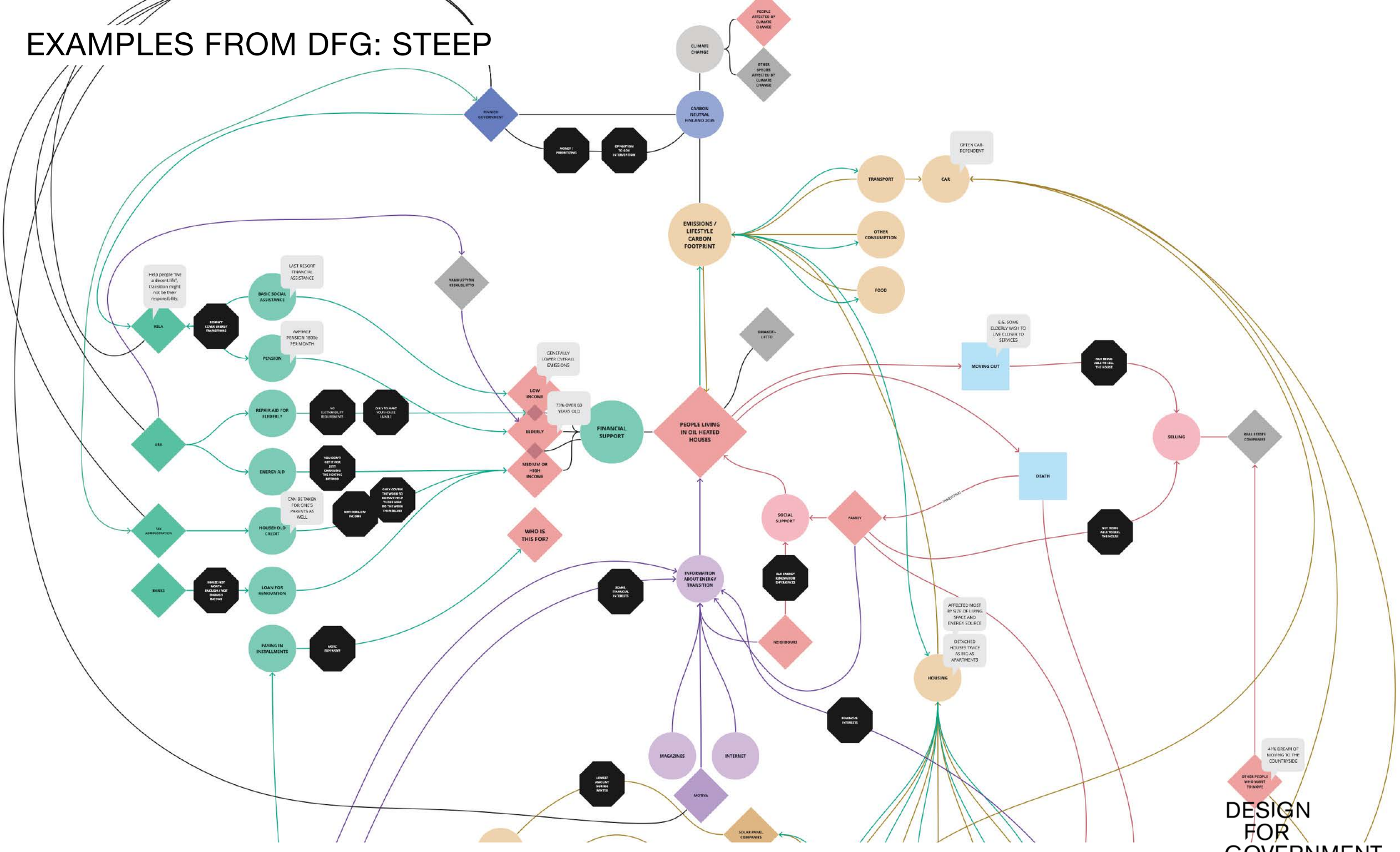
‘License to Heat’ project on post-oil heating, DfG 2020, by Hsin-Yun Lai, Daniel Leiviskä, Anh Nguyen, Emile Rebours

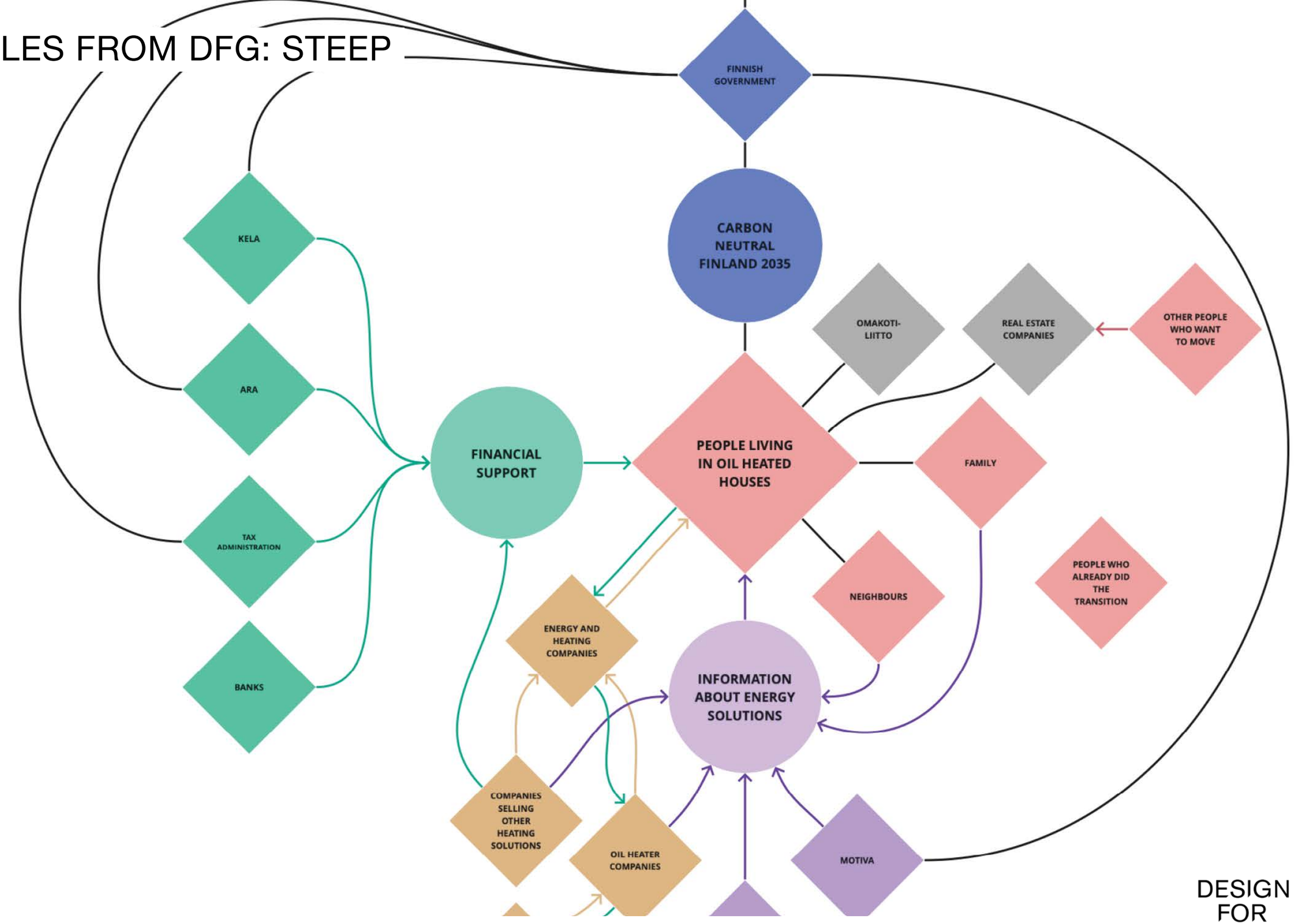
EXAMPLES FROM DFG: STEEP



DESIGN FOR GOVERNMENT

'License to Heat' project on post-oil heating, DfG 2020, by Hsin-Yun Lai, Daniel Leiviskä, Anh Nguyen, Emile Rebours

EXAMPLES FROM DFG: STEEP



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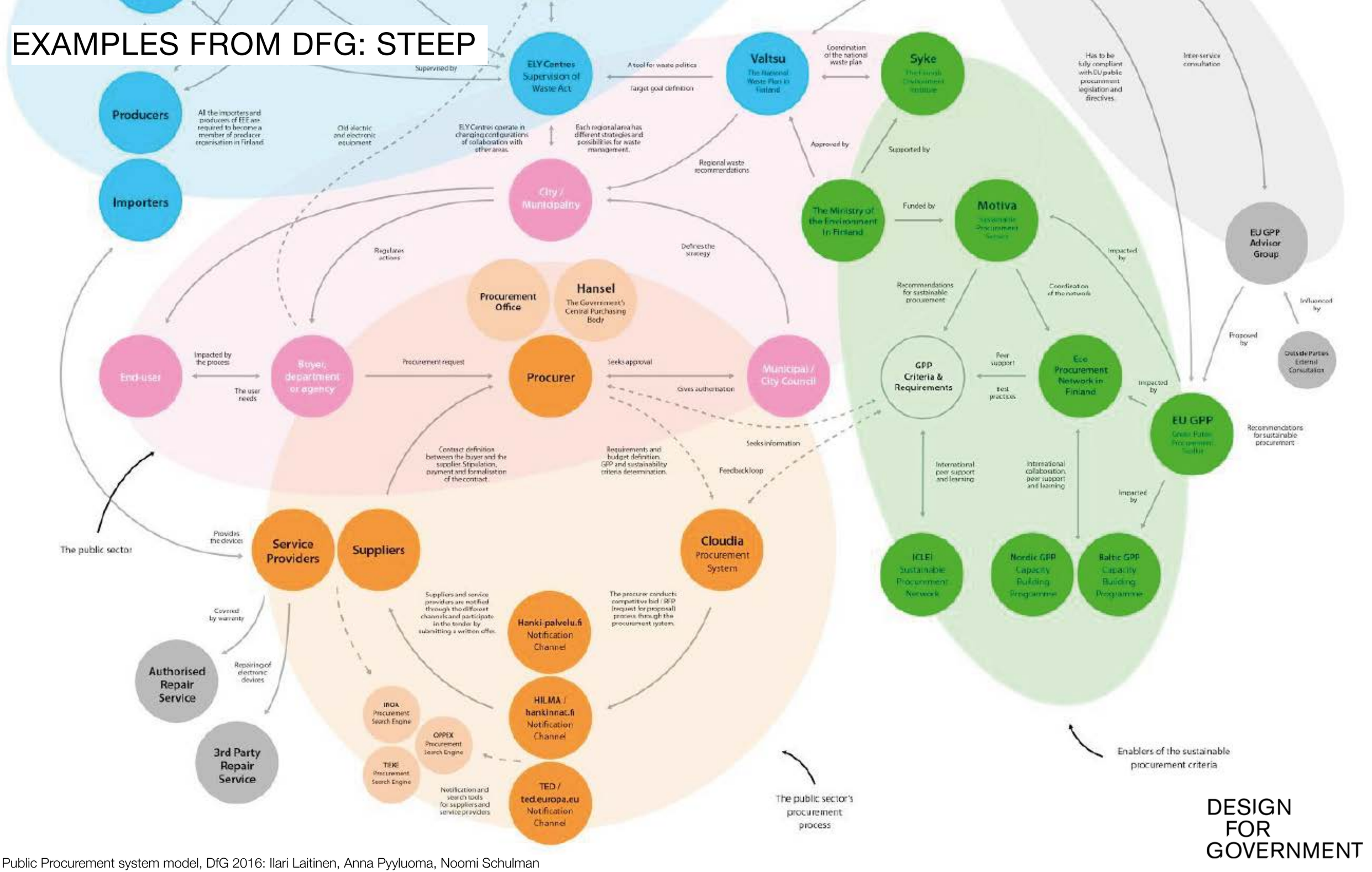

DESIGN FOR GOVERNMENT

Public Procurement system model, DfG 2016: Ilari Laitinen, Anna Pyyluoma, Noomi Schulman

Systems mapping excercise (1,5 hours)
Within the supergroups, divide in two and start mapping the system elements and their relations from two perspectives. We will swap the groups after 45 mins. You can use the four model types as inspiration.

1. **From the viewpoint of an individual**
   (citizen, customer, etc)
   For example:
   - Touchpoints
   - Barriers or gaps
   - Service needs
   - Service options
   - Social, financial, health aspects etc.

2. **From the viewpoint of the organisation**
   (public services or transport operators)
   For example:
   - Service ecosystem
   - Entities involved
   - Connections, gaps, feedback loops
   - Policies, regulations, incentives

“We can’t control systems or figure them out but we can dance with them!”

– Donella Meadows