Supporting
European
Aviation

EUROCONTROL

Setting the Scene: Theory and Direction

BALPA Flight Safety Conference

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FOUNDING MEMBER SESAR JOINT UNDERTAKING

NETWORK MANAGER

Systems Thinking

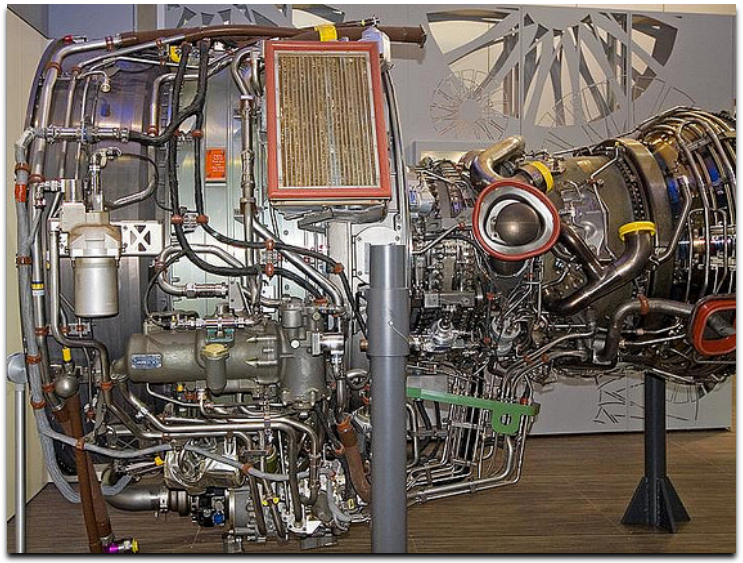
WHAT IS SYSTEMS THINKING?

Systems Thinking: 10 Axioms

1. A ‘system’ is a social construct (same for *boundaries*, *purposes*, *causes*)
2. Systems have boundaries, which are not fixed and often permeable
3. Systems have multiple purposes
4. A system does something that none of its (interconnected) parts can do
5. Influence and causation spreads through the system
6. Complex systems have a history
7. There will be different assumptions or imaginations about the ‘system’
8. Understanding requires synthesis (not just analysis)
9. Understanding can only ever be partial
10. There are multiple perspectives on a system

Adapted from Shorrock (2019) bit.ly/HS4KoT

Complicated/ Mechanical



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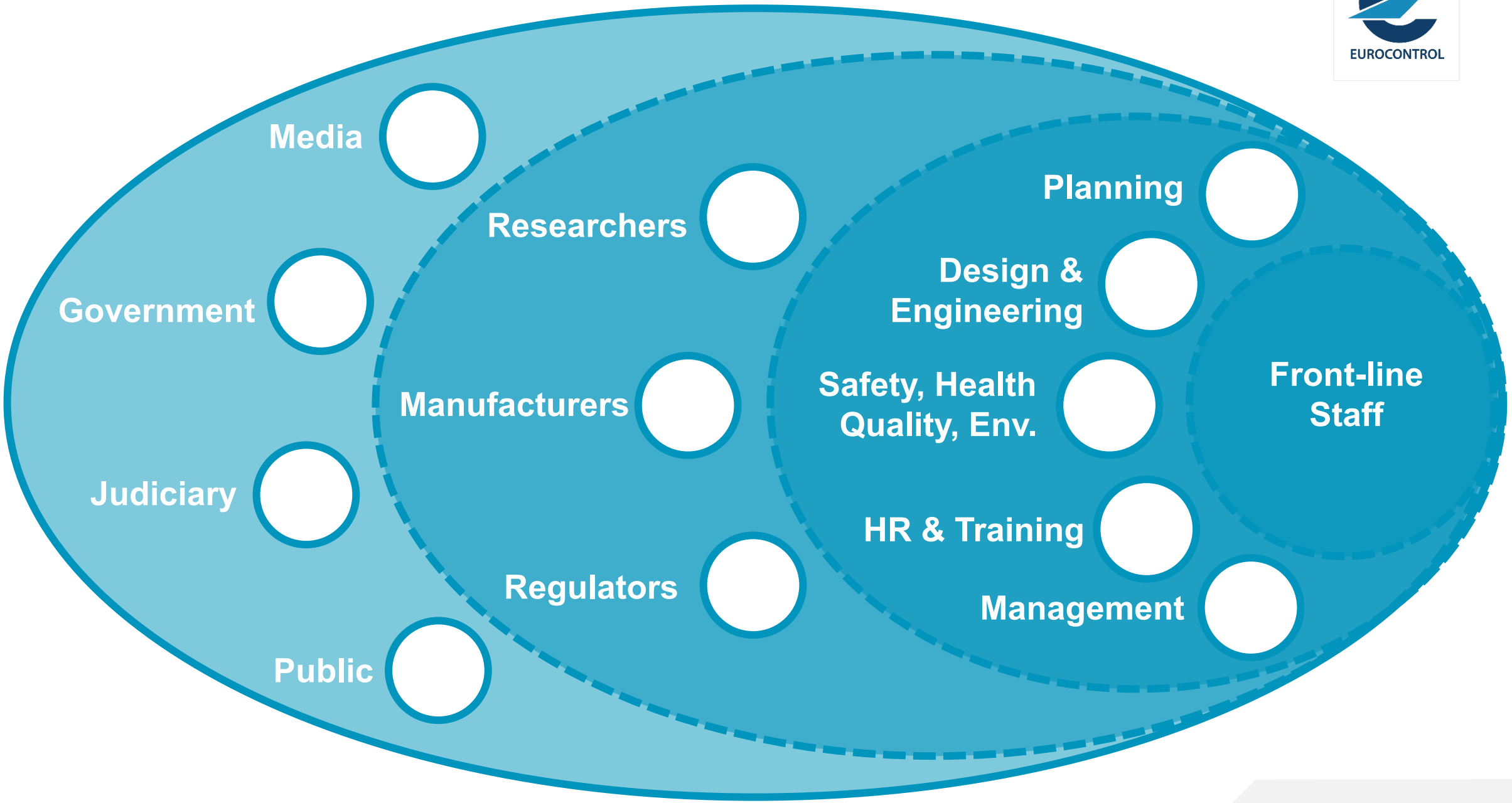
Nature of goals?
Understandability?
Deconstructability?
Clarity of boundary?
Quantifiability?
Cause-effect relationships?
Stability over time?
Predictability?
Tractability?

Complex/ Socio-technical

Implications for *understanding* and *intervention*?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Design &
Engineering
Manufacturers
Safety, Health
Quality, Env.
Front-line
Staff
Judiciary
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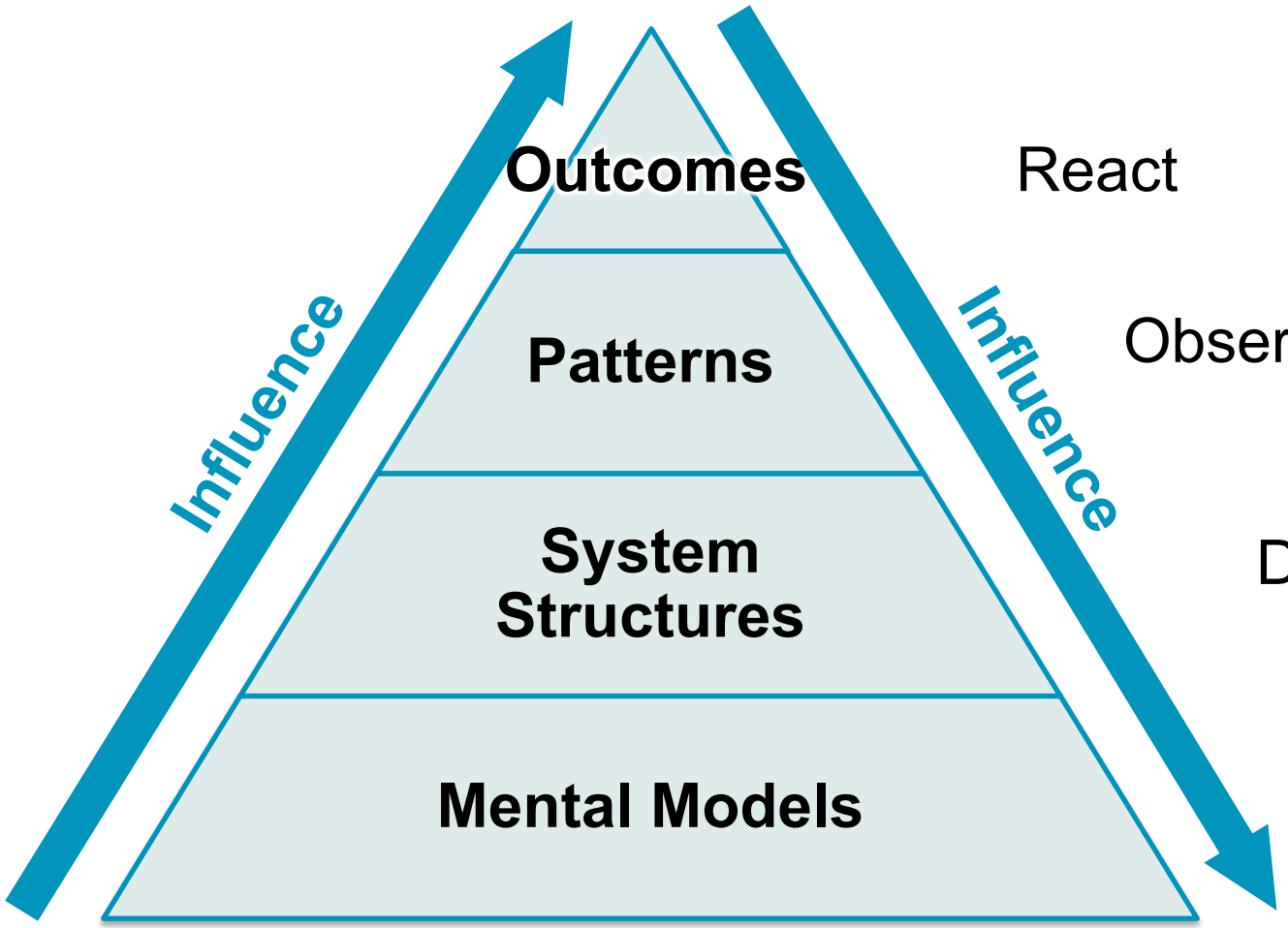
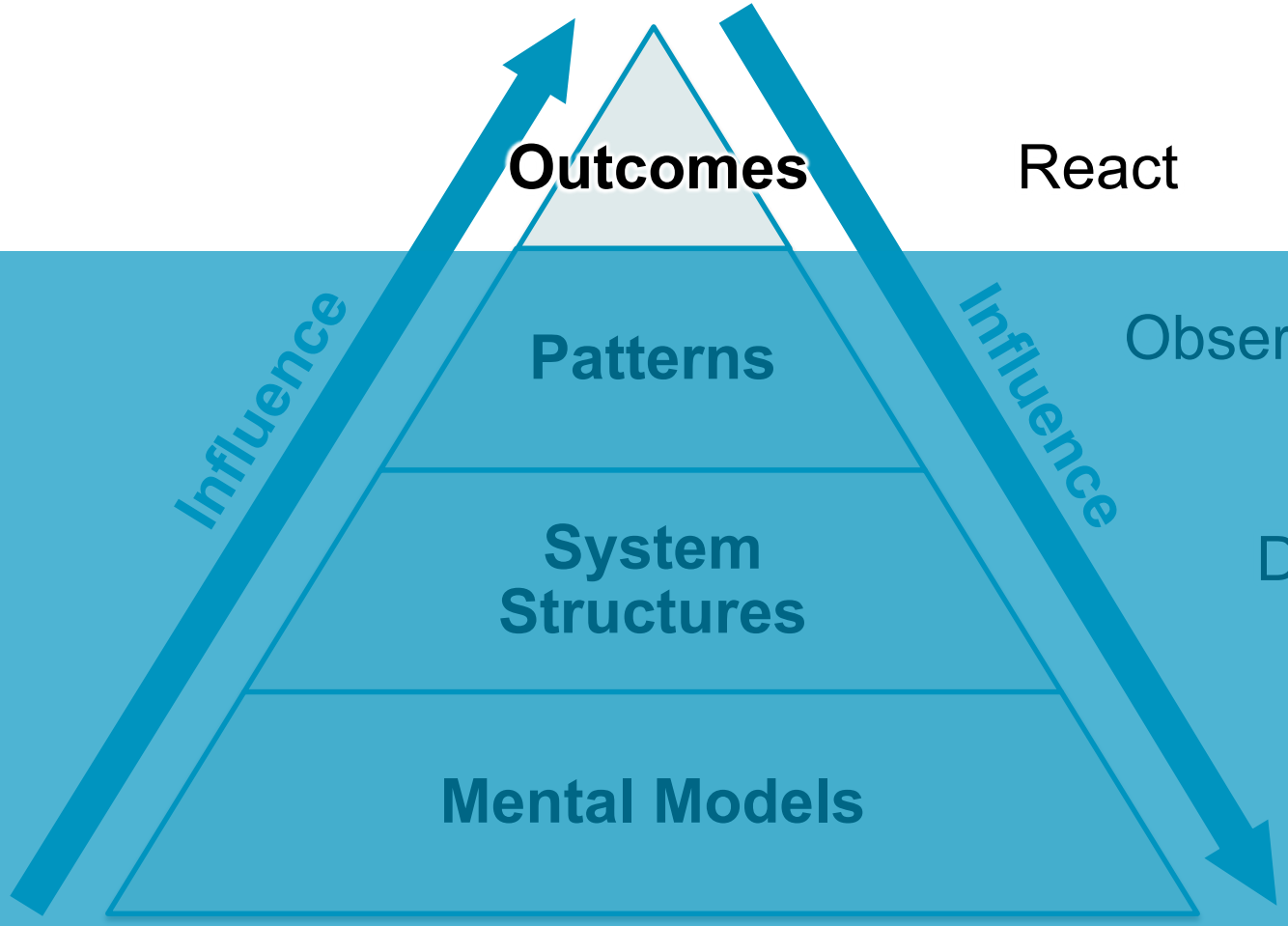
Regulators
Management
Public

Systems Thinking

HOW DO THINGS HAPPEN?


Outcomes
Patterns
System Structures
Mental Models
Influence
Influence
React
Observe & Anticipate
Design & Manage
Influence



React

Observe & Anticipate

Design & Manage

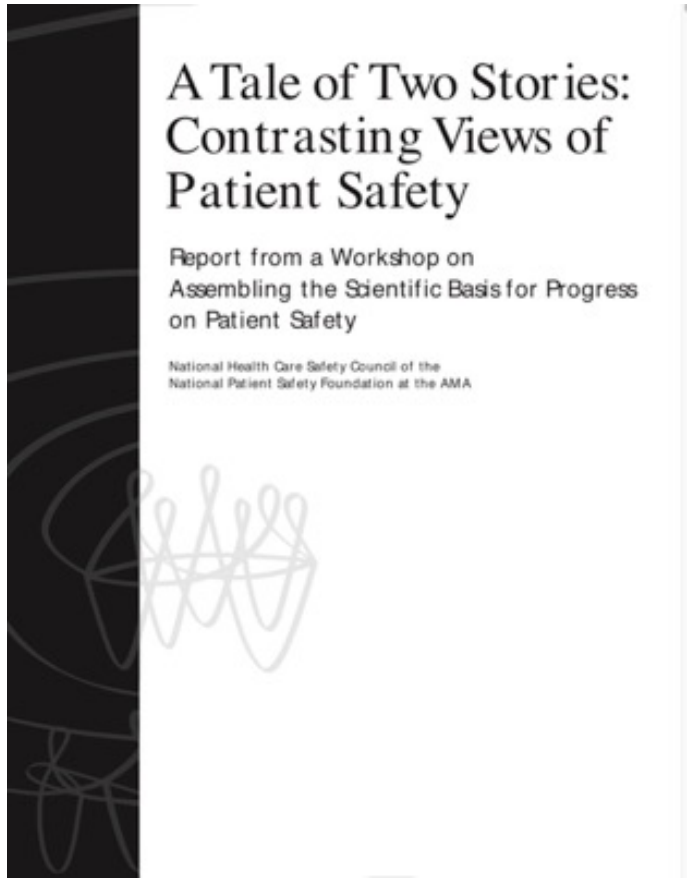
Influence

Systems Thinking

HOW DO WE EXPLAIN HOW THINGS HAPPEN?

The First Story
‘Human Error and Component Failure’

- Appears quickly after event
- Focuses on short time period
- High personalisation
- Focus on components
- Low context and complexity
- High newsworthiness



The Second Story
System Vulnerabilities

- Emerges slowly after long delay
- Focuses on longer time period
- Lower personalisation
- Focus on interactions
- Higher context and complexity
- Lower newsworthiness

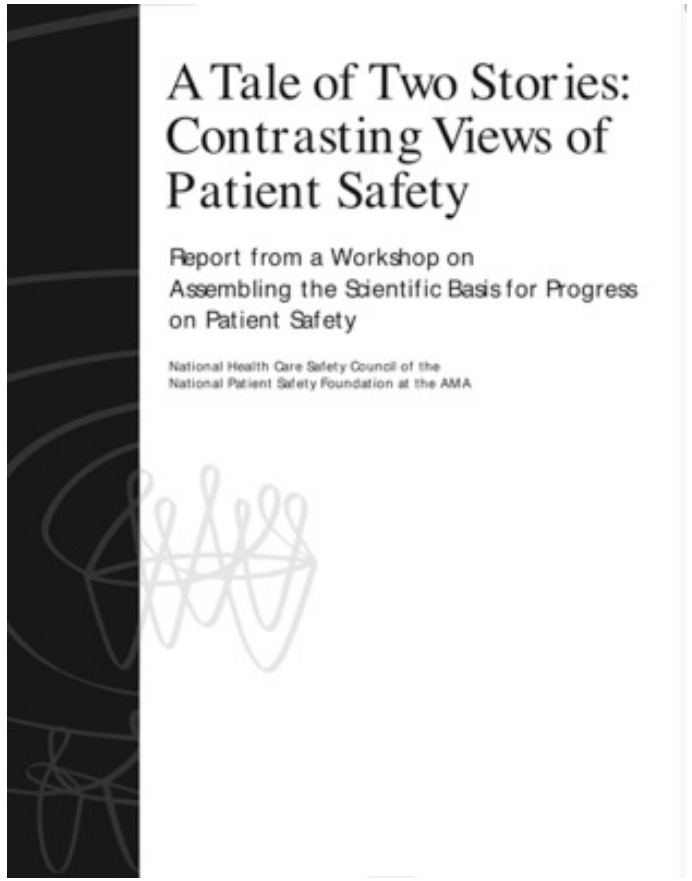


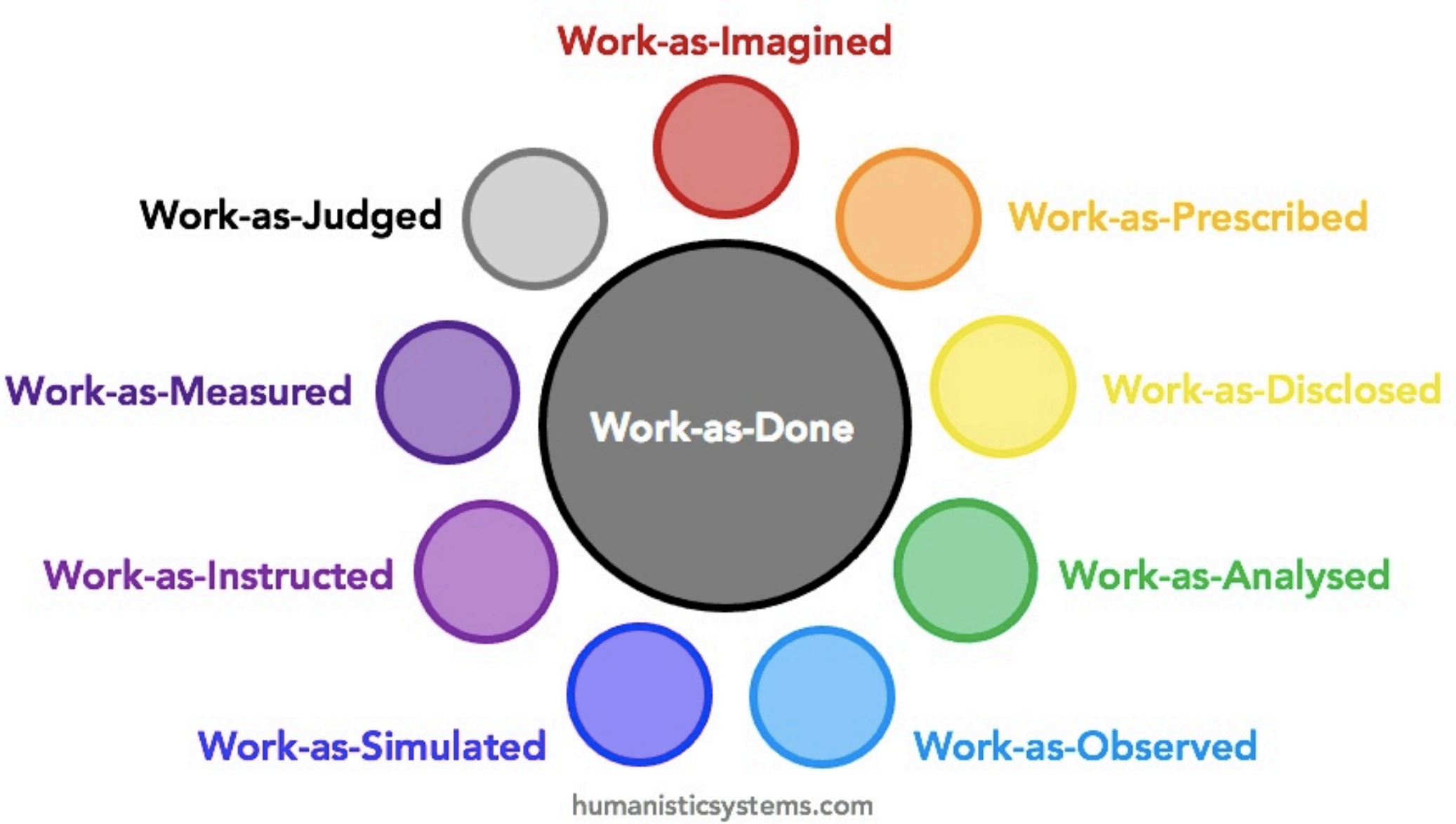
Photo credit: Angelo DeSantis https://flic.kr/p/dSbG9V CC BY 2.0

Did design and management make it:

- **easy** to do the right thing?
- **hard** to do the wrong thing?
- **very hard** to do a disastrous thing?

Systems Thinking

HOW DO WE UNDERSTAND HUMAN WORK?



Shorrock (2020)

https://bit.ly/39xoX1o

societal

political

legal & regulatory

economic

social & cultural

organisational & institutional

physical & environmental

technological

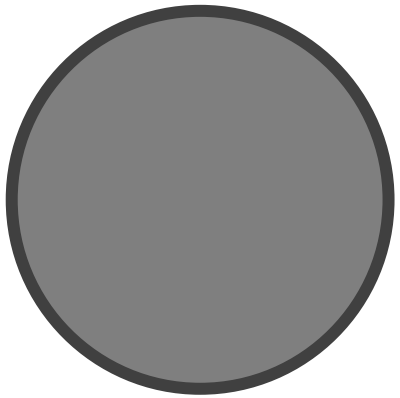
personal

procedural

temporal

informational

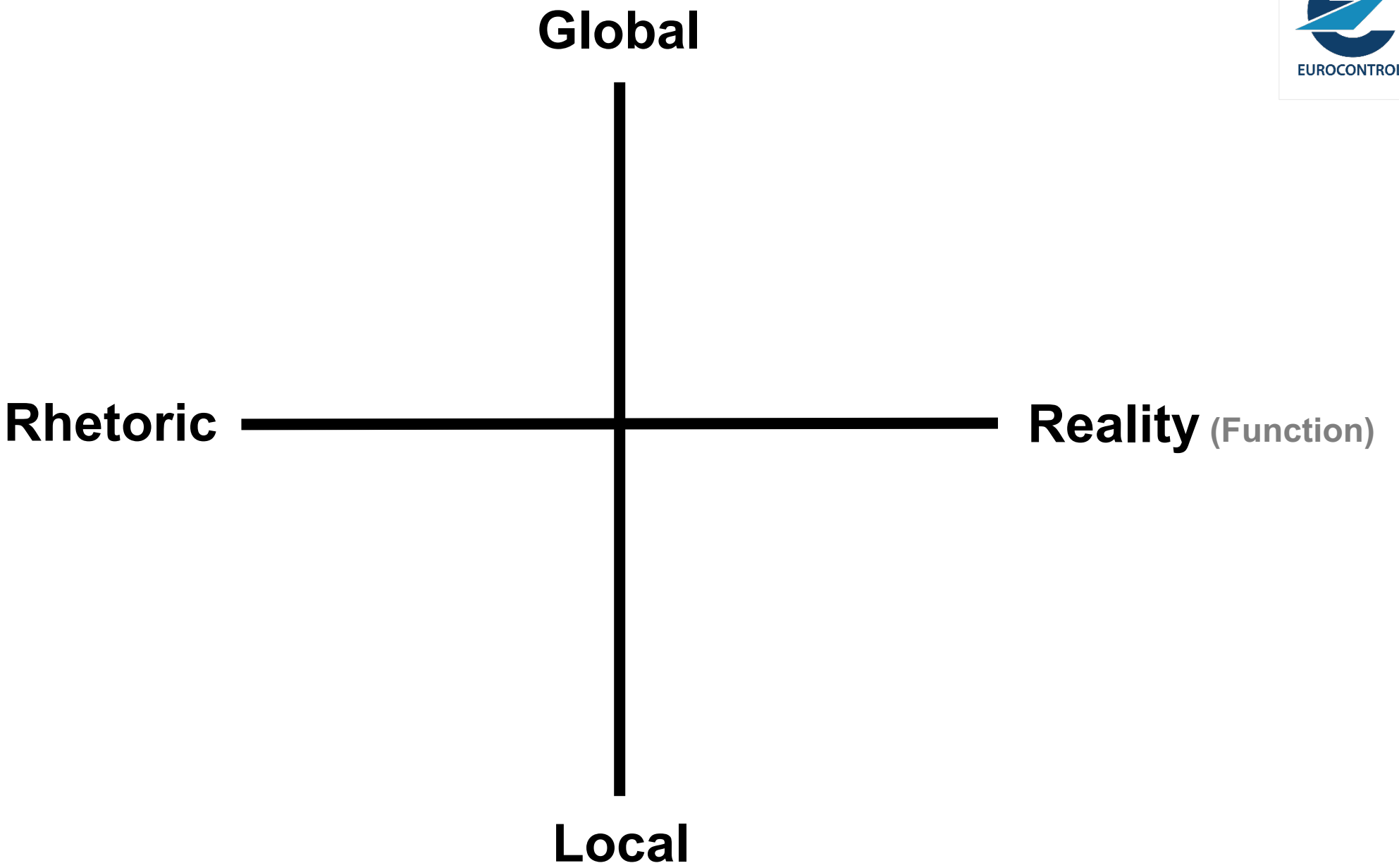
work-as-done



CONTEXTS FOR WORK-AS-DONE

Adapted from https://humanisticsystems.com/2020/10/07/ten-contextual-conversations/

Goals

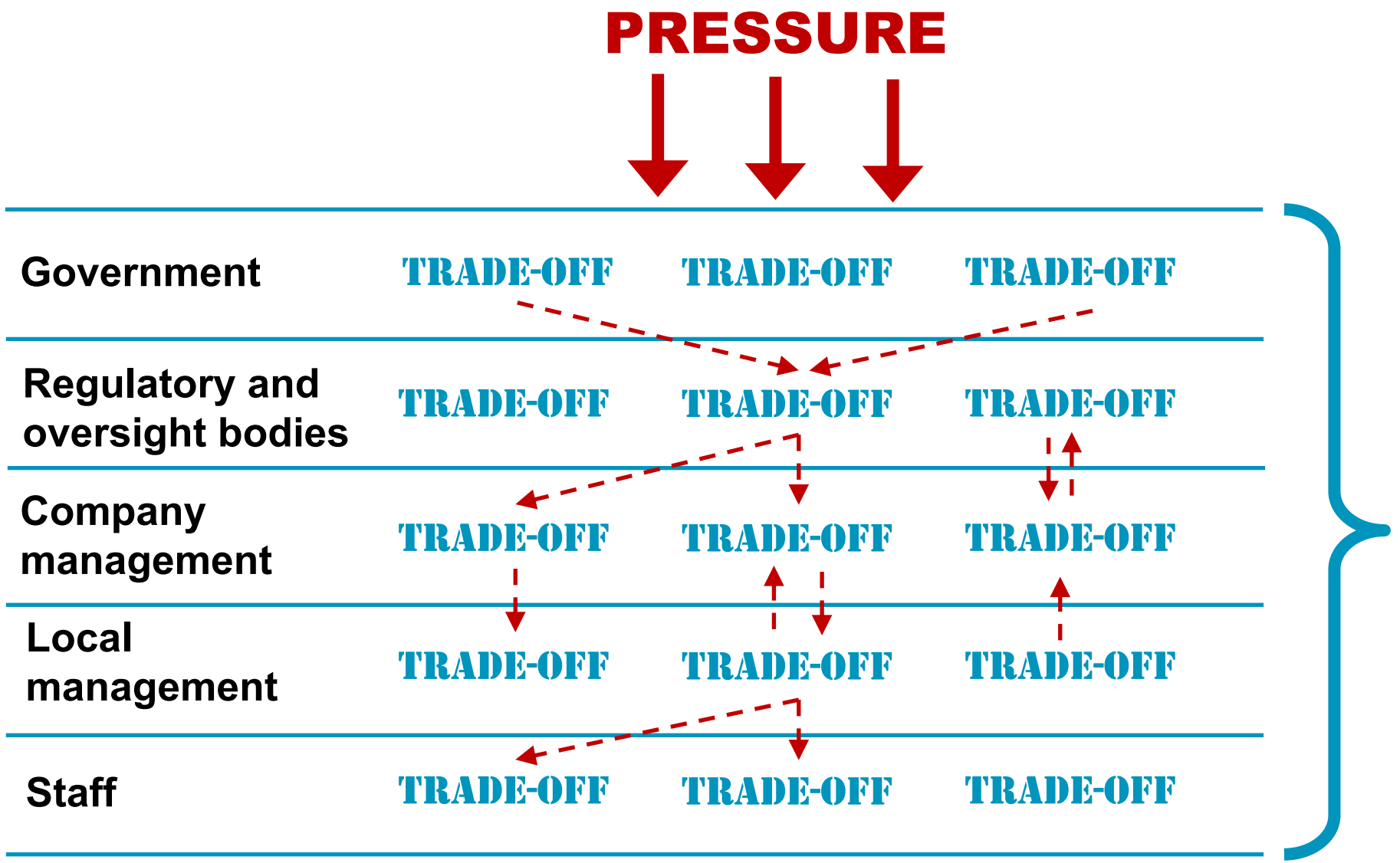


Shorrock (2018)

Five Truths about Trade-offs

1. Trade-offs occur at all levels of systems
2. Trade-offs trickle down
3. Trade-offs combine in unexpected ways
4. Trade-offs are necessary for systems to work.
5. Trade-offs require expertise

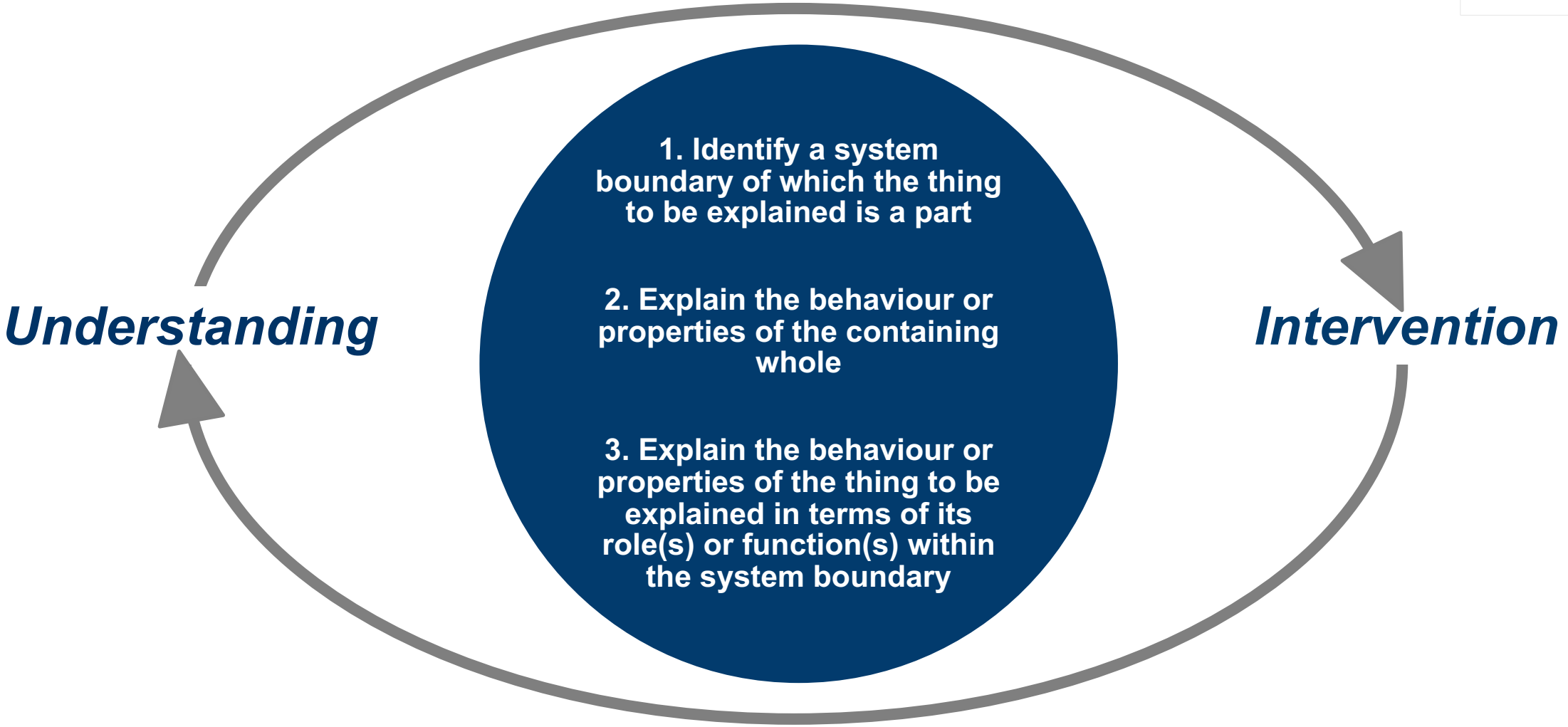
Shorrock (2019)



Shorrock (2019) adapted from Rasmussen (1997)

Systems Thinking

WHAT CAN WE DO TO UNDERSTAND & INTERVENE (WELL)?


Understanding
1. Identify a system boundary of which the thing to be explained is a part
2. Explain the behaviour or properties of the containing whole
3. Explain the behaviour or properties of the thing to be explained in terms of its role(s) or function(s) within the system boundary
Intervention

Ackoff (2000)

SKYbrary The single point reference for aviation safety knowledge

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Operational Issues | Human Performance | Enhancing Safety | Safety Regulations

Systems Thinking for Safety

The Systems Thinking for Safety Toolkit provides useful principles, practical advice, narratives and methods to encourage a systems thinking approach to systems, work and safety.

Loss of Separation

Emergency and Contingency

practical advice, to systems,

Read more >>

Highlighted Article

2014 Safety Forum Airborne Conflict

One Safety Issue - One Coordinated Outcome

posted 29 July 2014 in Portal:Airborne Conflict

The findings and conclusions of the recent Airborne Conflict Safety Forum are now available on SKYbrary along with all the presentations.

Read more >>

Toolkits
- Systems Thinking for Safety New
- AllClear?
- Airspace Infringement Prevention
- Stabilised Approach Awareness Toolkit for ATC
- Flight Deck Procedures - A Guide for Controllers
- Level Bust Toolkit
- TCAS Awareness
- Just Culture Toolkit

Safety knowledge contributed by EUROCONTROL ICAO FLIGHT SAFETY FOUNDATION essi European Strategic Safety Initiative UKFSC IFA SM ICG CAST

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Toolkit:Systems Thinking for Safety: Ten Principles

Executive Summary

[edit]

"To understand and improve the way that organisations work, we must think in systems." Image: NATS Press Office

To understand and improve the way that organisations work, we must think in systems. This means considering the interactions between the parts of the system (human, social, technical, information, political, economic and organisational) in light of system goals. There are concepts, theories and methods to help do this, but they are often not used in practice. We therefore continue to rely on outdated ways of thinking in our attempts to understand and influence how sociotechnical systems work. This White Paper distills some useful concepts as principles to encourage a 'systems thinking' approach to help make sense of – and improve – system performance. It is hoped that these will give new ways of thinking about systems, work and safety, and help to translate theory into practice.

Principles 1, 2 and 3 relate to the view of people within systems – our view from the outside and their view from the inside. To understand and design systems, we need to understand work-as-done. This requires the involvement of those who do the work in question – the field experts. (Principle 1. Involvement of Field Experts). It follows that our understanding of work-asdone – past, present and future – must assimilate the multiple perspectives of those who do the work. This includes their goals, knowledge, understanding of the situation and focus of attention situated at the time of performance (Principle 2. Local Rationality). We must also assume that people set out to do their best – they act with good intent. Organisations and individuals must therefore adopt a mindset of openness, trust and fairness (Principle 3. Just Culture).

Principles 4 and 5 relate to the system conditions and context that affect work. Understanding demand is critical to understanding system performance. Changes in demands and pressure relating to efficiency and capacity, from inside or outside the organisation, have a fundamental effect on performance. (Principle 4. Demand and Pressure). This has implications for the utilisation of resources (e.g. staffing, competency, equipment) and constraints (e.g. rules and regulations) (Principle 5. Resources and Constraints), which can increase or restrict the ability to meet demand.

Principles 6, 7 and 8 concern the nature of system behaviour. When we look back at work, we tend to see discrete activities or events, and we consider these independently. But work-as-done progresses in a flow of interrelated and interacting activities (Principle 6. Interactions and Flows). Interactions (e.g. between people, equipment, procedures) and the flow of work through the system are key to the design and management of systems. The context of work requires that people make trade-offs to resolve goal conflicts and cope with complexity and uncertainty (Principle 7. Trade-offs). Finally, continual adjustments are necessary to cope with variability in system conditions. Performance of the same task or activity will and must vary. Understanding the nature and sources of variability is vital to understanding system performance (Principle 8. Performance Variability).

Principles 9 and 10 also relate to system behaviour, in the context of system outcomes. In complex systems, outcomes are often emergent and not simply a result of the performance of individual system components (Principle 9. Emergence). Hence, system behaviour is hard to understand and often not as expected. Finally, success and failure are equivalent in the sense that they come from the same source – everyday work, and performance variability in particular (Principle 10. Equivalence). We must therefore focus our attention on work-as-done and the system-as-found.

EUROCONTROL (2014) bit.ly/ST4SAFETY

Network Manager
nominated by
the European Commission

EUROCONTROL

Systems Thinking
Learning Cards

Moving towards Safety-II

Feedback
If you have any comments on the cards, please contact steven.shorrock@eurocontrol.int and esp@eurocontrol.int.

Find out more
To find out more about systems thinking for safety, go to: http://bit.ly/ST4SAFETY

Edition 1.1 November 2014

Photo: NATS Press Office https://flic.kr/p/cwfQQL CC BY-NC-ND 2.0

EUROCONTROL

Foundation: System Focus

Safety must be considered in the context of the overall system, not isolated individuals, parts, events or outcomes

Most problems and most possibilities for improvement belong to the system. Seek to understand the system holistically, and consider interactions between elements of the system.

Systems Thinking Principles

Systems Thinking for Safety

Practical advice

- **Identify the stakeholders.** Identify who contributes or delivers resources to the system and who benefits, i.e. system actors (including staff and service users), experts/designers, decision makers, influencers.
- **Consider system purposes.** Reflect on the common or superordinate purpose(s) that defines the system as a whole, considering customer needs. Study how parts of the system contribute to this purpose, including any conflicts or tension between parts of the system, or with the superordinate system purpose(s).
- **Explore the system and its boundary.** Model the system, its interactions and an agreed boundary, for the purpose, question or problem in mind (concerning investigation, assessment, design, etc.). Continually adapt this as you get data, exploring the differences between the system-as-imagined and the system-as-found.
- **Study system behaviour and system conditions.** Consider how changes to one part of the system affect other parts. Bear in mind that decisions meant to improve one aspect can make system performance worse.

Read more
http://bit.ly/0-SF

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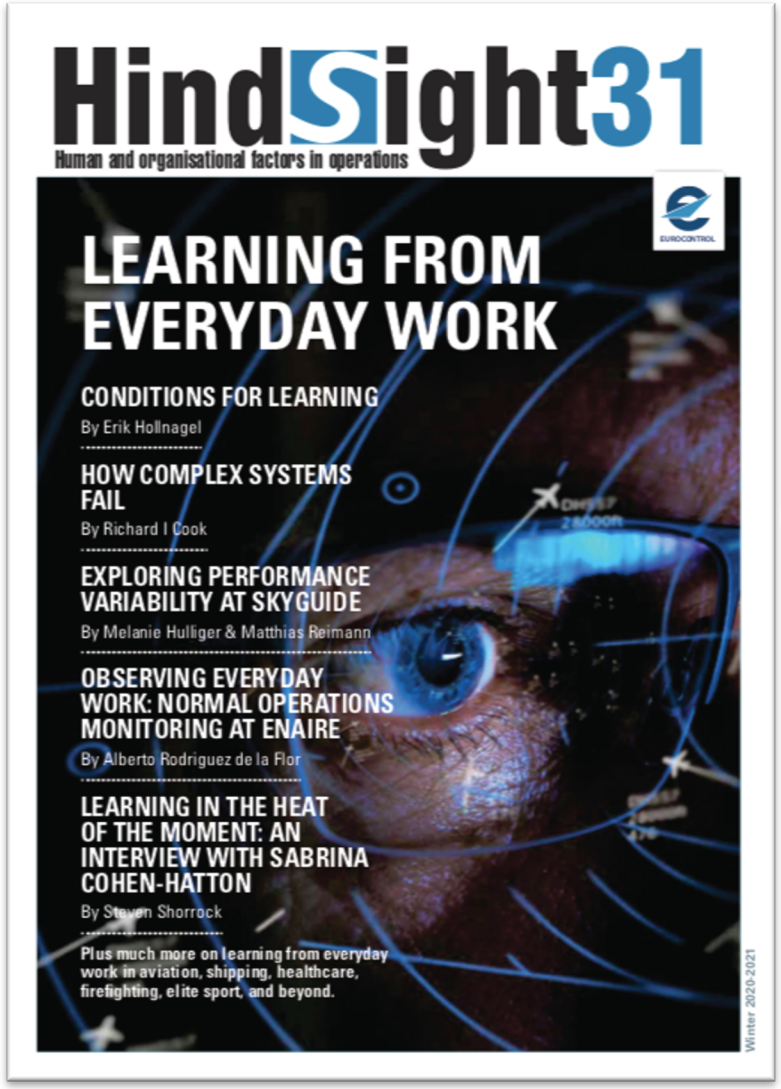

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