“Using Systems Thinking to address complex engineering challenges.”

Prepublicity:

The INCOSE Vision 2025 broadens our world view to address the **global challenges that face society and industry.**

The **UN Sustainable Development Goals** have been identified as an excellent metric with which to identify progress towards this vision.

This presents us with complex challenges that can only be **addressed** through processes that can be successfully delivered **by learning together with our customers and suppliers and Systems Engineering** leadership through influence. Fortunately we have examples which can light the way for the **learning journey** we are on and **enhance resilience** in the face of the **uncertainties**

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Using systems thinking to address complex engineering challenges

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Conclusions from my 2014 keynote

INCOSE

1. **Complex** problems are context dependent
2. The **principles** of systems architecting are transferable but the frameworks are not.
3. **Integration** is enabled by establishing a **meta-structure, shared language and measurement system**
4. **Purpose of architectures** is to generate **context dependent understanding** to enable policy formation, design and problem solving
5. **Stakeholder views determine purpose** and need to be managed with an **ongoing learning process**
6. The framework can be used to
   - manage complex projects
   - develop and maintain policy initiatives
   - interpret and predict real world behaviour
   - **develop resilience and adaptability in the face of uncertainty**.

Learning together

“5. Stakeholder views determine purpose and need to be managed with an ongoing learning process”

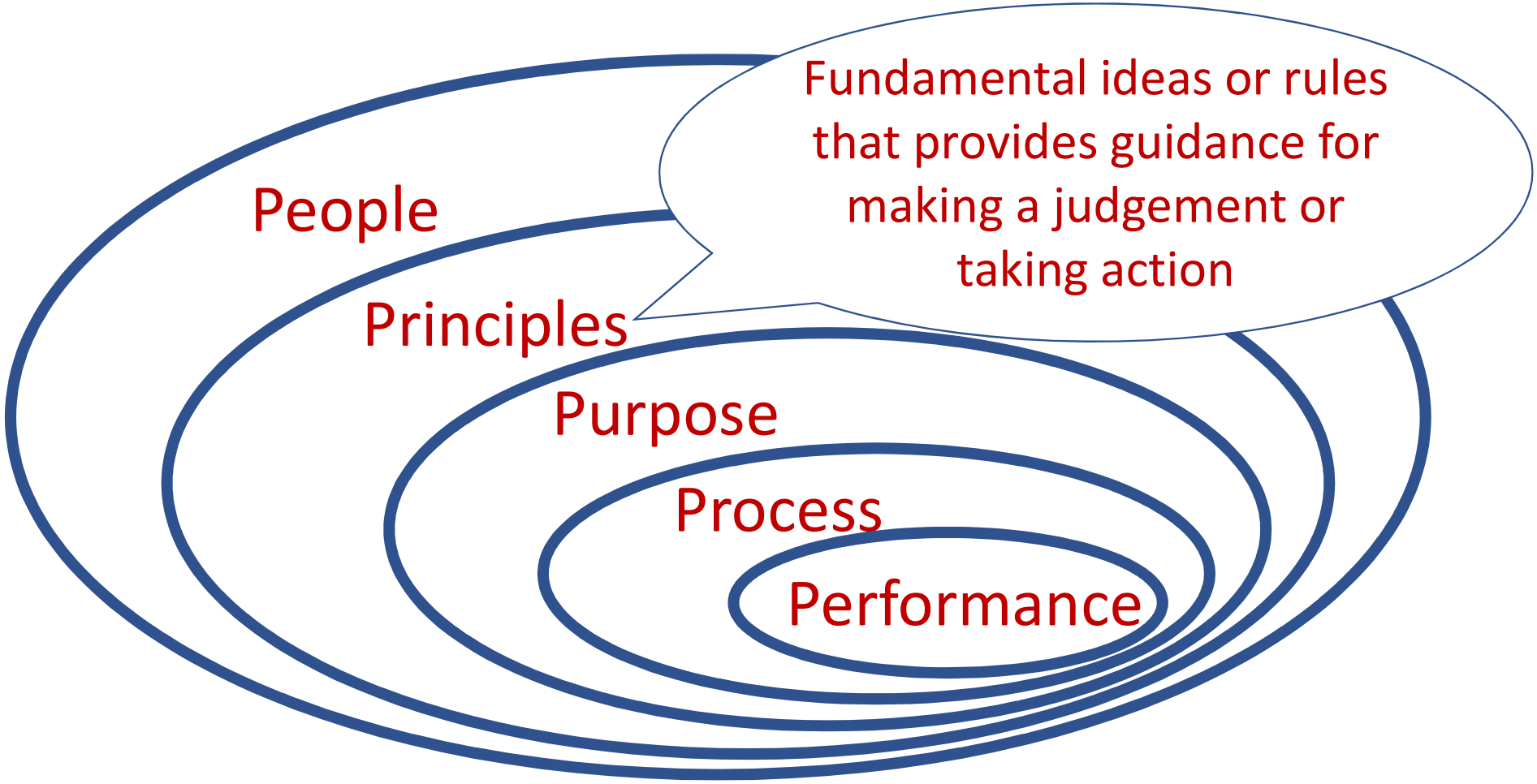
Impelling Purpose

Sharing a few insights, to help us, as INCOSE **people**, to deal with Complex Problems - Better.

Continuing our *learning journey together*

Learning together

Systemic view on system challenges



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Impelling Purpose - INCOSE Example

Vision 2025 – Sustainable Development Goals

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Alan Harding IW2018 Plenary

A meta structure and measurement System

Defined : http://www.undp.org/content/dam/undp/library/corporate/brochure/SDGs_Booklet_Web_En.pdf

Annual report : https://unstats.un.org/sdgs/files/report/2017/TheSustainableDevelopmentGoalsReport2017.pdf

The opportunity for systems excellence is Global

"It is not what the vision is,
it is what the vision does that is important."

Blockley and Godfrey

http://www.icebookshop.com/bookshop_main.asp?ISBN=9780727760821

What is a system?

INCOSE Fellow's Initiative

Purpose: Inclusive definitions of Systems and Systems Engineering

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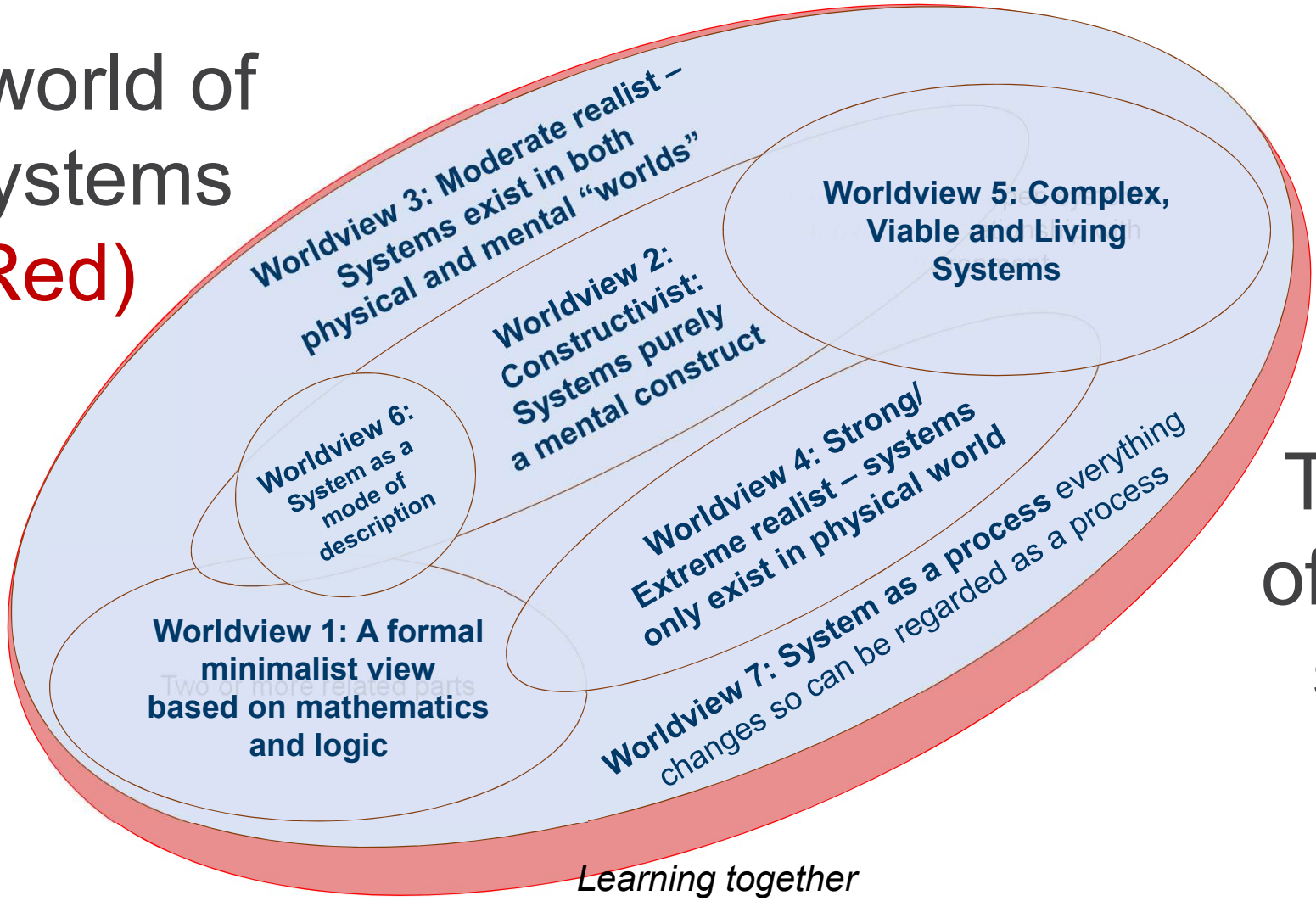
Aligning world views of systems

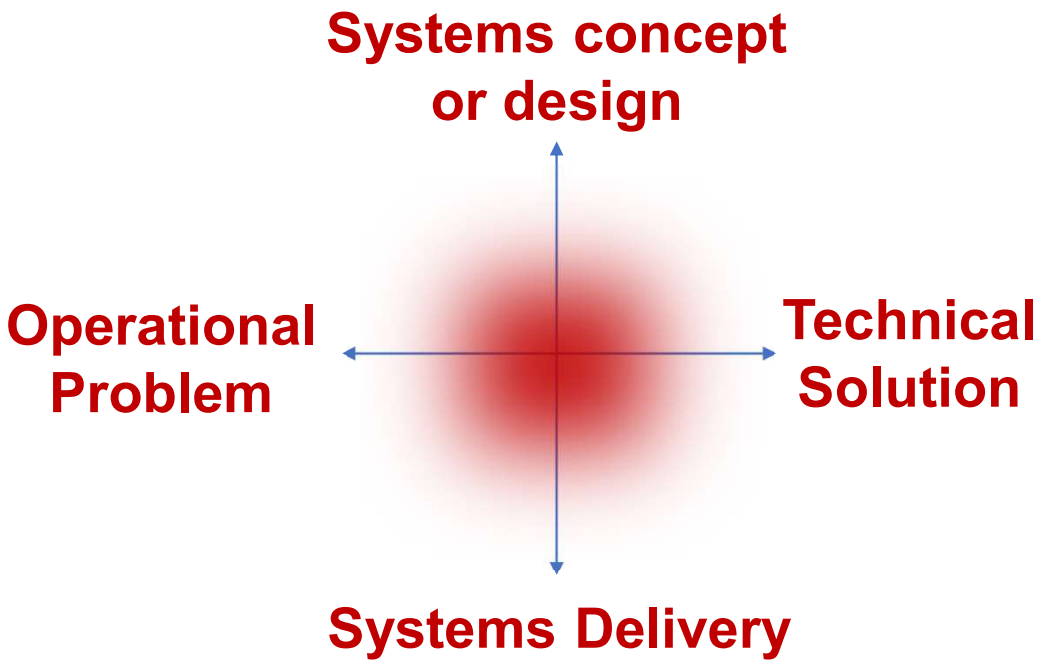
The world of all systems (Red)



The world of INCOSE systems (Blue)

Worldviews on Systems Engineering

- > 200 people surveyed: IS 2018 poster paper
- 48 definitions analysed
- Consistent with *systems* worldview map
- Distribution reflects respondents/definition focus



Summary on systems worldviews

Observations

1. No worldview is wrong
2. No worldview is complete
3. The set of worldviews defines a landscape
4. Worldviews overlap - don't 'fit together'
5. Worldview-centred Definitions don't add up to a coherent whole

Implications

1. General definition must encompass all worldviews
2. Subordinate definitions don't map directly to worldviews (because of 4&5 above)

What is a system? An inclusive definition

A system is a structured set of parts or elements, which together exhibit **behaviour** or **meaning** that the individual parts do not.

- **'Behaviour'** refers to **physical** systems
- **'Meaning'** refers to **conceptual** system
- Further layers of definition are appropriate to different world views

New definitions covering all worldviews

A system is a structured set of parts or elements, which together exhibit **behaviour** or **meaning** that the individual parts do not.

A physical system

A conceptual system

- A closed system
- An open system
- A viable system
- A complex system
- An anticipatory system
- A natural system
- An artificial system
- A hybrid system

A Complex System is a system in which there are **uncertain relationships** between **cause and effect**: each effect may be due to multiple causes; each cause may contribute to multiple effects; and cause-effect chains are circular and entangled rather than linear and separable.

For Systems Engineering Practitioners

Worldview analysis has emerged as a systems engineering tool

used to:

- **dissolve** the boundaries between conventional disciplines, and belief systems
  - **organizes** us around
    - purpose
    - physical real world context
  - **usable** at any level
    - from complex to simple
    - from global to personal
- **promote** cooperation, collaboration and integration
- **reduce** prejudice and conflict

An enabler for Vision 2025 & UN SDG's
Requires a transdisciplinary approach

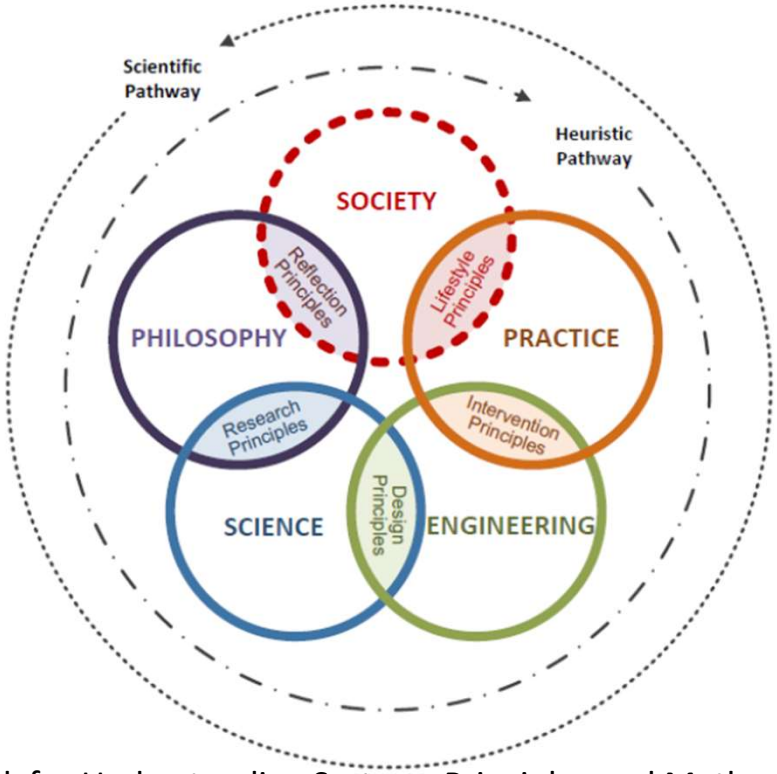
Systems Engineering - top lev

Fundamental ideas or rules that provides guidance for making a judgement or taking action

Systems Engineering is ~~an i~~ ~~disciplinary~~ a transdisciplinary appr~~o~~ach and means, based on systems principles and concepts, and applying scientific, technological and management methods, to enable ~~the realization of~~ successful realization, use and retirement of engineered systems

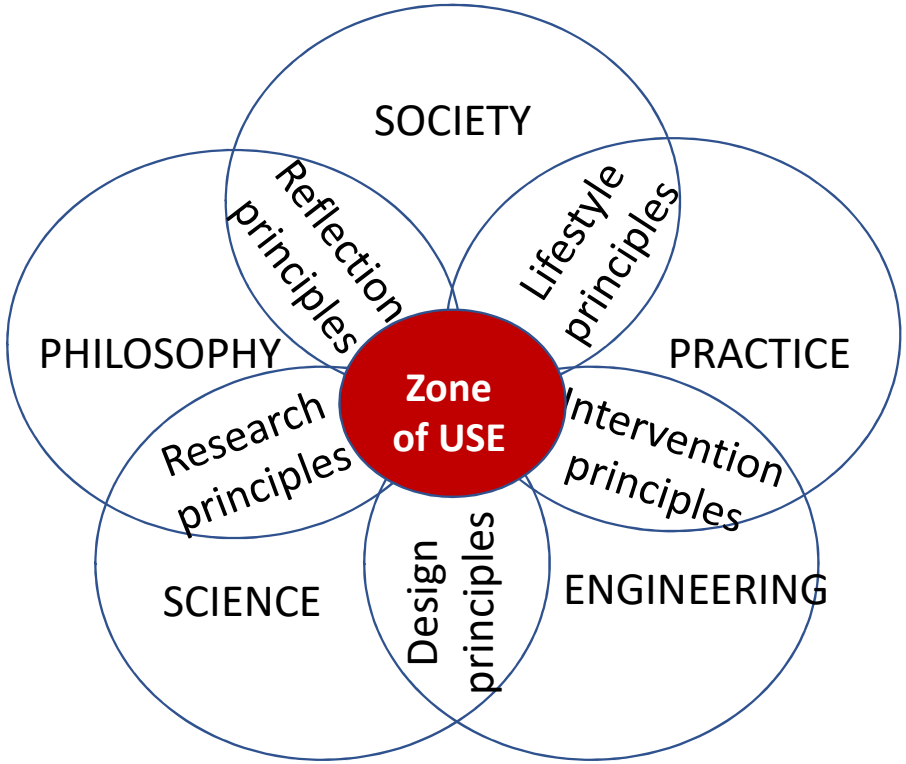
Understanding and use of systems principles

Systematic understanding



A Framework for Understanding Systems Principles and Methods
David Rousseau, IS2018 Paper 128

Systemic use



A Framework for Using Systems Principles and Methods
After David Rousseau, IS2018 Paper 128

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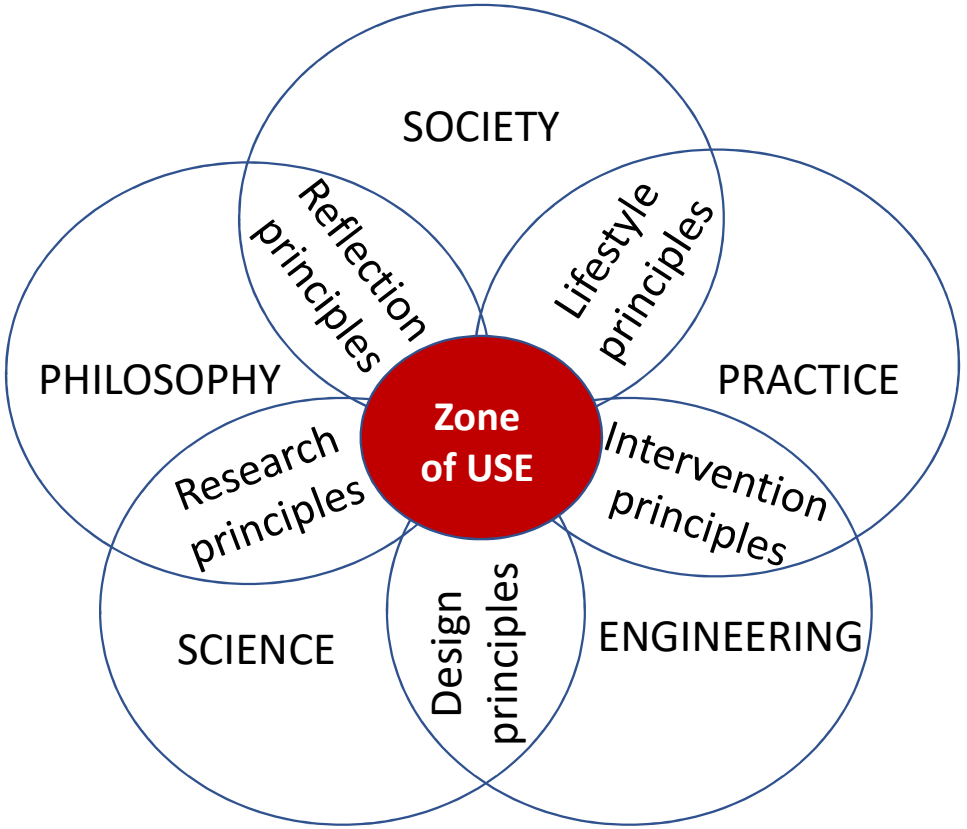
Example 1 - Polcevera Collapse[1]



[1] https://www.theglobeandmail.com/opinion/article-what-lessons-can-be-learned-from-the-genoa-bridge-collapse/

Example 1 - Polcevera Collapse

Reflection Principle

It is a cultural problem

Disasters are incubated[1]

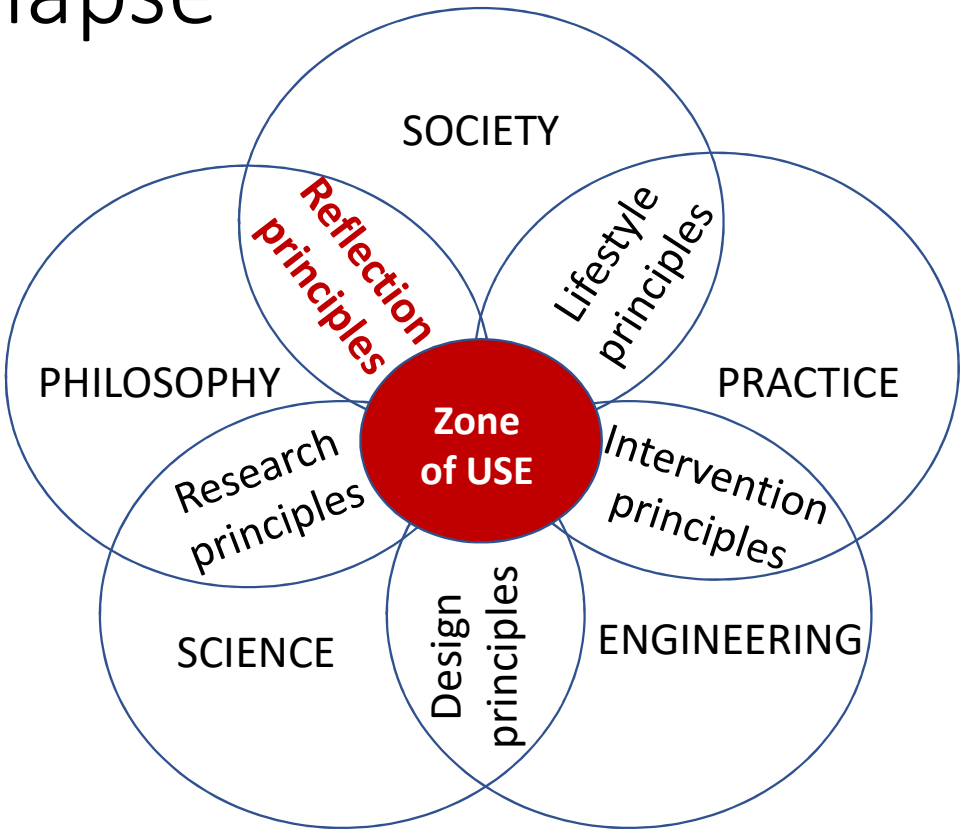
Is there a failure of hindsight[2]?

What is the purpose of the public enquiry?

- Prevent similar disasters?
  - Need to look **systemically**

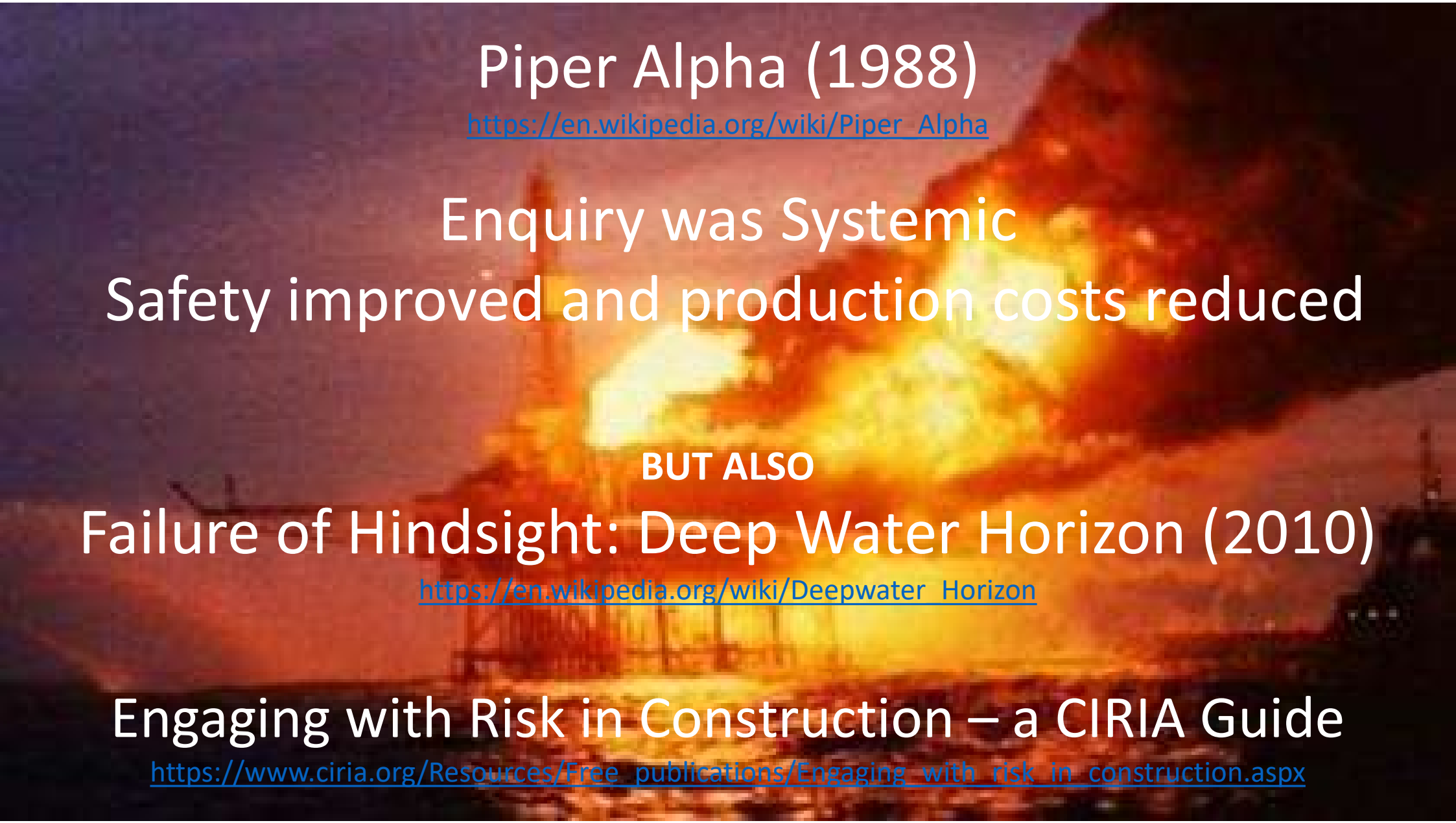
Or

- Discover who was to blame?
  - Tends to be **systematic**



[1] **Man-Made Disasters,** by Barry A. Turner **(**1978), Wykeham Publications, ISBN 0 85109 750 2 (first edition) http://www.mindtherisk.com/literature/157-man-made-disasters-by-barry-a-turner 01/09/2018

[2] **The Failure of Hindsight**, B. Toft (1992) Disaster Prevention and Management: An International Journal, Volume: 1 Issue: 3, 1992


Piper Alpha (1988)
https://en.wikipedia.org/wiki/Piper_Alpha
Enquiry was Systemic
Safety improved and production costs reduced
BUT ALSO
Failure of Hindsight: Deep Water Horizon (2010)
https://en.wikipedia.org/wiki/Deepwater_Horizon
Engaging with Risk in Construction – a CIRIA Guide
https://www.ciria.org/Resources/Free_publications/Engaging_with_risk_in_construction.aspx

Perhaps we are learning? – Grenfell disaster

..... "begin thinking about buildings as a system so that we can consider the different layers of protection that may be required to make that building safe on a case-by-case basis."

Dame Judith Hackitt (2018)

Building a Safer Future –

Independent Review of Building Regulations and Fire Safety: Final Report

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/707785/Building_a_Safer_Future_-_web.pdf

Vision - Inspiring success

Releasing personal energy

Generating the reason for collaboration

Adjusting our point of view

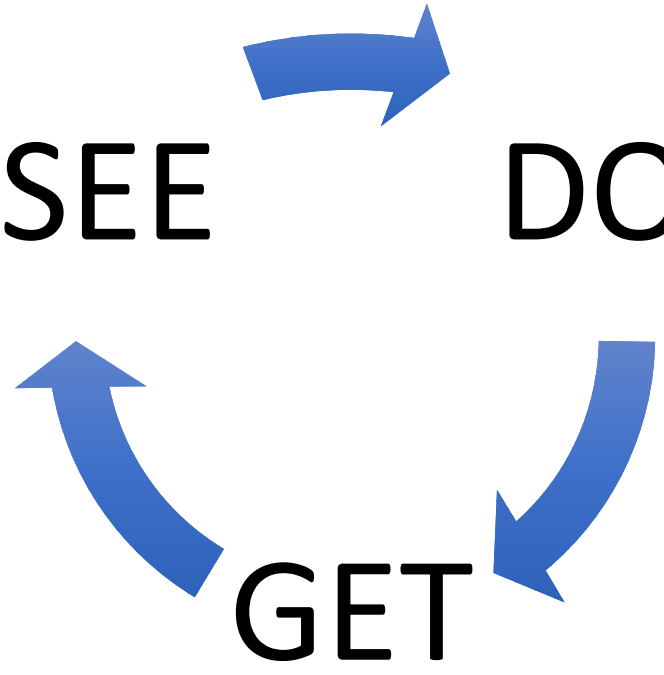
But is it what we do??

First axiom of Systems Thinking[1]

Impelling Purpose - drives the need to learn

[1] http://myengineeringsystems.co.uk/5-axioms/

Impelling purpose - Changing the way we see it



If we want to change the outcome we need to

change the way we see the problem

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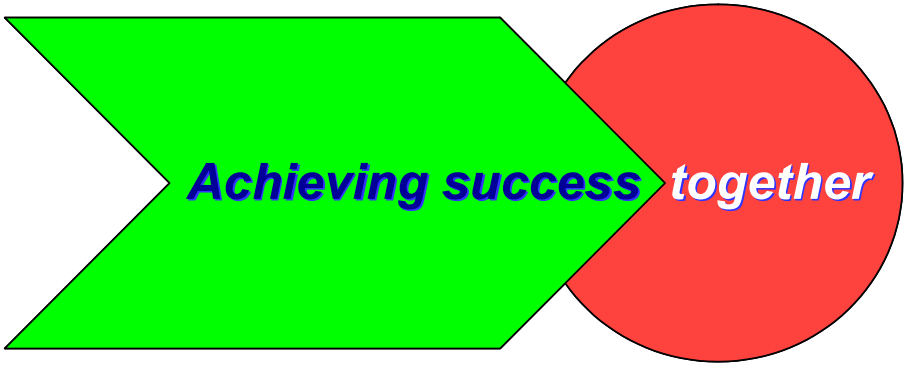
systems-thinking UK

Aligning teams to purpose



‘the world’s most refreshing interchange’

Source ‘The T5 Handbook 1998’

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Example of Impelling Purpose

Delivered on time and within Budget

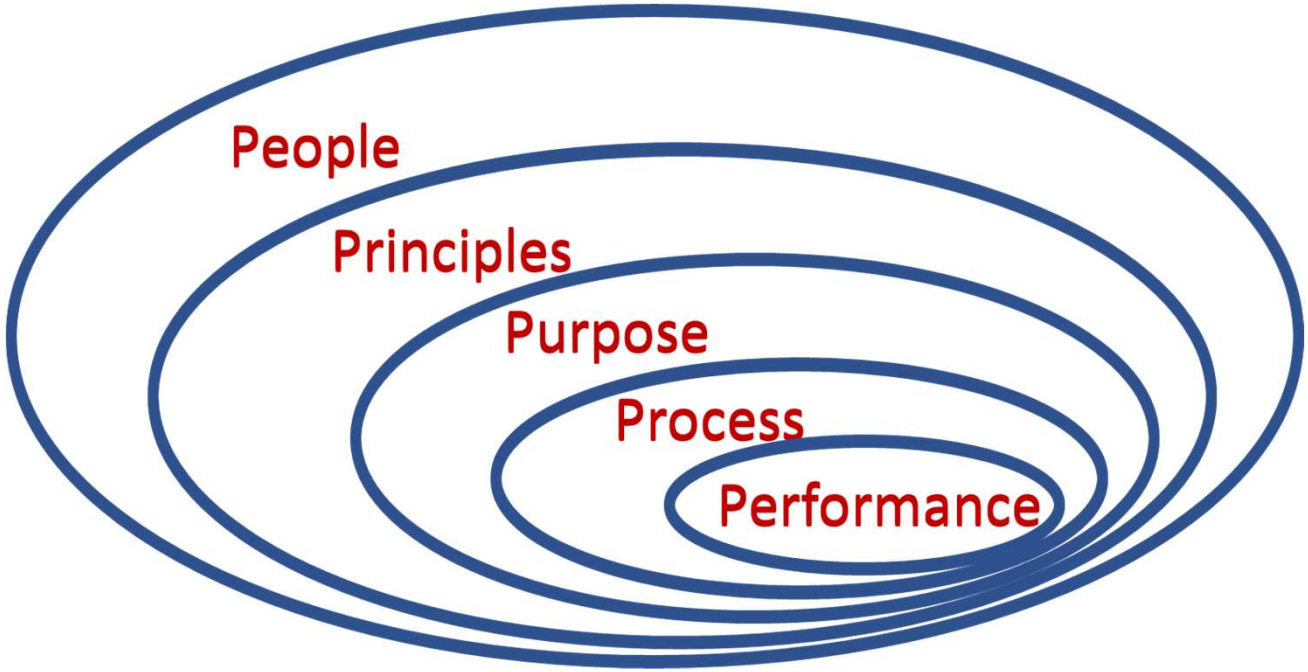
Example of lack of systems thinking

Building Airport terminals can be financially disastrous

- **eg Berlin Brandenburg Airport** https://en.wikipedia.org/wiki/Berlin_Brandenburg_Airport
- **By 2006, construction cost budgeted at €2.83bn**
- **August 2016 €6.9 billion**
- **European Commission approved additional Private Finance part guaranteed by Federal and Local Government €2.2 billion!**
- **Opening date: 3rd June 2012 latest estimate 2020!!**

What can we learn together from this comparison?

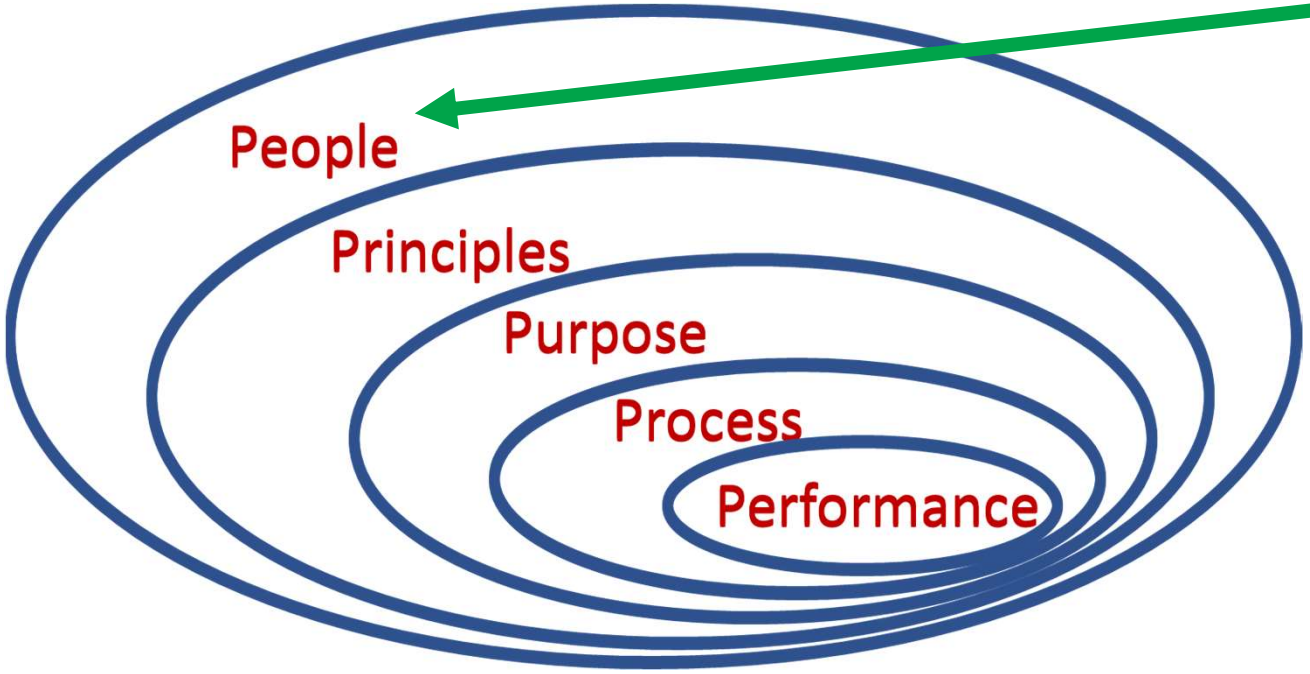
Integrating complex systems though:



T5 Success was achieved by integrating the people first [1].

[1] https://www.nao.org.uk/defencevfm/wp-content/uploads/sites/16/2013/02/BAAPlcTerminal5.pdf

Outcomes are governed by people behaviours



A **transdisciplinary** approach is essential

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Changing my behavior!

I have lost 22 Kg by applying this approach and enjoyed it!

Conclusion

Addressing **complex** challenges

Opportunities are truly inspiring

Uncertainties are truly challenging

We are on a **learning journey** together

A systematic approach is not sufficient

Transdisciplinary learning is required

Systemic approach is essential for us all

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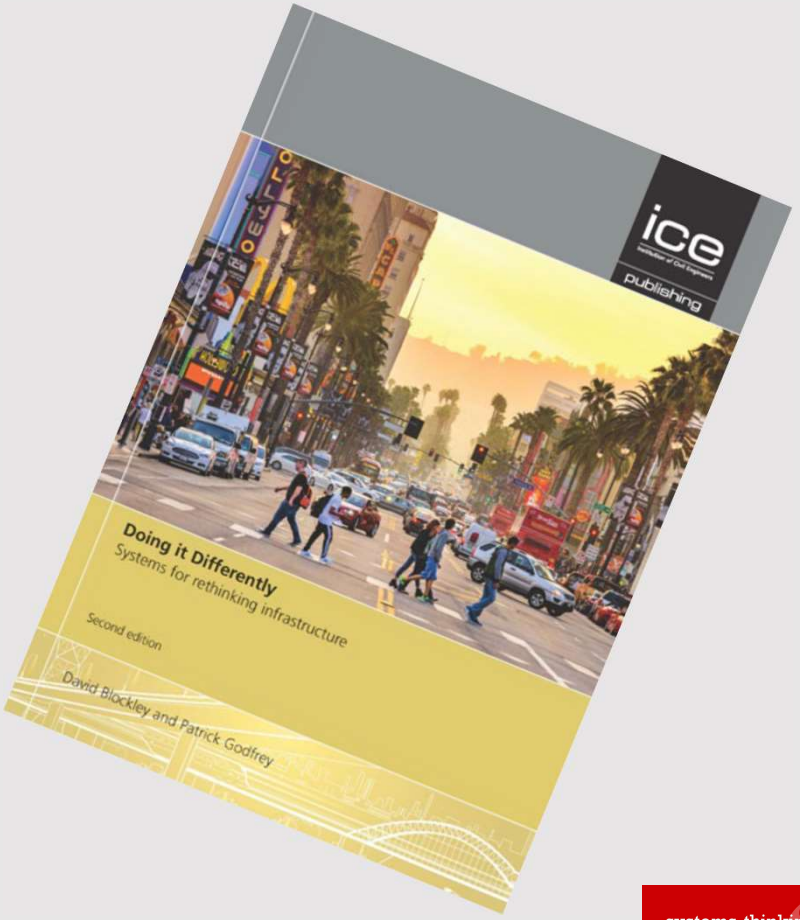
There is a guide book for our journey

Doing it differently – Systems for rethinking infrastructure

David Blockley, Patrick Godfrey



And a **website**

http://myengineeringsystems.co.uk/

Paperback	Amazon uk
Price: : £45	https://www.amazon.co.uk/Doing-Differently-Second-David-Blockley/dp/0727760823
ISBN: 9780727760821	
Published: January 2017	
Pages: 184	

systems-thinking UK

References

UN Sustainable Development Goals

http://www.undp.org/content/dam/undp/library/corporate/brochure/SDGs_Booklet_Web_En.pdf

https://unstats.un.org/sdgs/files/report/2017/TheSustainableDevelopmentGoalsReport2017.pdf

Doing it differently - systems for rethinking Infrastructure – Blockley and Godfrey (2017)

https://www.amazon.co.uk/Doing-Differently-Second-David-Blockley/dp/0727760823

https://www.amazon.com/Doing-Differently-Second-David-Blockley/dp/0727760823

INCOSE Fellows Definitions study Sillitto et al (2018)

Paper 30 What do we mean by "system"? - System Beliefs and Worldviews in the INCOSE Community.

Paper 31 **A fresh look at Systems Engineering – what is it, how should it work?**

Paper 32 **Envisioning Systems Engineering as a Transdisciplinary Venture**

David Rousseau, IS2018

Paper 128 A Framework for Understanding Systems Principles and Methods

Engaging with risk CIRIA guide

https://www.ciria.org/Resources/Free_publications/Engaging_with_risk_in_construction.aspx

Building a Safer Future Independent Review of Building Regulations and Fire Safety

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/707785/Building_a_Safer_Future_-_web.pdf

National audit office case study T5

https://www.nao.org.uk/defencevfm/wp-content/uploads/sites/16/2013/02/BAAPlcTerminal5.pdf

Questions?