



Systems Thinking

Making sense of complexity and managing its unintended consequences

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Learning together



Complex problems (wicked or messy)

4 integrated concepts

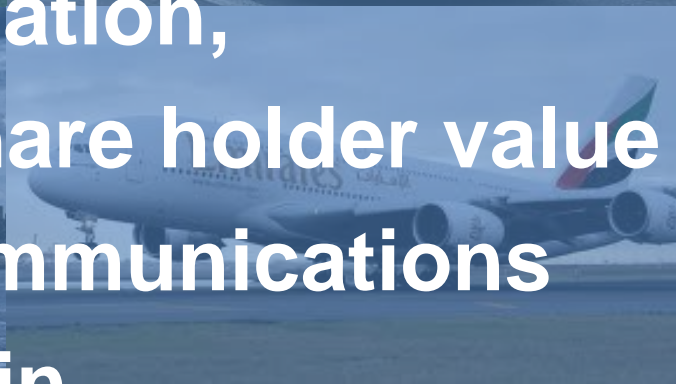
- People
- Purpose
- (new) Process
- Performance

Some complex systems ?



Some complex systems ?

- Globalisation,
- Privatisation,
- Sustainability
- Democratisation,
- Creating share holder value
- Internet communications
- Supply chain
- Safety constrained innovation
- Interdependence of infrastructure



Increasing
Complexity



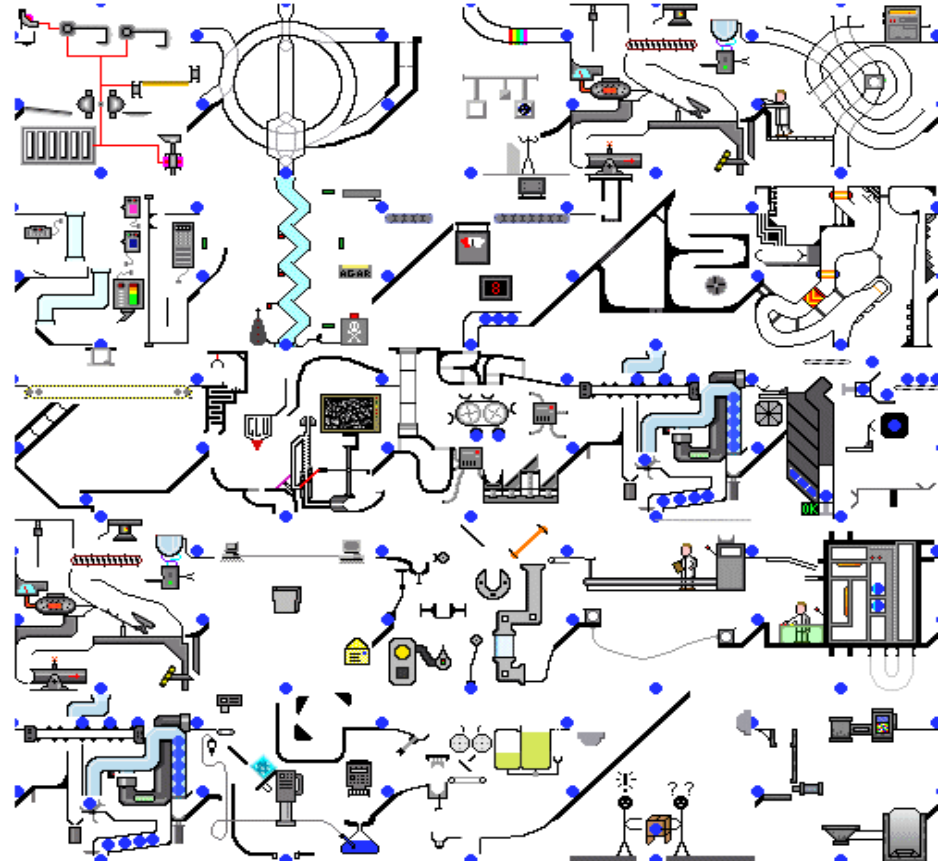


Addressing whole problems and needs

- We are living off our legacy infrastructure and it is failing us economically. We have to do far better for much less.
- Successful business will be businesses that can **LEARN** better and faster **TOGETHER** than our competitors.
- Otherwise the future is decline into a third world economic performance

What do we mean by complexity?

Is this Complex?



A Tree - Complex or Complicated?

- It depends on your point of view
- To the Ecologist it is complex
- To the Structural Engineer it is complicated but not complex to analyse



Relationships between people – complex or complicated?

It depends
upon your
point of view



Stakeholder's points of view?

Need to manage uncertainty

*“Engineers are increasingly concerned with **complex systems**, in which the parts interact with each other and with the outside world in many ways – the **relationships** between the parts determine how the system **behaves**. **Intuition rarely predicts the behavior of novel complex systems.**”*

Source: ‘Creating systems that work’ Royal Academy of Engineering 2007

Learn our way to success

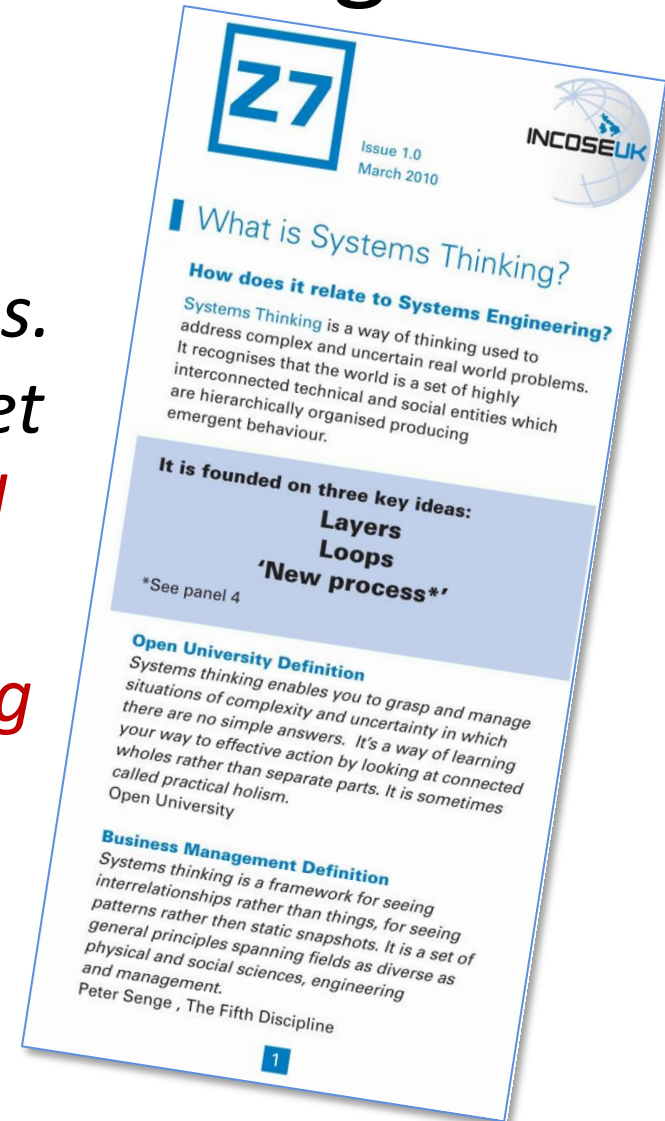
Learning together

Introducing systems thinking

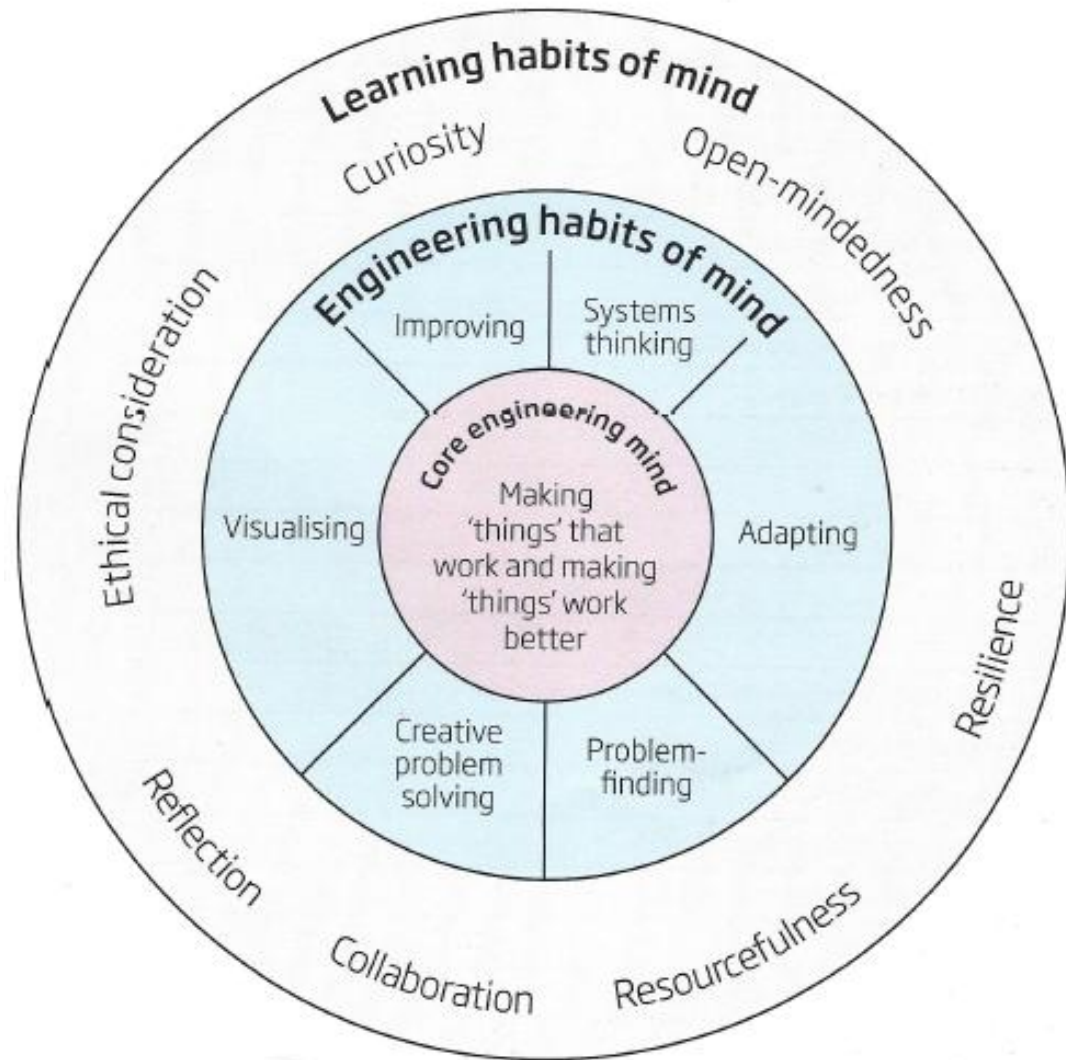
*Systems Thinking is a way of thinking used to address complex and uncertain real world problems. It recognises that the world is a set of highly **interconnected technical and social entities which are hierarchically organised producing emergent behaviour.***

INCOSE UK Z7 Guide

http://www.incoseonline.org.uk/Documents/zGuides/Z7_Systems_Thinking_WEB.pdf

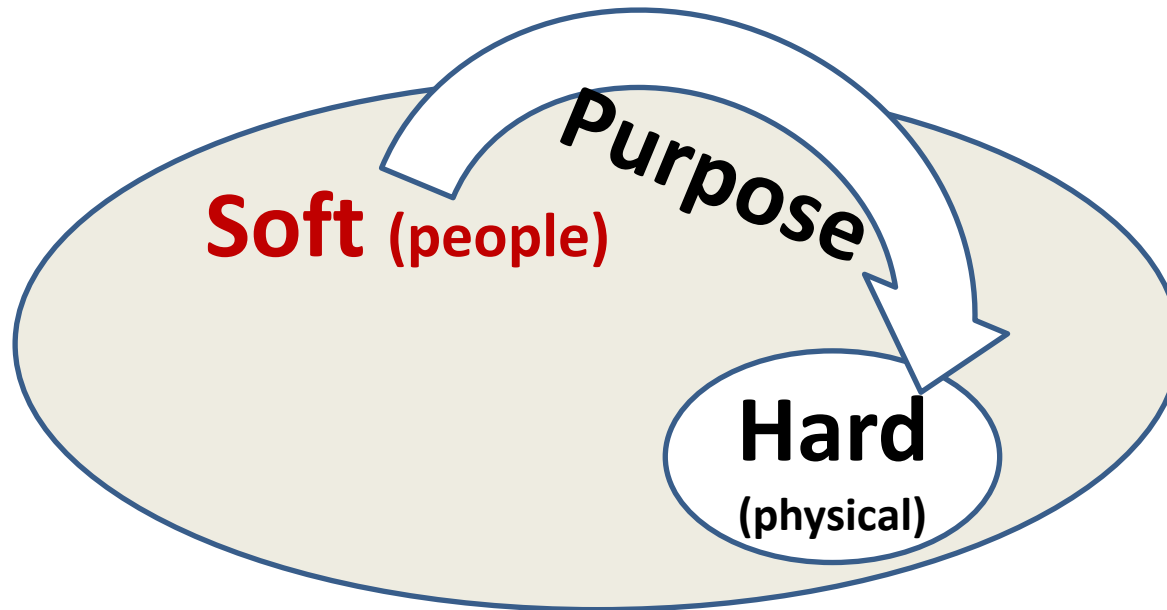


Systems thinking is an engineering habit of mind.



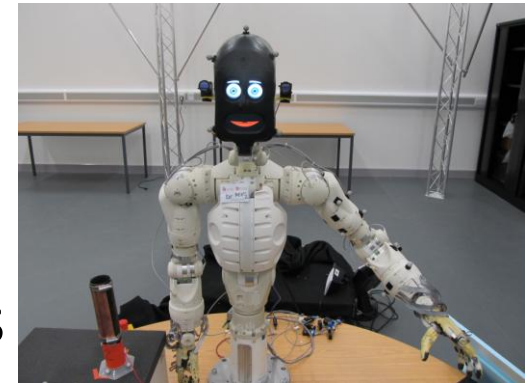
Thinking like an engineer (2014) Royal Academy of Engineering
<http://www.raeng.org.uk/publications/reports/thinking-like-an-engineer-implications-summary>

A clarifying principle



Safety Assurance of Robotic Co-Workers

- **Human-centric perspective**
 - Managing expectations
 - Cognitive models for Human Robot Interaction (HRI)
- **Robot-centric view**
 - Integration of safety considerations from the outset, i.e. “by design”
 - Formalize safety requirements as high-level policies to guide learning!



The need is real : kidney operation

- Da Vinci Xi is a new surgical robot
- replace open surgery with a minimally invasive approach
- It is learning to do it under supervision not control of surgeon

Sunday Times 08/03/15



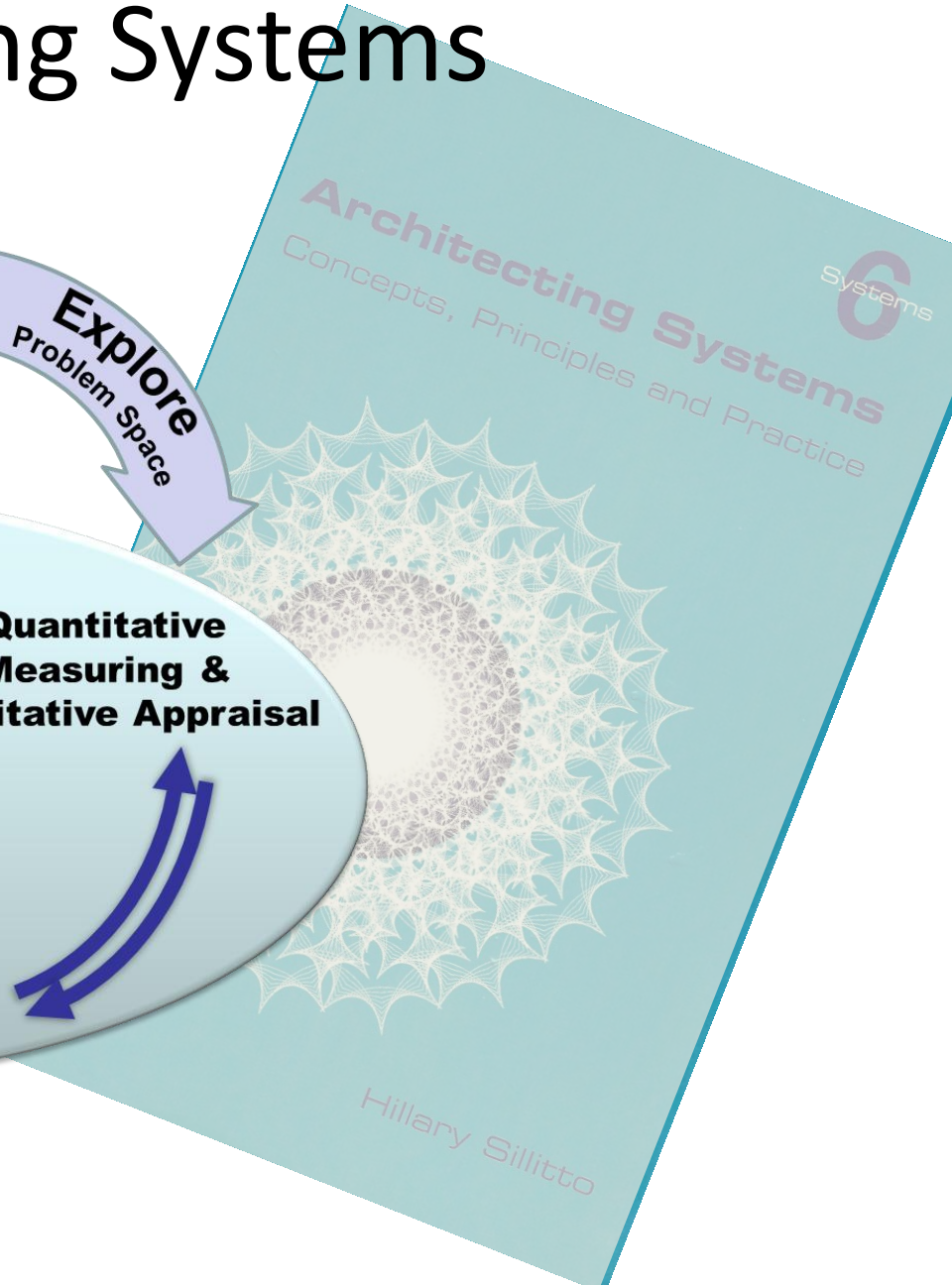
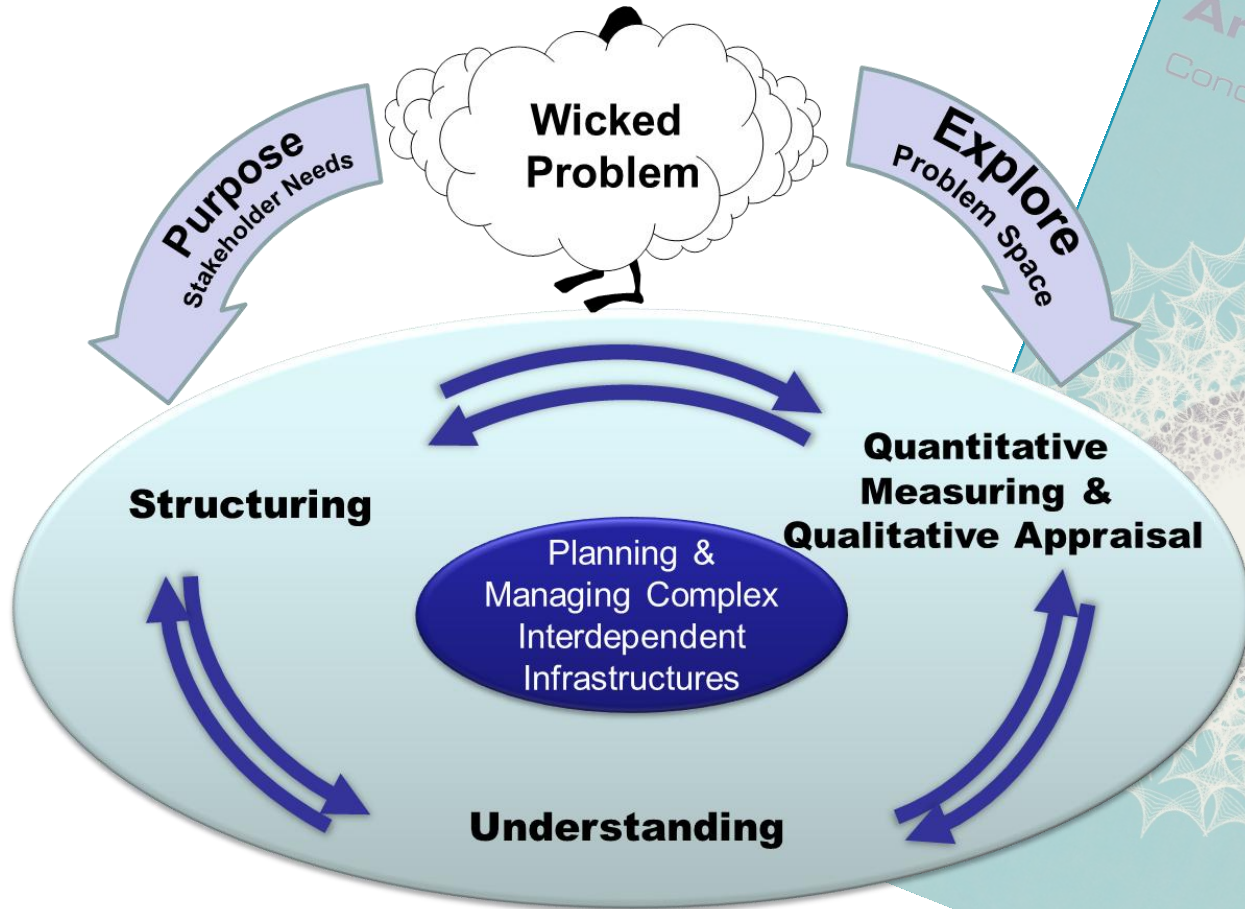
New Process

- A holistic view of process
 - people and physical processes
 - consistency helps integrate hard and soft
 - helps to align stakeholders to purpose
- Process define ‘How change happens’.
 - includes natural, hard (physical) and soft (people).

Why (purpose) is the driver

How is the means, operates on (who, what, where and when)

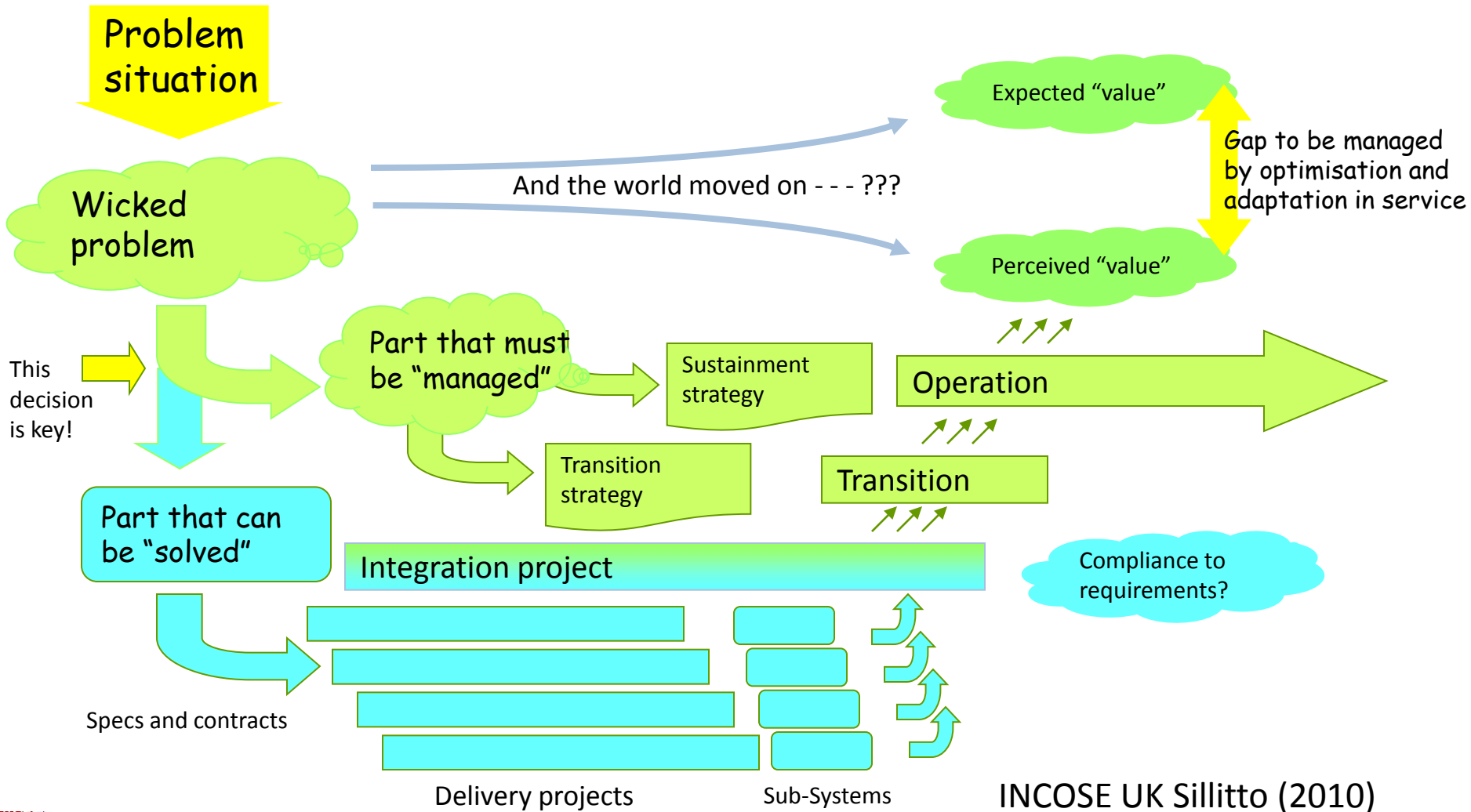
Architecting Systems



Olympics 2012



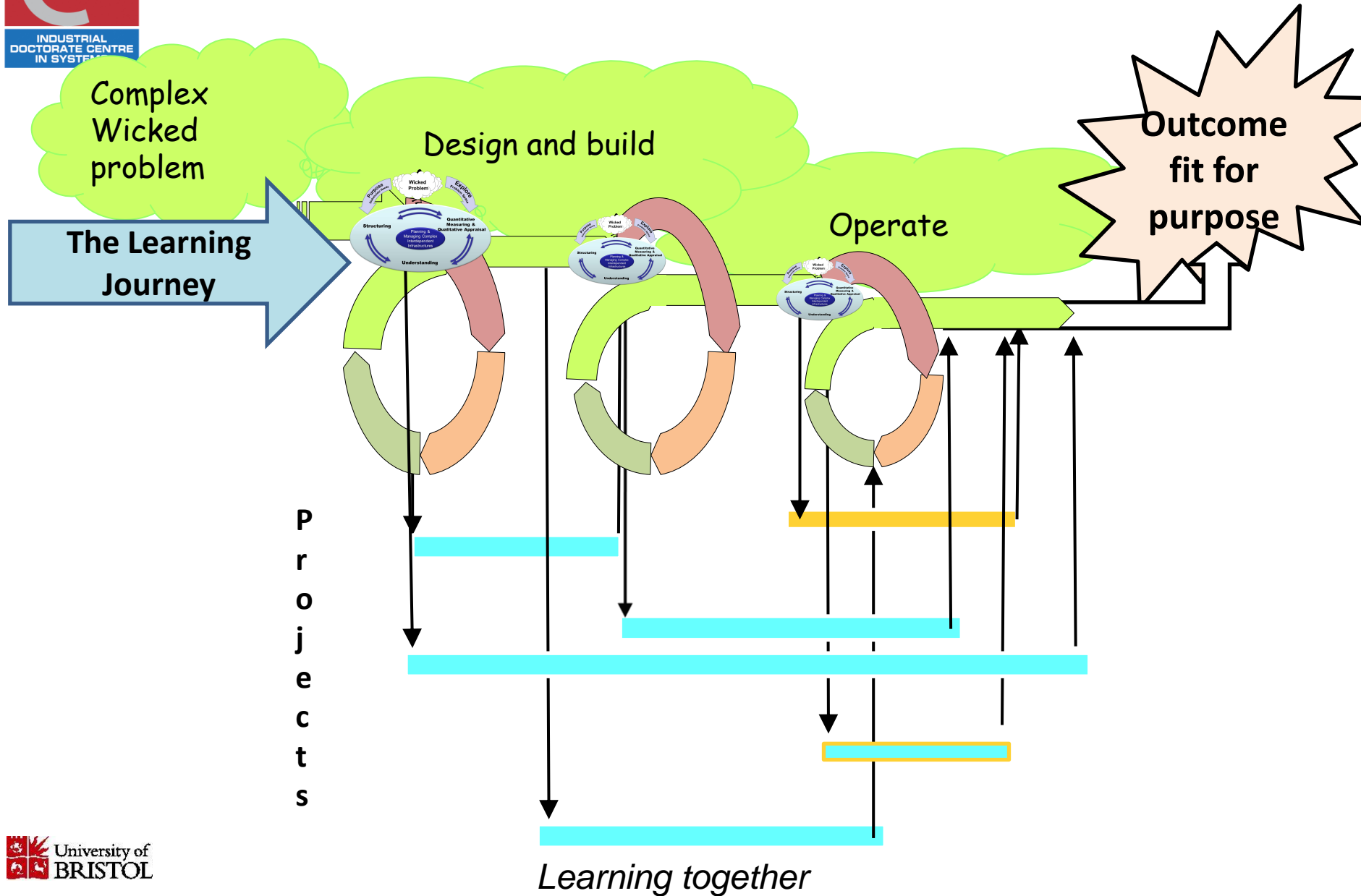
What has to be architected



The learning loop

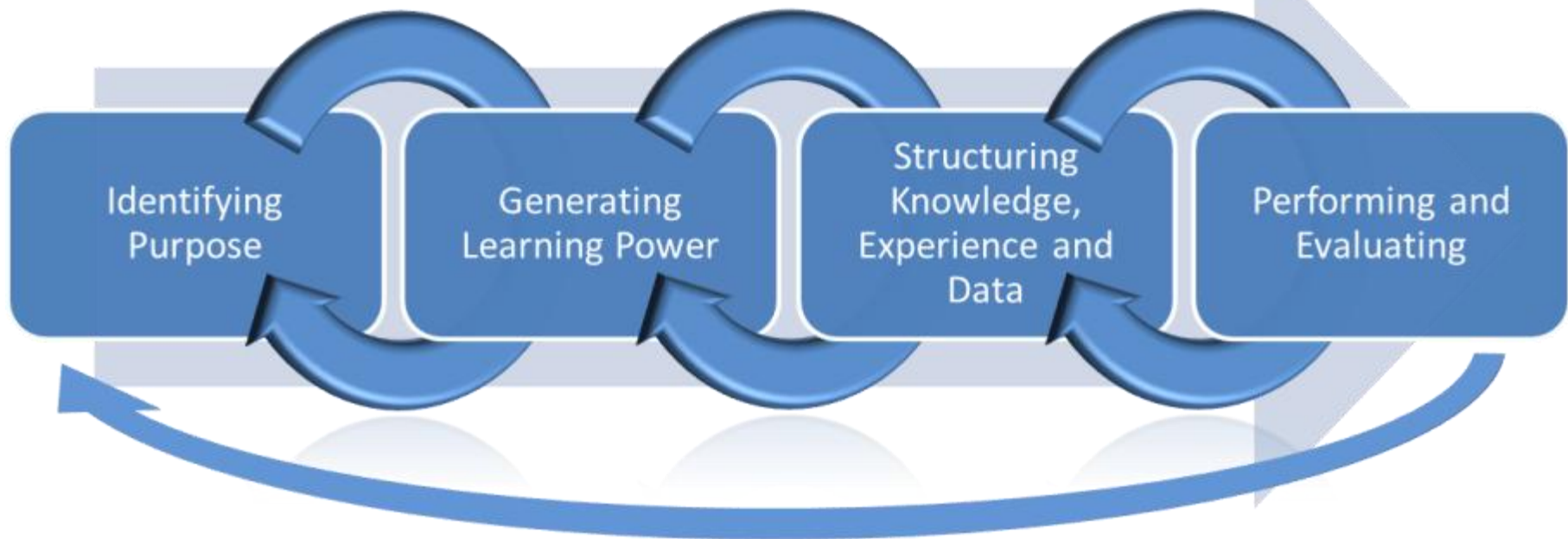
- Intervene to manage the changing uncertainties





ICIF Learning Journey Process

Supporting the way stakeholders **learn together**
to deal with uncertainty



Problem structuring

Shared model Building

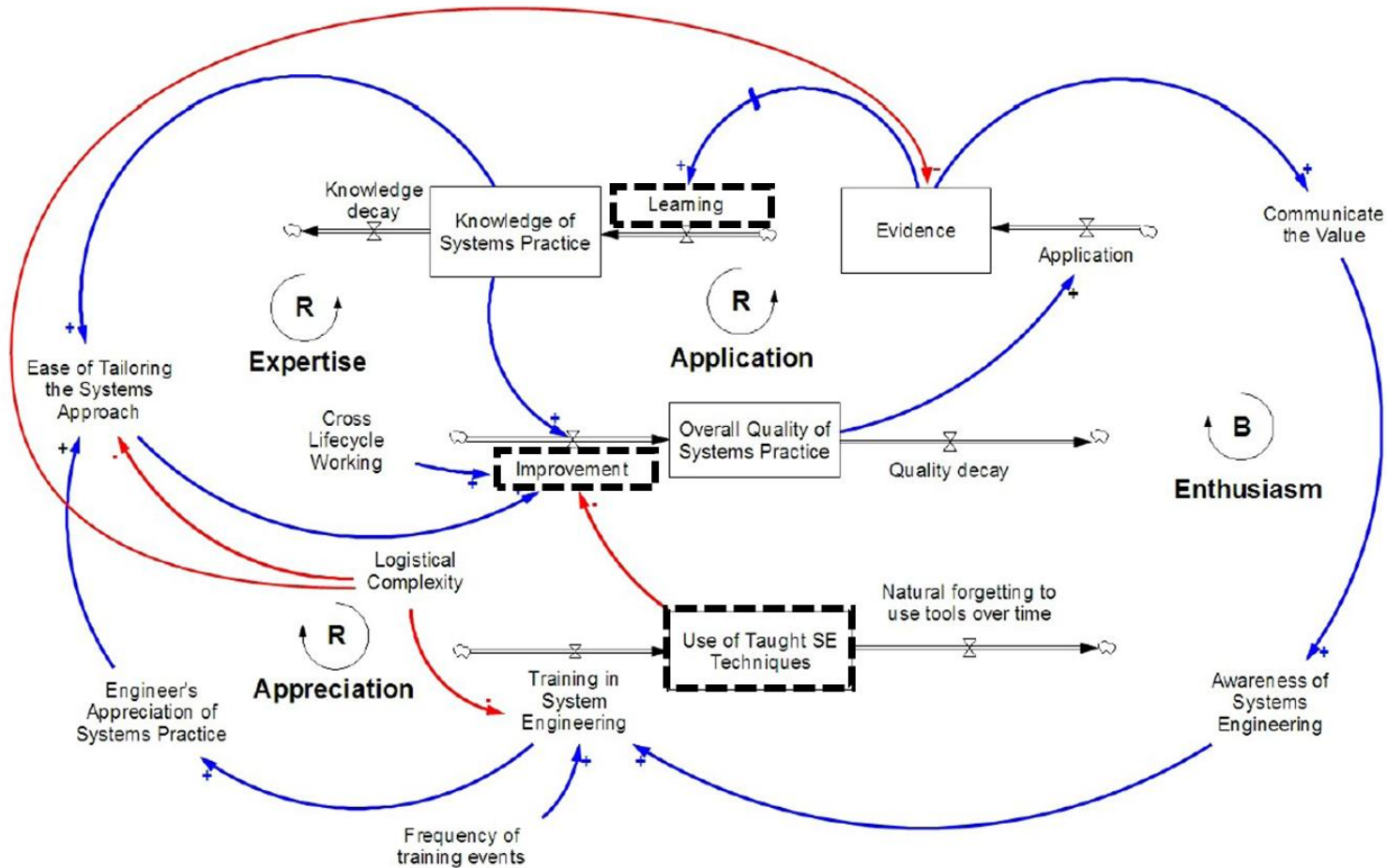
- A means of
 - Aligning stakeholder objectives to purpose
 - Establishing a problem structuring framework
 - Engaging the organisation in performance improvement
 - Identifying and dealing with unintended consequences

Shared Model Building - Big Picture



Example of shared model at Roll Royce

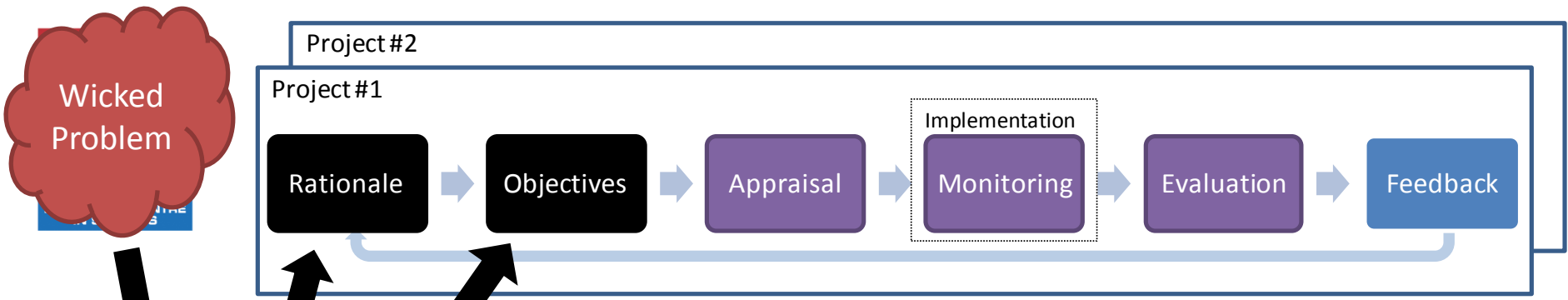
Accelerate improvement in Systems Engineering



Infrastructure interdependence, resilience and cross-sectoral working

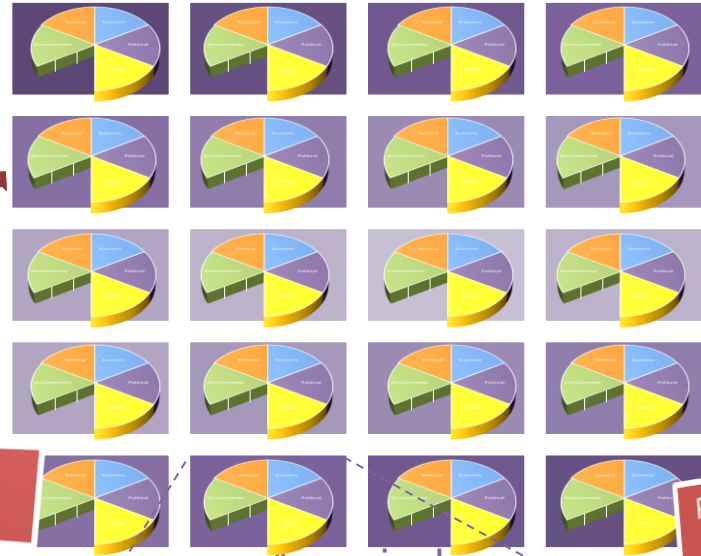
15.28 **“The Interdependency Planning and Management Framework (IPMF)**, published in November, enables the identification and appraisal of cross-sectoral delivery benefits and facilitates engagement between stakeholders. It was developed in a joint research programme between the University of Bristol and University College London.”





Stakeholder Needs & Capability Requirements

Stakeholder Viewpoints

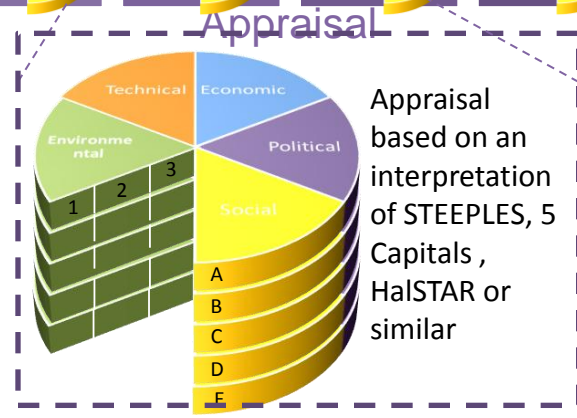


Identified Interdependency

Matrix Approach

Primary Goal 1	X				
	Primary Goal 2				
		X			
			Primary Goal 3	X	
				Primary Goal 4	X
					Primary Goal 5
		X			

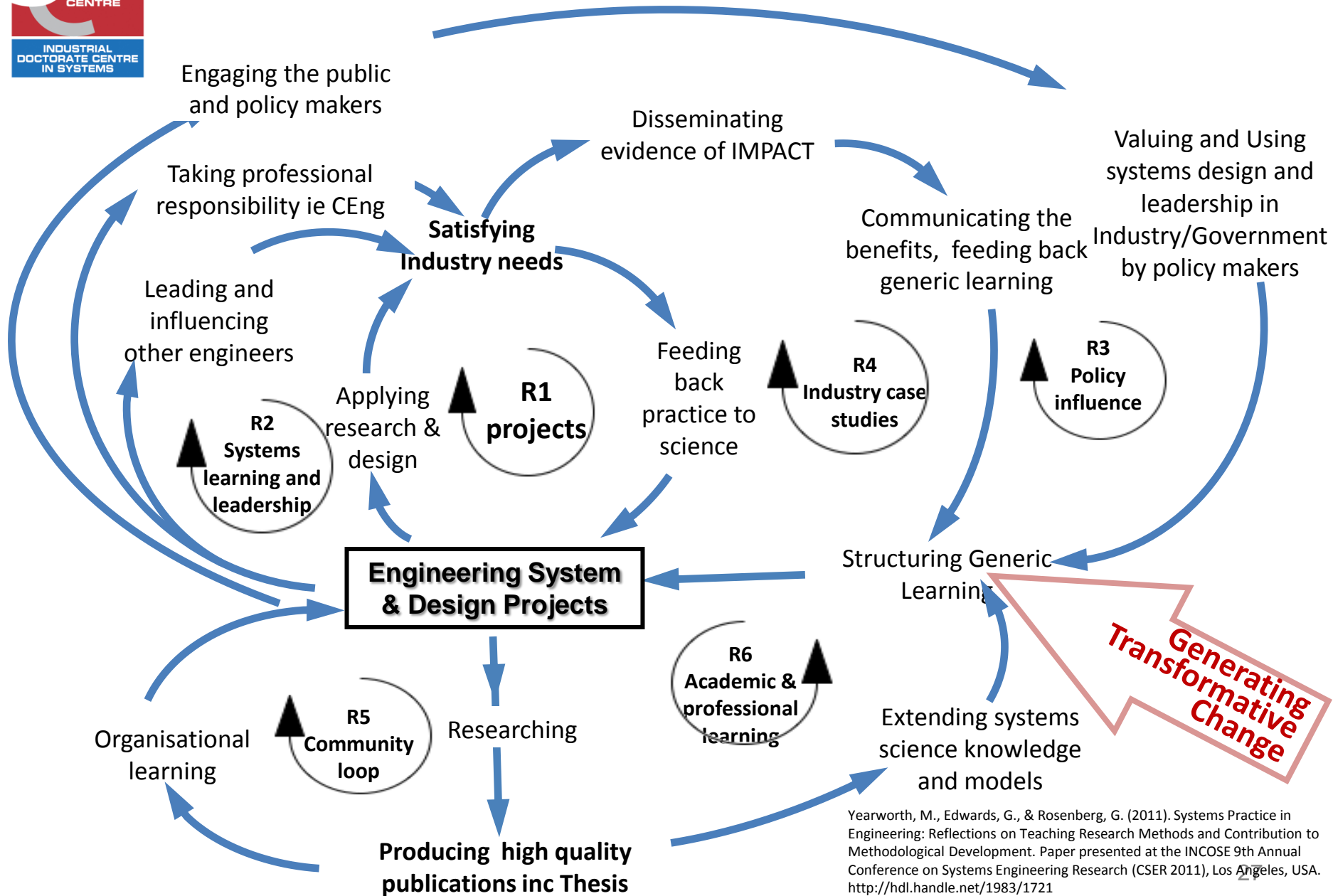
Policies/Projects/Assets (across Sectors)



Learning together

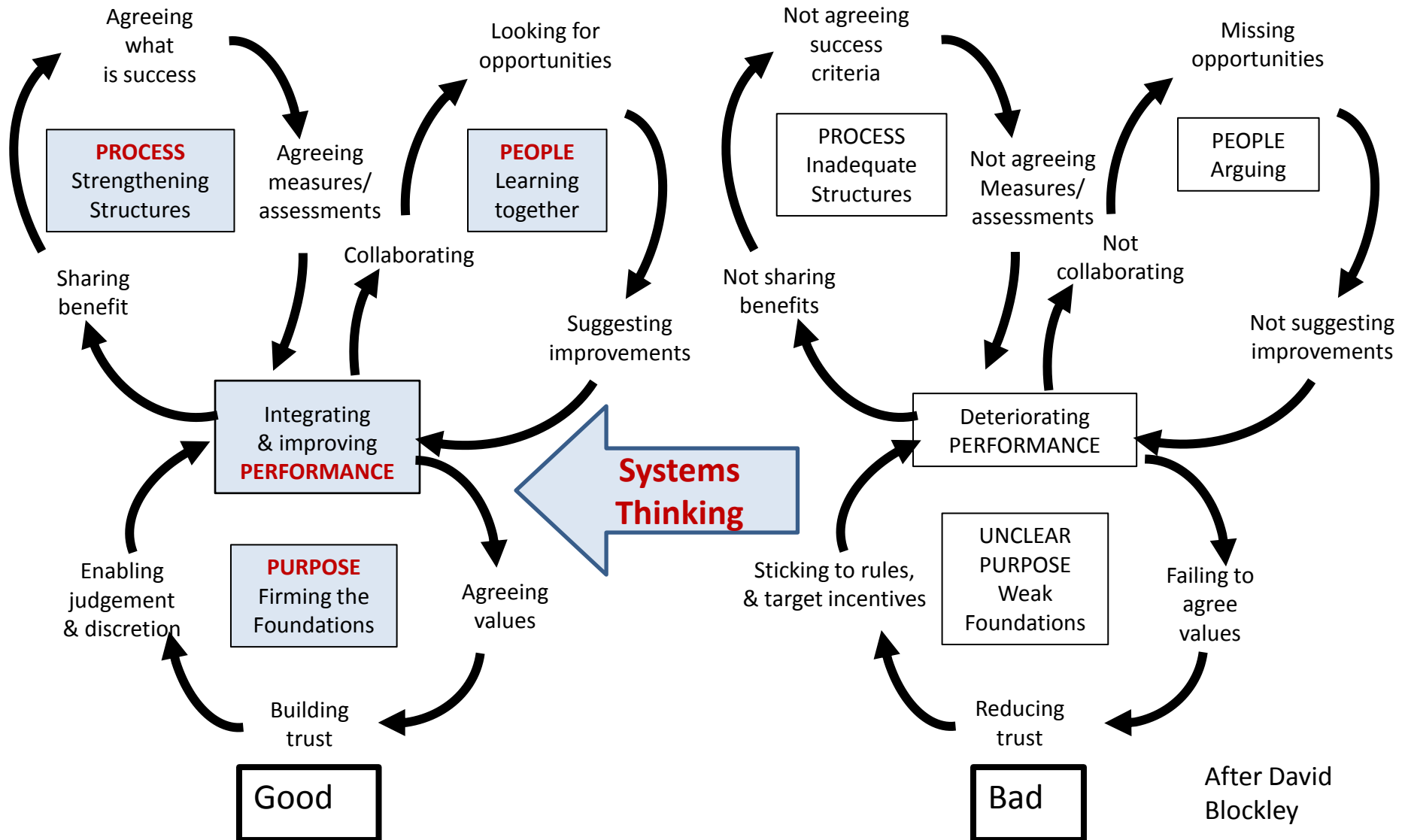
Primary Goal 1	X				
	Primary Goal 2				
		X			
			Primary Goal 3	X	X
				Primary Goal 4	
					Primary Goal 5
			X		

Generating transformative change



Yearworth, M., Edwards, G., & Rosenberg, G. (2011). Systems Practice in Engineering: Reflections on Teaching Research Methods and Contribution to Methodological Development. Paper presented at the INCOSE 9th Annual Conference on Systems Engineering Research (CSER 2011), Los Angeles, USA. <http://hdl.handle.net/1983/1721>

Integrating People, Purpose, Process and Performance



Questions?