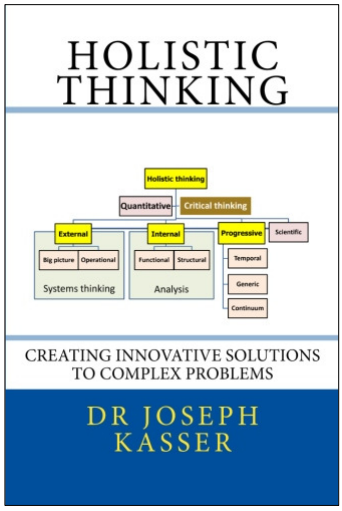
A systems thinking approach for managing complex systems
Session 4 of 6
Hierarchies and emergence

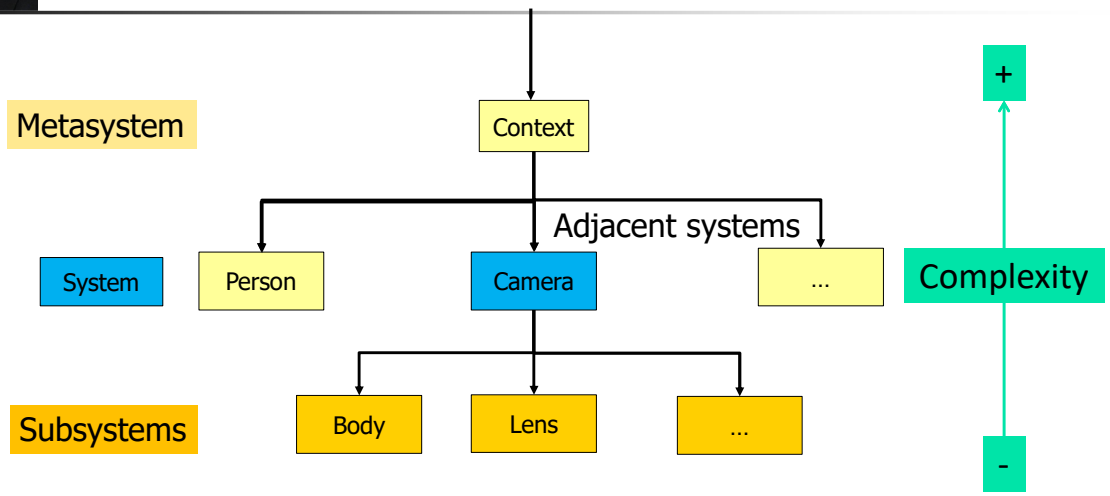
Version 1.1.0

Topics

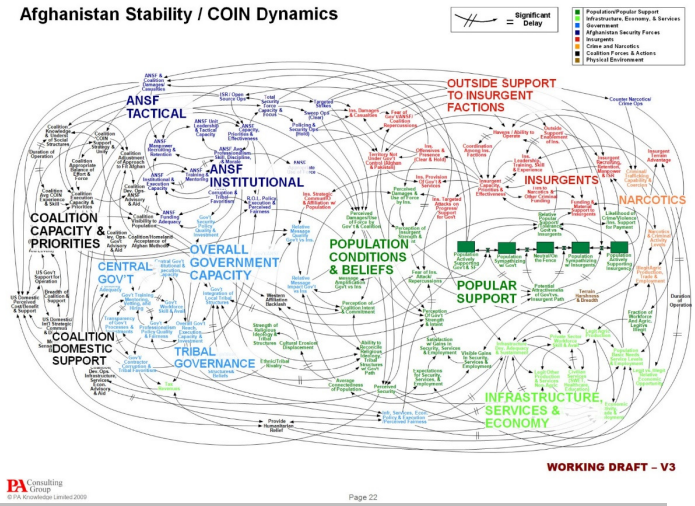
- Purpose
- Thinking and systems thinking
- Systems and system of interest
- Principle of hierarchies
- Emergence and emergent properties
- Problems and solutions
- The problem formulation template
- Complexity
- Interface partitioning
- Classification and types of problems



Camera in context



"When we understand that slide, we'll have won the war," General McChrystal



* http://msnbcmedia.msn.com/i/MSNBC/Components/Photo/2009/December/091202/091203-engel-big-9a.jpg, accessed 8 April, 2011

Principle of Hierarchies

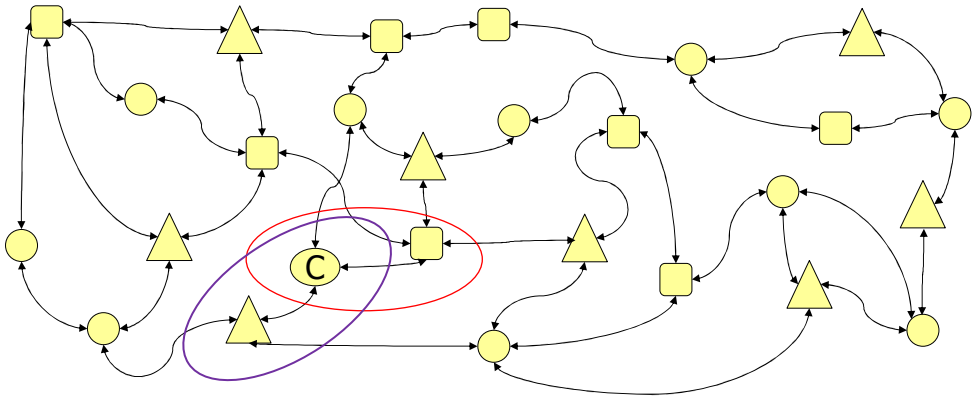
- Each level organizes the level below it plus one or more emergent qualities (~~or unpredictable novelties~~).
- The mechanism of an organization is found at the level below, its purpose at the level above.
- Knowledge of the lower level infers an understanding of matters on the higher level.
- Properties emerging on the higher level have no direct reference to the lower-level organization.
- The higher the level, the greater its variety of characteristics, but the smaller its population.
- The higher level cannot be reduced to the lower, since each level has its own characteristic structure and emergent properties
- An organization at any level is a distortion of the level below, the higher-level organization representing the figure which emerges from the previously organized ground.
- A disturbance introduced into an organization at any one level reverberates at all the levels it covers.
- Every organization, at whatever level it exists, has some sensitivity and responds in kind

Using the Principle of Hierarchies

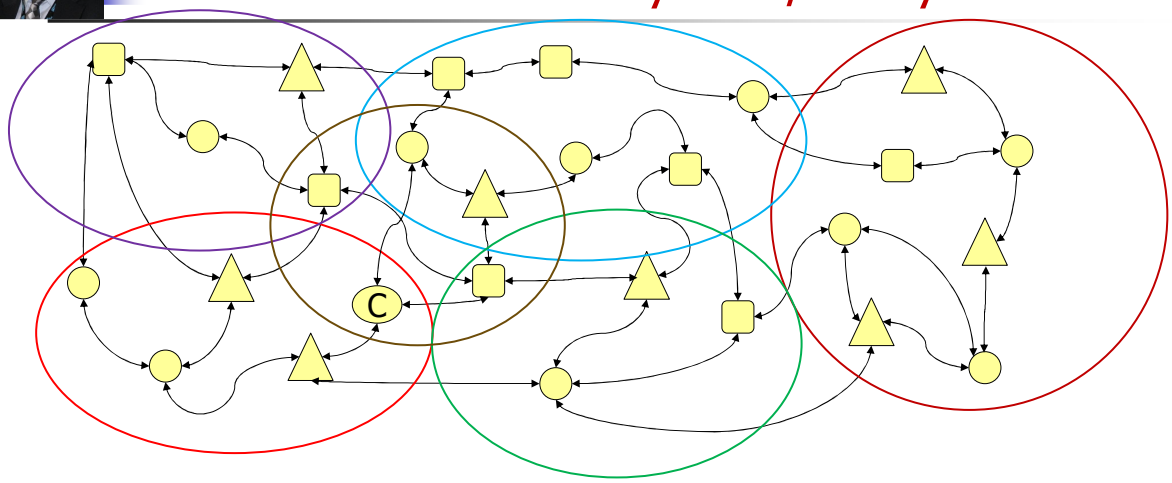
- Keep the systems and subsystems at the same level in the hierarchy of systems
- Use multiple views from different perspectives
- Abstract out or hide the internal components of systems and subsystems in any one view
- Use Miller's rule (7±2 objects)
- You only have to deal directly with three levels
  - Metasystem level
  - System level
  - Subsystem level

You are always here

In general, where is the system and the SOI?



Where is the system/subsystems?



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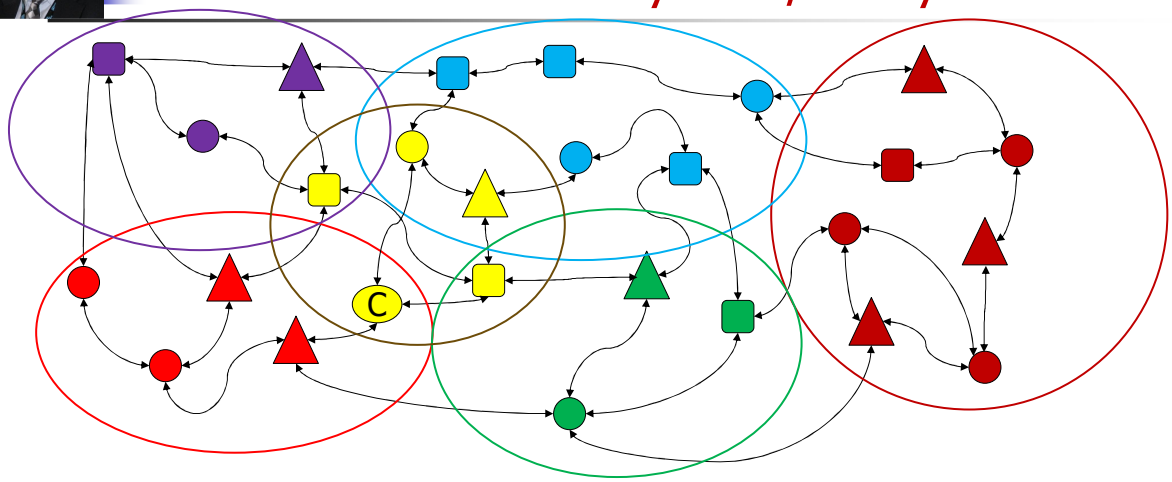
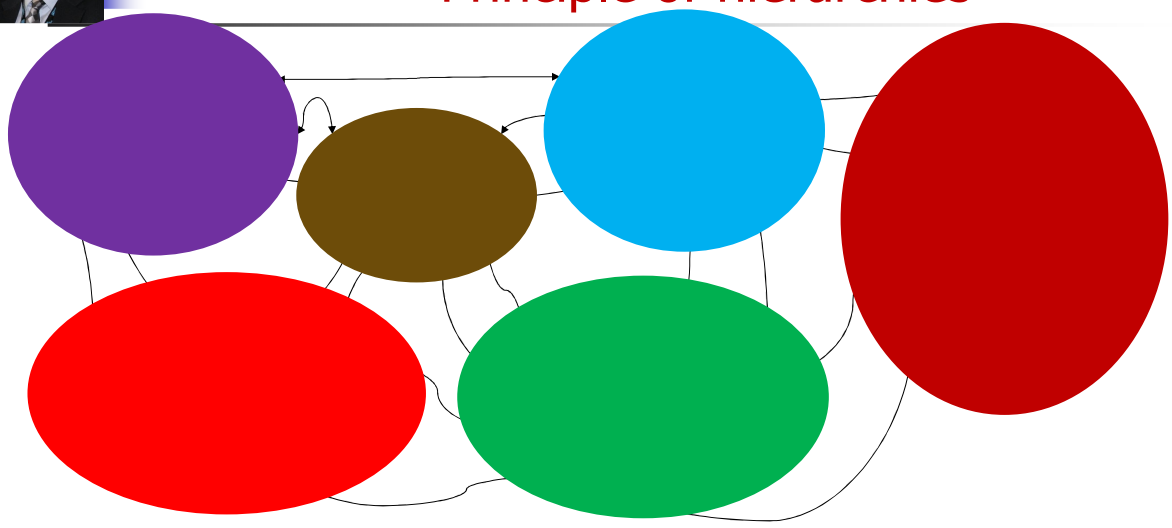


Principle of hierarchies



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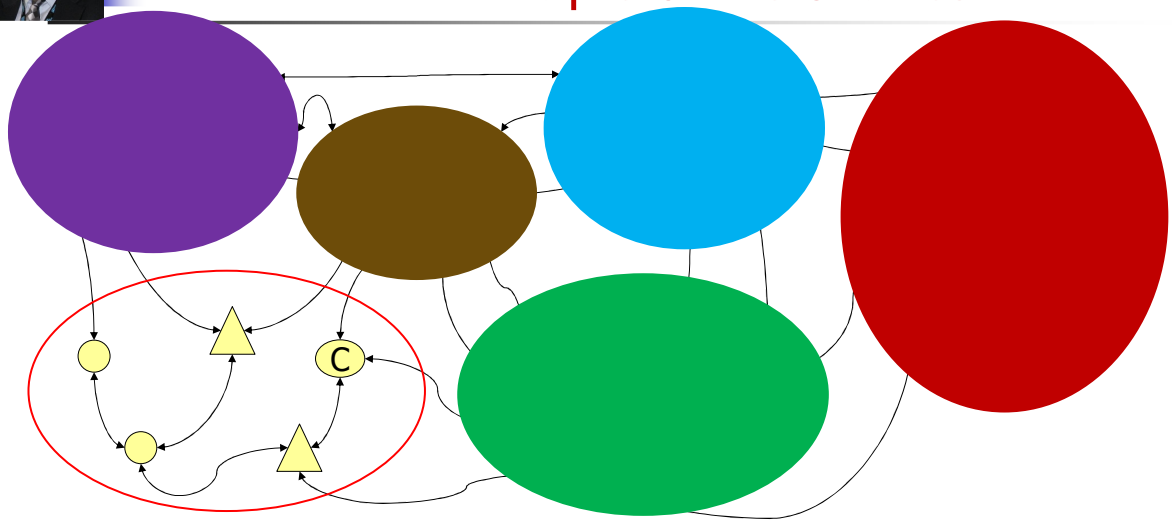

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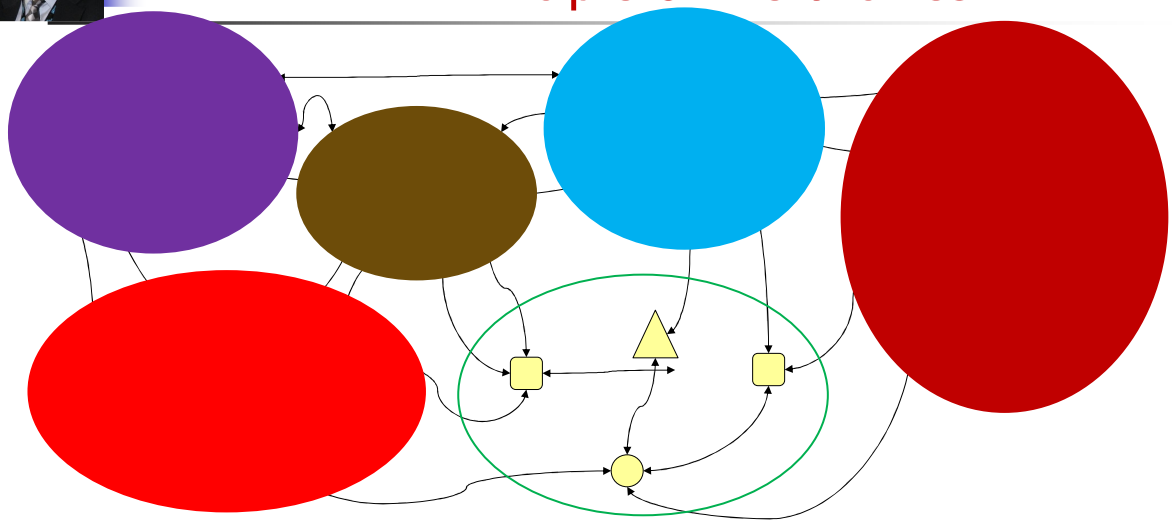

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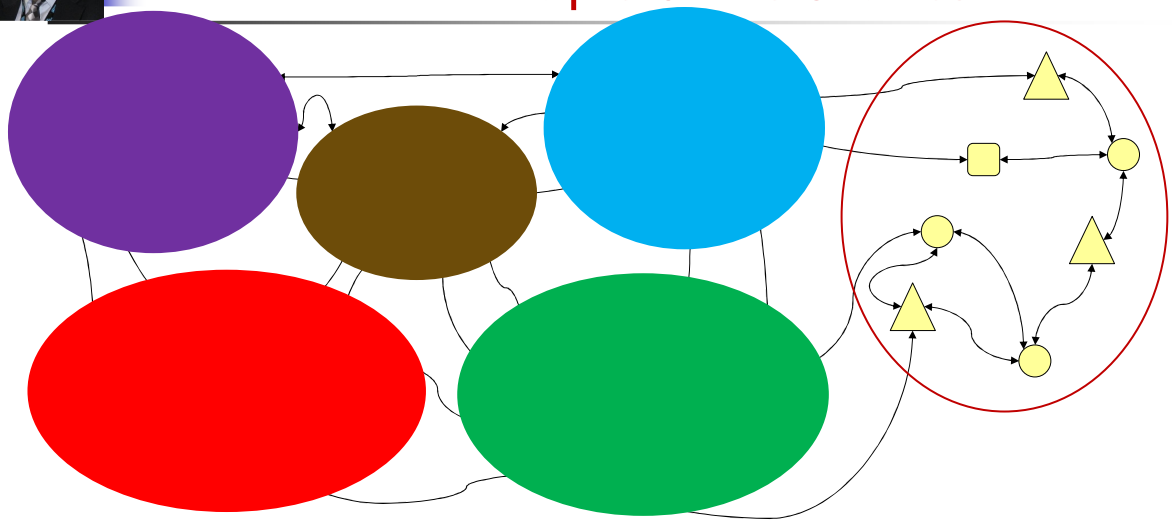

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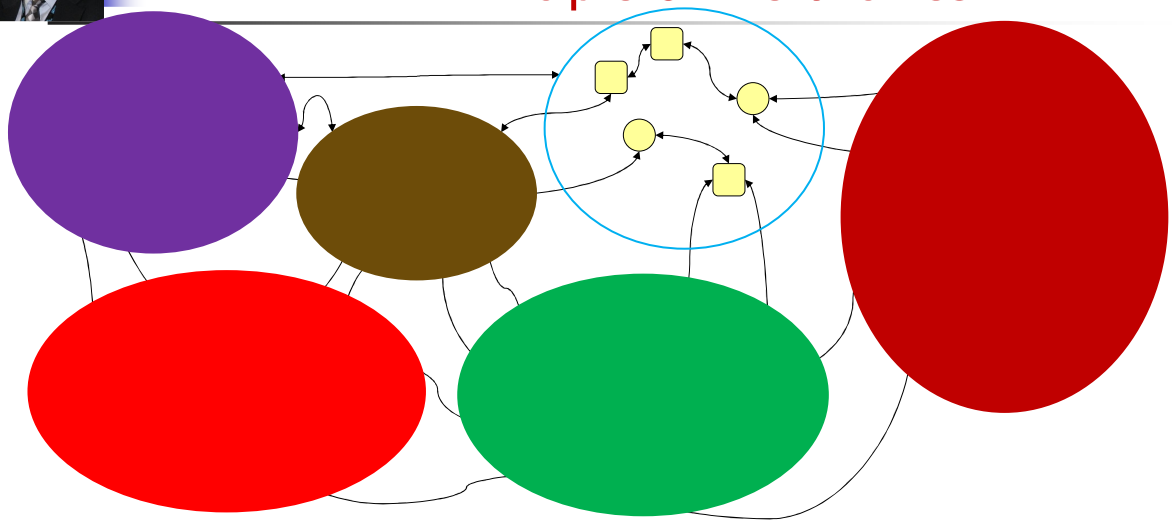

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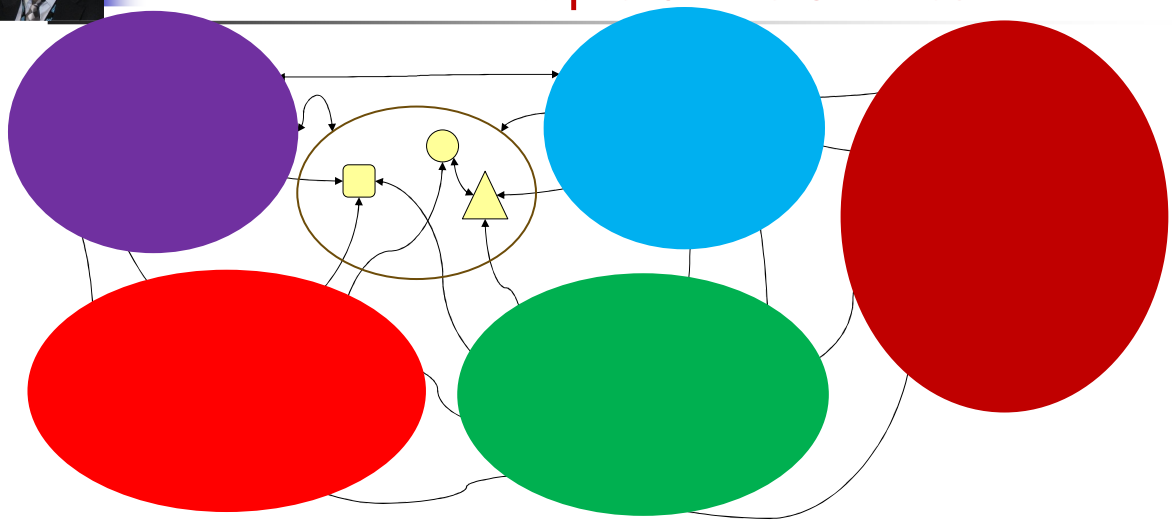

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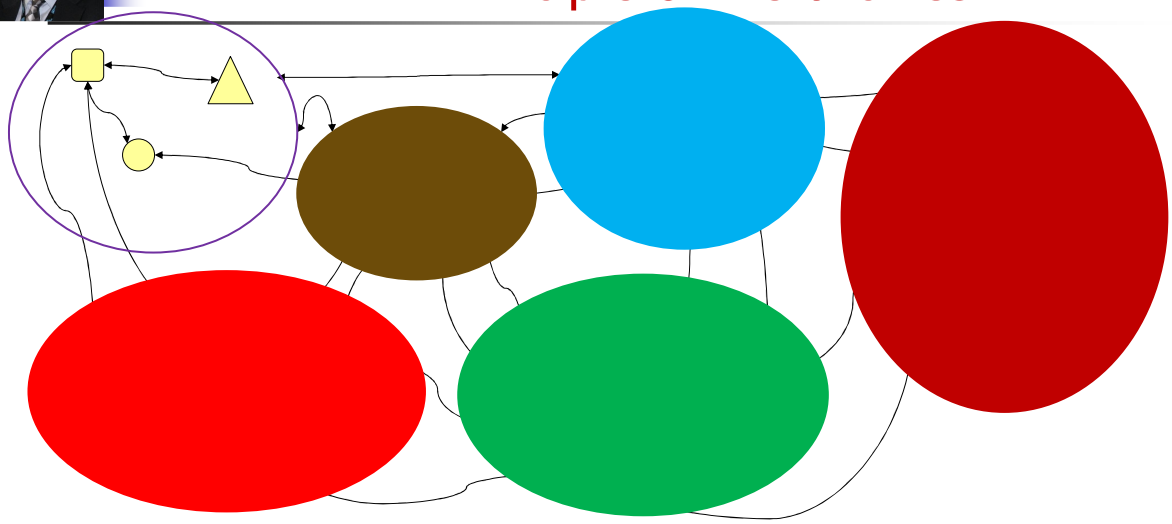
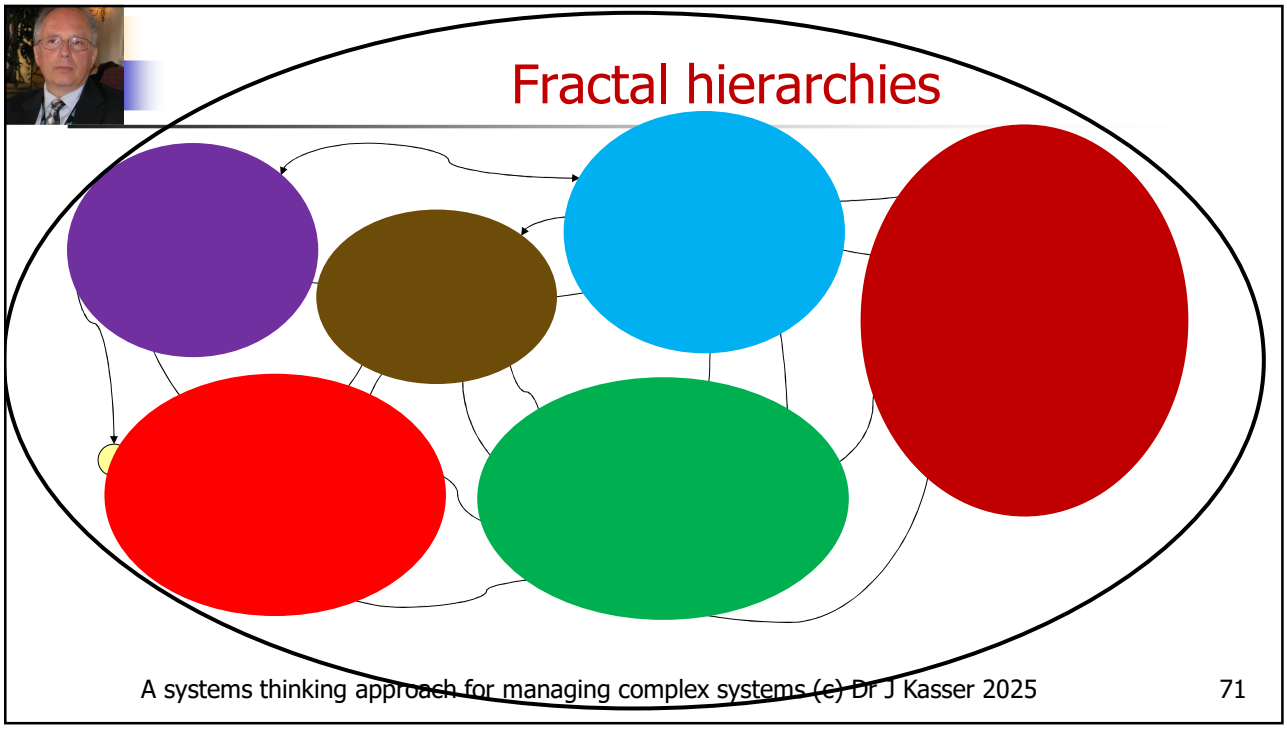
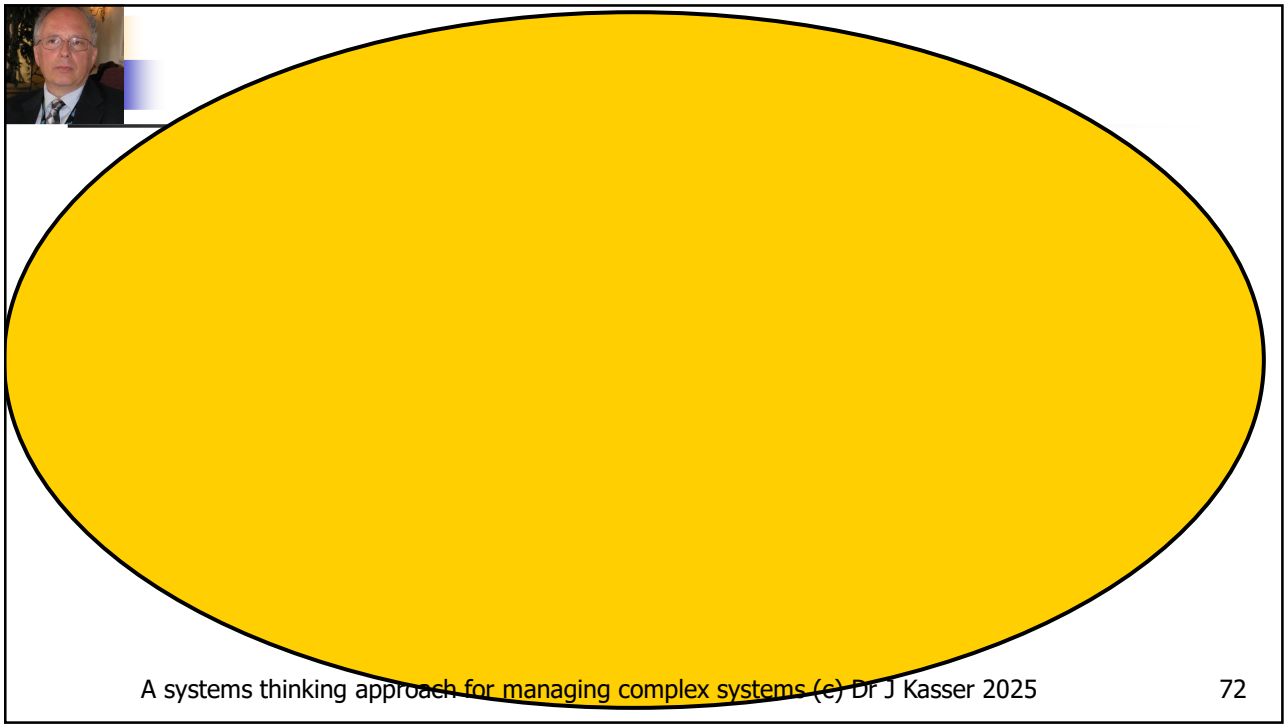



Fractal hierarchies



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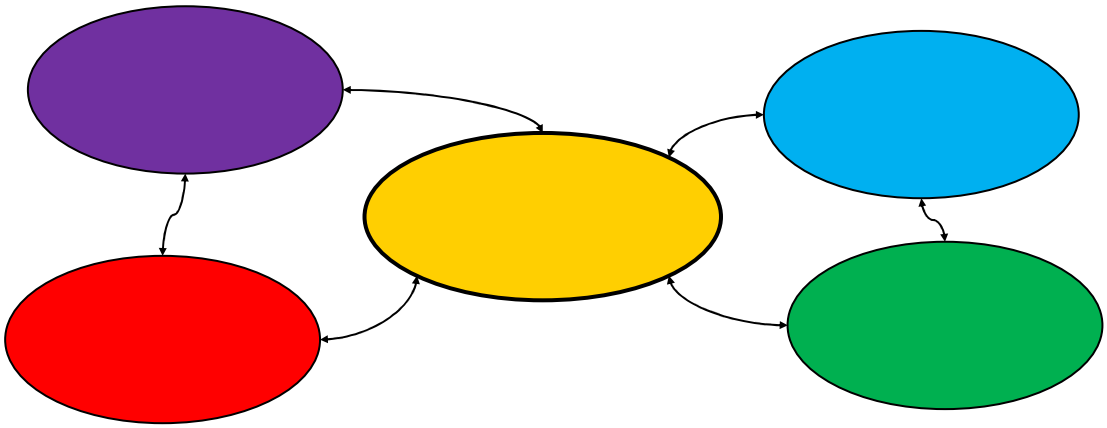
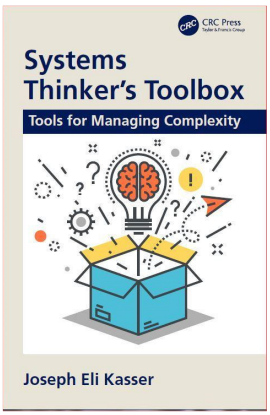


Tools, techniques and templates

	Tools, techniques and templates	Slide
1	Compliance Matrix	5
2	System of Interest (SOI)	13-36
3	Holistic Thinking Perspectives	39-43
4	Active Brainstorming	47-52
5	Principle of Hierarchies	57-73
6	Continuum of Solutions	
7	Problem Formulation Template	
8	Hitchins-Kasser-Massie-Mabelo Framework (HKM^{2}F)	
9	Subjective and Objective Complexity	
10	Interface partitioning	
11	Mission and Support Systems Architecture	
12	Three Structures of a Problem (well-, ill- and wicked)	
13	Iterative Problem Solving	



Was this reductionism?

- No
- You are considering the whole system and its interactions with adjacent systems
- You are considering each subsystem as appropriate
- You are just not doing it all at the same time

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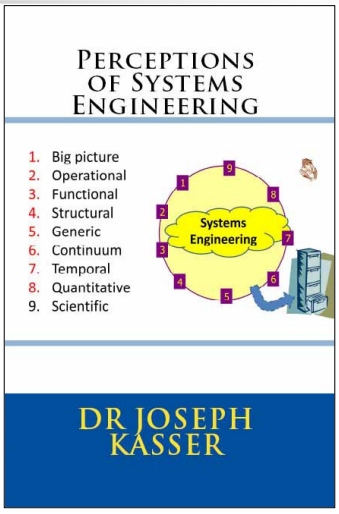


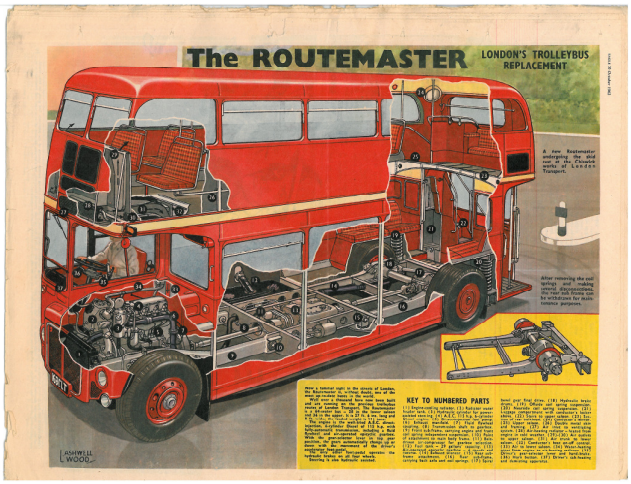
Emergence

- The process of coming forth, issuing from concealment, obscurity, or confinement*
  - * Oxford English dictionary
- Functionality emerges from the components and the interactions between the components
  - Example
    - Wires, transparent container, inert gas or vacuum
    - Power source
- Emergent properties are of a system as a whole, not of a component
  - Desired = light, undesired (usually) = heat
- Principle: a property of level in hierarchy that is not observed at a lower level

Emergent properties/behaviour

1. **Known at design time**
   1. **Desired** – being the purpose (design) of the system
   2. **Undesired** – based on experience and should be
      1. designed out
      2. compensated for
   3. Don't care
2. **Unknown at design time**
   1. **Undesired** – functionality performed by the system that is undesired, also known as 'side effects'.
   2. **Serendipitous** – beneficial and desired once discovered, but not part of the original specifications
   3. Don't care

Parts and interactions between parts



Eagle, 20 October 1962

- Examine how the parts interact
  - Understand that what the system does emerges from the parts and their interaction
- Examine parts individually
  - Understand how the parts work individually
  - As a property that emerges from their parts and the interactions between their parts

Exercise 4 Emergent properties/behaviour

1. Perceive the INCOSE **International Symposium** or any other **conference you have attended** from the 8 descriptive HTPs
2. Identify at least three different emergent properties/behaviours of the conference (using Active Brainstorming)
3. For each emergent property identify the parts (components, subsystems, etc.) and the interactions between the parts that cause the emergent behaviour
4. List the emergent property/behaviours
5. For each emergent property/behaviour, list the parts and draw the interactions between the parts that cause the emergent property/behaviour
6. Create a PowerPoint file for the exercise containing
   1. The list of the emergent properties/behaviours
   2. The list of parts for each emergent property/behaviour
   3. The drawings showing the interactions between the parts that cause the emergent property/behaviour
   4. A compliance matrix for the exercise
   5. A copy of this slide and the version number of the lesson
   6. The lessons learned from this excercise
7. Save file as yourlastname-firstname-4.pptx (e.g., mouse-michael-4.pptx)
8. Email file to Beyondsystemsthinking@yahoo.com