Systems Thinking in Practice Course

Part I Sept 2013

Quick Reference Guide

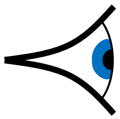
Defence Academy of the United Kingdom

dstl

Cranfield University

Tools for understanding

What is a system?



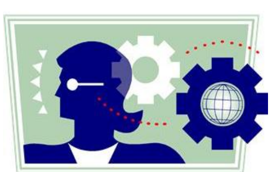
Different definitions based on variety of view points.

System engineers design things for a purpose so often use a definition which includes purpose, such as

"A combination of interacting elements organized to achieve one more stated purposes"

System thinkers are also interested in systems that just "are", i.e. not designed, such as social systems. A useful definition in this context could be:

"A system is an open set of complementary, interacting parts with properties, capabilities and behaviours emerging both from the parts and from their interactions"[1]



However, most complex systems are **unbounded, dynamic and open**. So in reality:

"the concept of a system is used not to refer to things in the world but to a particular way of organising our thoughts about the world. [..] we consider the notion of "systems as an organising concept…"[2]

The systems trinity

Systems Engineering is:

Applying the systems approach to the realisation of a new system or the modification of an existing one

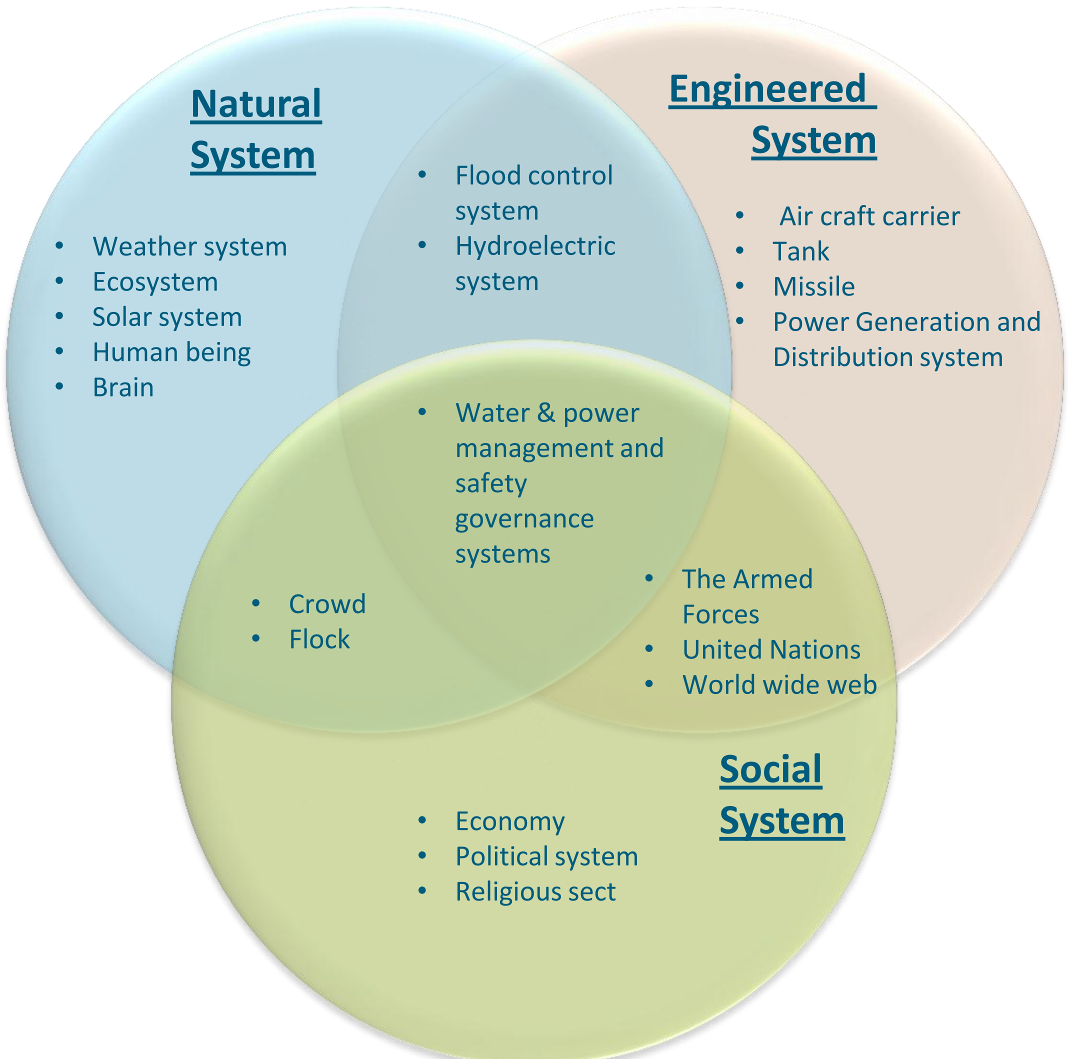
Systems Approach is:

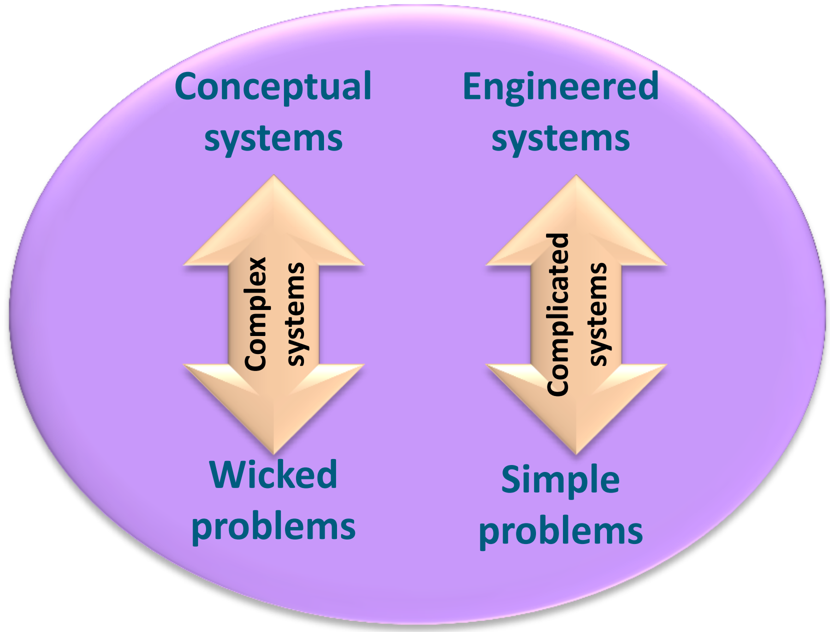
Applying the systems thinking in a systemic and repeatable manner

Systems Thinking is:

Applying the concept of a system to a situation in order to gain insight and understanding

Types of system

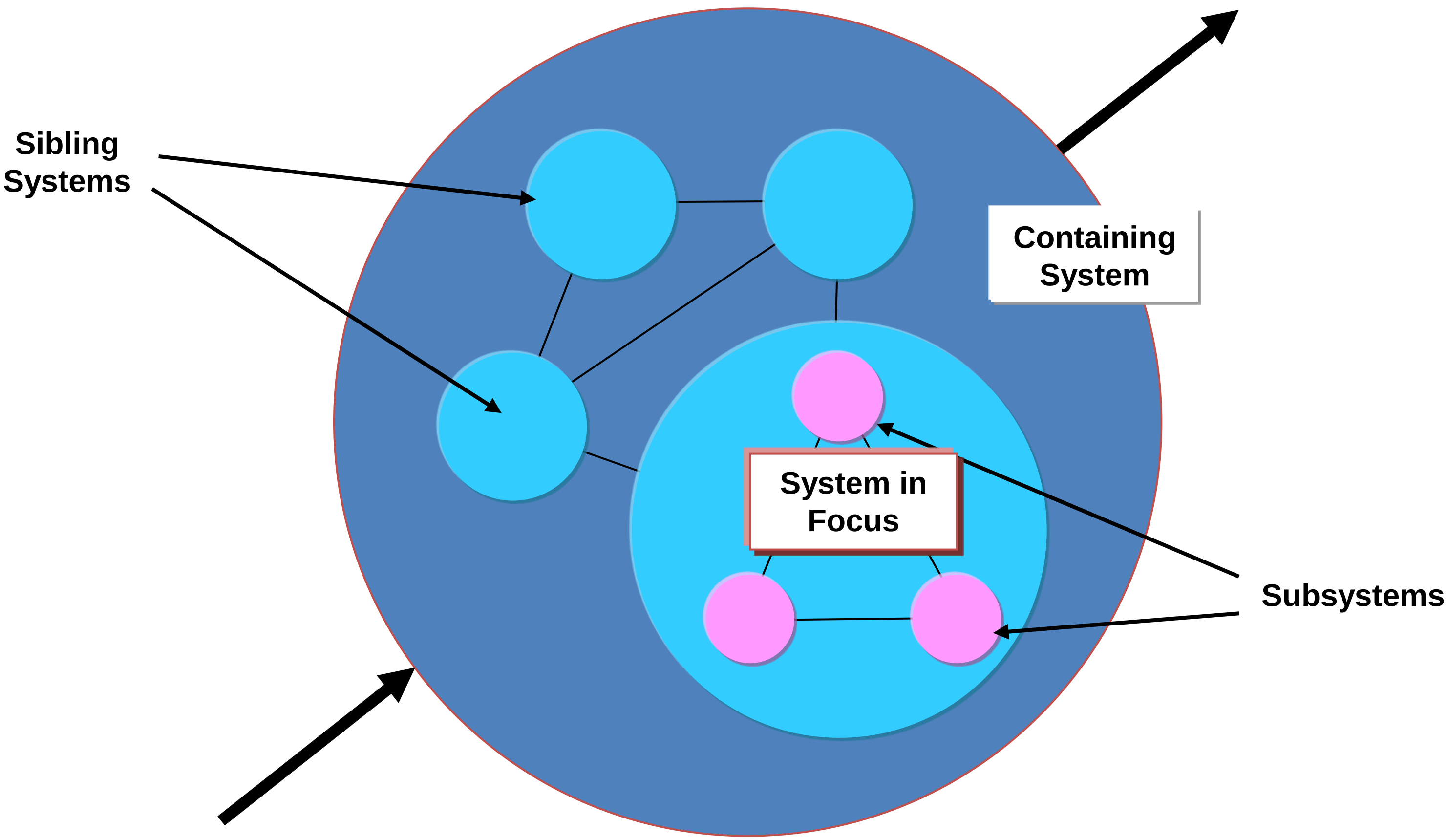




Adapted from reference 4

Systems hierarchy

Systems are recursive/multi-scale



Reference 3

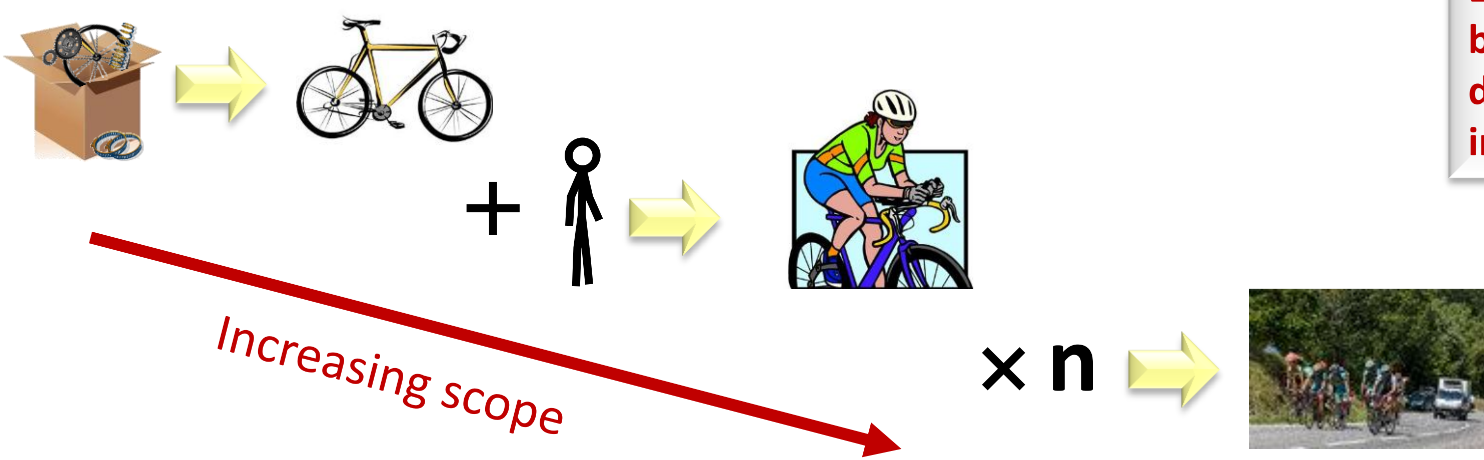
Emergence

All systems display emergent behaviour; it is a consequence the interaction of the various components. Therefore to understand emergence we **need to consider the whole** and how the components **interact** with each other.

The properties of a bike as a whole are not found in any of the individual components. Only when the components are assembled in the right sequence and the right place do we get the desirable emergent behaviour of a bike. If we increase the scope of the observation we see more emergent behaviour.

Emergence is a phenomena which **occurs at all scales of organisation.**

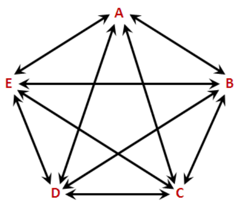
Emergent behaviour may be known, or unknown, desirable or undesirable, intended or unintended!



Simple vs Complex

The complexity of a system is due not only to the number of parts it comprises but the level and type of interactions between them and its environment.

Systems with thousands of parts but with few connections are detailed (complicated) but not complex.



Complex systems are those with numerous, interacting elements which influence each other in many different ways. The greater the level of variety in element type, state and interaction the greater the complexity of a system and the more difficult it is to predict or understand its behaviour. A key characteristic of complex systems is the presence of multiple pathways through which cause and effect play out.

Complex *adaptive* systems are able to change their structure and behaviour over time in an attempt to increase their 'success' or ability to thrive (i.e. responds to threats and opportunities). The adaptive behaviour of elements within a system adds a further dimension to the system's complexity.

Rich picture

Remember those contributing to the picture will do so based on their beliefs and values – and that includes you!

First part of SSM (see section on SSM), drawn pre-analysis before you have an understanding of the problem situation.

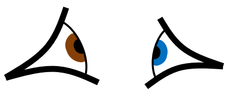
Graphical tool that aims to capture a broad, high level view of the problem situation. Generally constructed by interviewing people with the purpose of exploring a problem situation, capturing a frank and open view of the problem, including concepts and subjective notions, social roles and conflicts.

Remember what is captured is only *a* representation of the problem situation

Principles & guidelines[5]

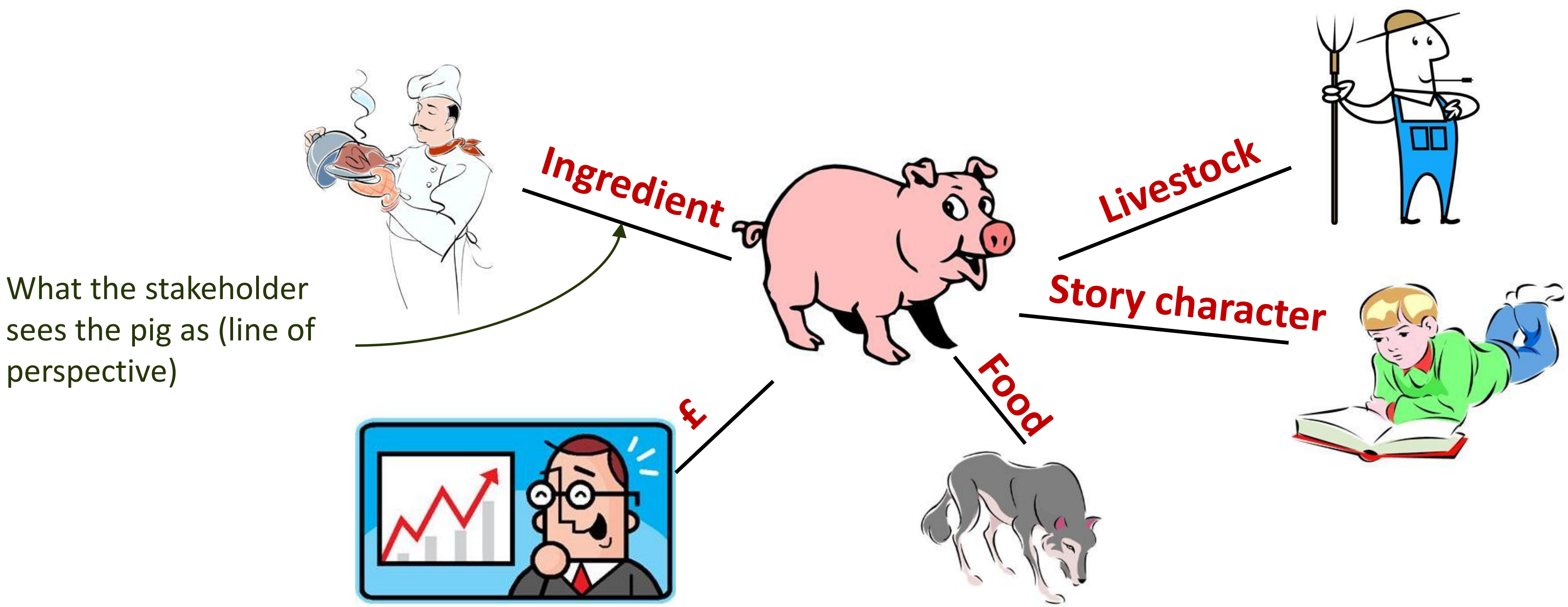
- Use as many colours as necessary
- Put in whatever connections you see between your pictorial symbols (places lacking connections may prove significant)
- Avoid too much writing
- Don't include systems boundaries
- Represent every observation that occurs to you
- Do not seek to impose any style or structure on your picture
- Include factual data about the situation ***and*** subjective information

Pig model[6]

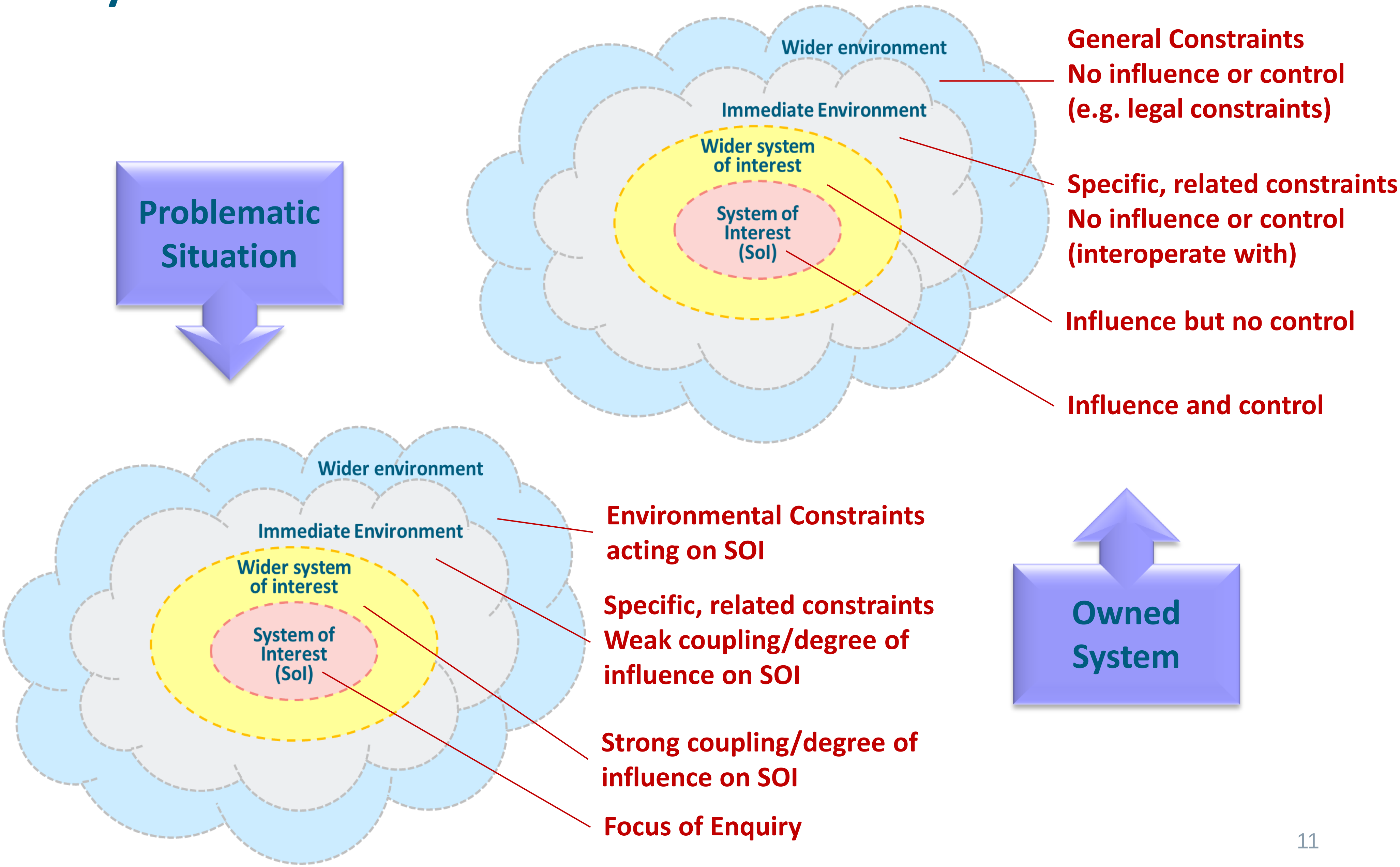


Simple technique used to explore different perspectives in a problem situation. Name arises from the original model developed by Gareth Morgan demonstrated the model's concepts by considering a pig as the focus.

Draw the system in focus or problem in the centre (so you need to decide what the pig is, encouraging discussion on the system boundary). Then identify each stakeholder in the system/problem and add them around the pig (text or cartoon), linking them with a line. Annotate the link with the perspective of the stakeholder.



Systems have a context



Ladder of abstraction[7]

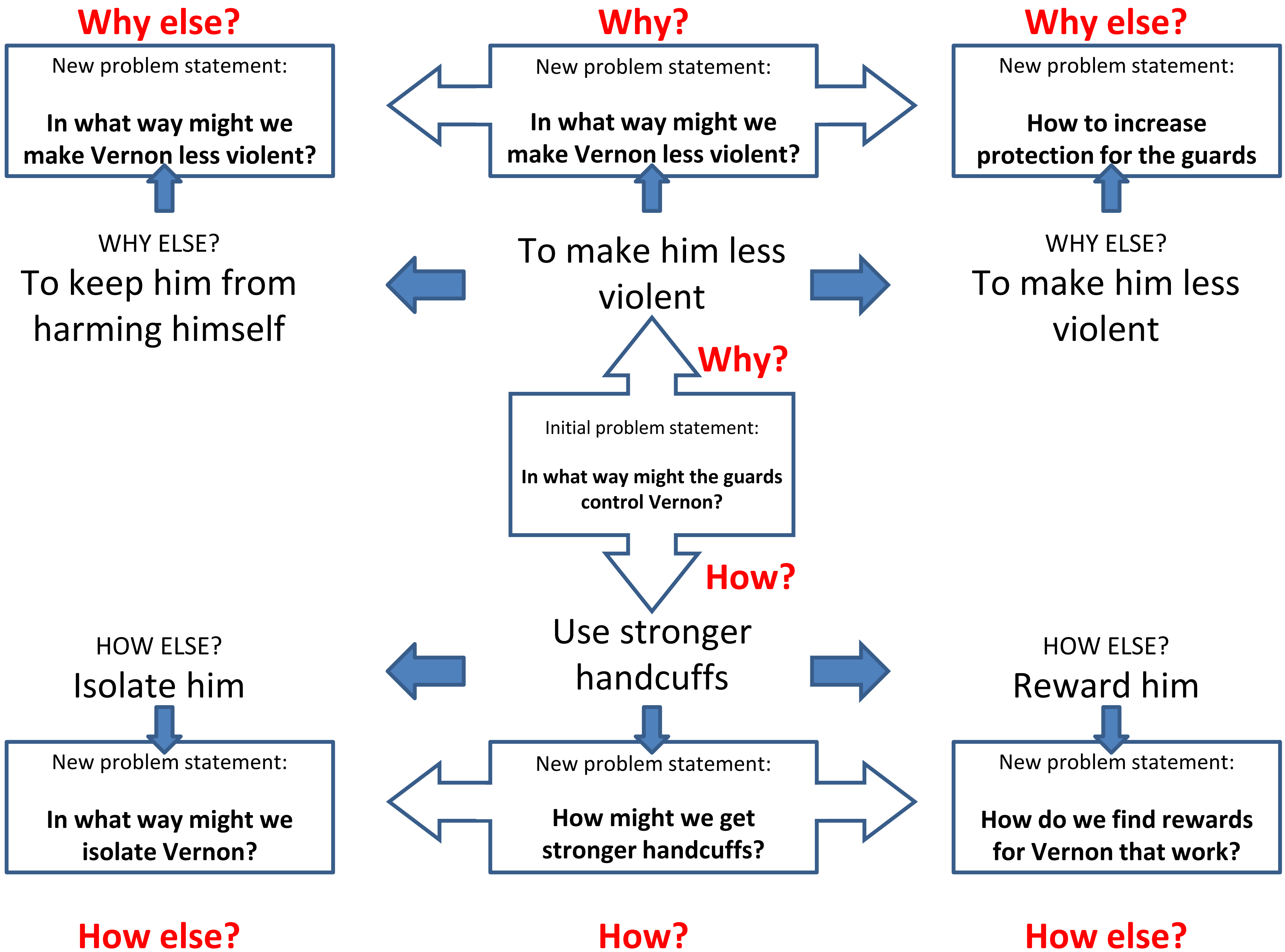
A redefinition technique which seeks to identify the essence of a problem through a series of abstractions by moving through progressively higher levels of problem abstraction.

Take any particular perspective of a problem and imagine it is on the rung of a ladder. The other rungs of the ladder are different perspectives that are more or less abstract than the original. Asking "why?" moves up the ladder to a higher level of abstraction, asking "how?" moves down the ladder to a lower one.

Moving up the ladder enables broader problem statements to be identified; moving down the ladder narrows the problem statement into smaller, more task based sub-problems. New definitions are evaluated for applicability.

Establish an invitational stem that encourages many possible responses to the problem statement (e.g. other examples: "how to…?", "how might…?")

	Problem owner	Action verb	An objective
In what ways might	the guards	control	Vernon?


Why else?
New problem statement:
In what way might we make Vernon less violent?
Why?
New problem statement:
In what way might we make Vernon less violent?
Why else?
New problem statement:
How to increase protection for the guards
WHY ELSE?
To keep him from harming himself
To make him less violent
WHY ELSE?
To make him less violent
Why?
Initial problem statement:
In what way might the guards control Vernon?
How?
HOW ELSE?
Isolate him
Use stronger handcuffs
HOW ELSE?
Reward him
New problem statement:
In what way might we isolate Vernon?
New problem statement:
How might we get stronger handcuffs?
New problem statement:
How do we find rewards for Vernon that work?
How else?
How?
How else?

Diagrammatic tools

Concept maps[8]

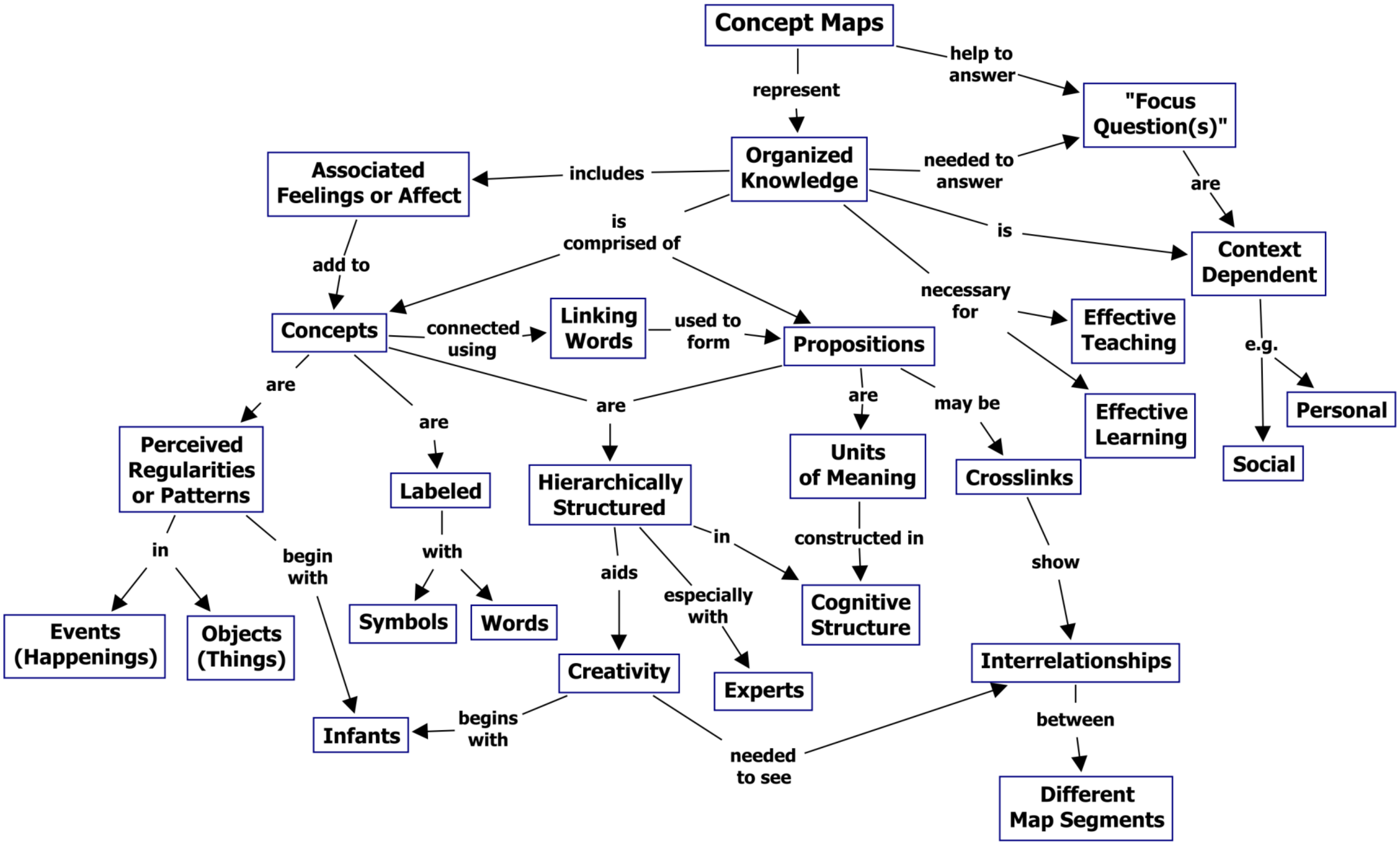
Concept maps are graphical tools for organizing and representing knowledge. They include concepts, usually enclosed in circles or boxes of some type, and relationships between concepts indicated by a connecting line linking two concepts. Words on the line, referred to as linking words or linking phrases, specify the relationship between the two concepts.

Concepts are represented in a hierarchical fashion with the most inclusive, most general concepts at the top of the map and the more specific, less general concepts arranged hierarchically below.

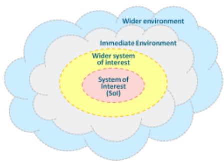
Best constructed with reference to a particular question we seek to answer, called a focus question.

Relationships or links between concepts in different segments or domains of the concept are represented by drawing a cross-link. These help the analyst to see how a concept in one domain of knowledge represented on the map is related to a concept in another.

Example concept map[8]



Context diagram

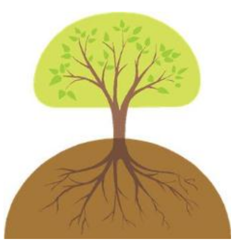


Based on the System in context diagram (see page 9) and drawn from the perspective of a system owner.

Context maps are a means of representing the System of Interest in its environment, elements within and beyond the system boundary that the system owner can control, influence or is constrained by, and interactions between the elements.

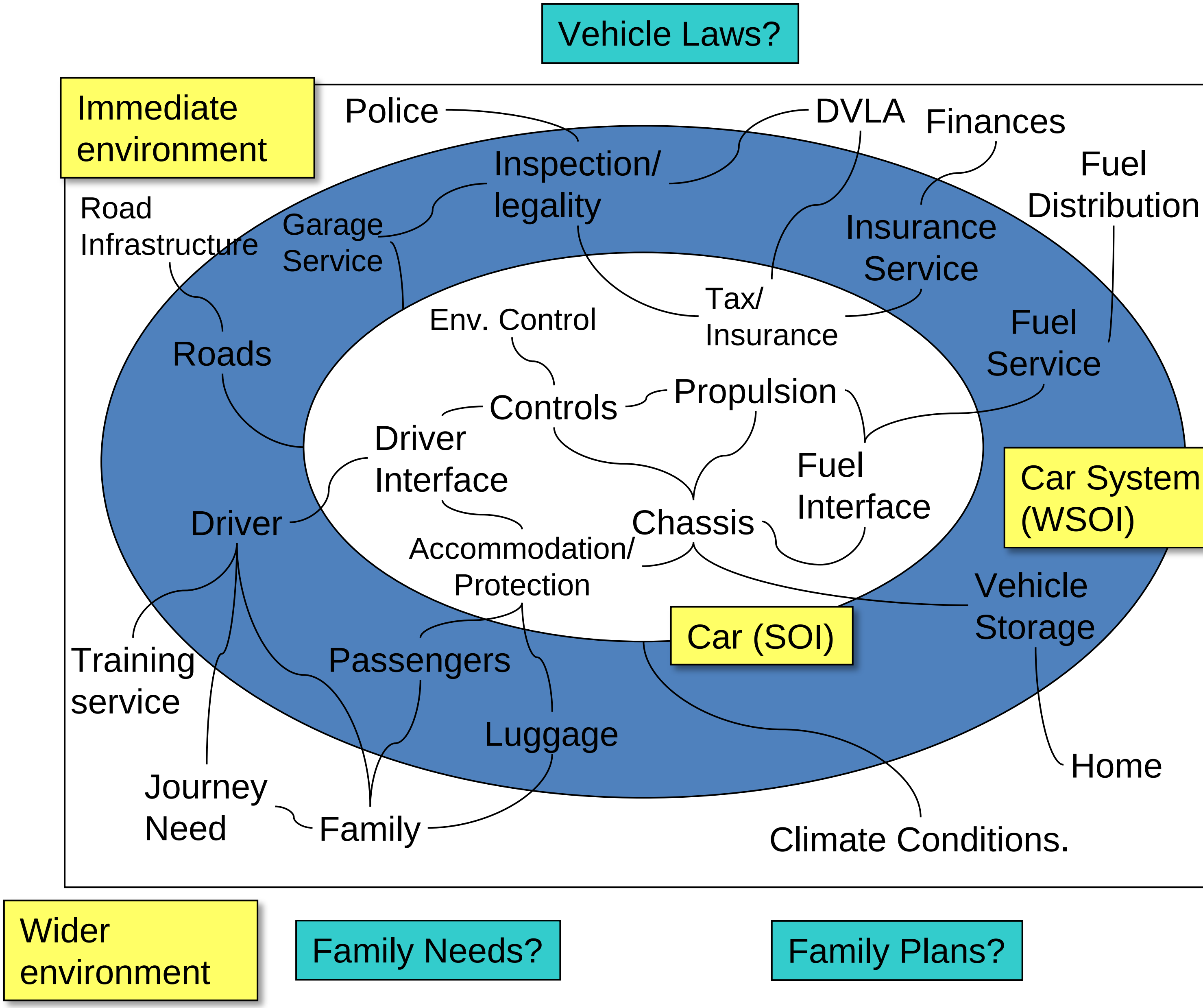
Can be used to identify and agree boundaries, establish requirements for interfaces and interoperability, compliance requirements (rules, regulations and standards), identifying dependencies and formulating engagement strategies for influencing owners of elements that are beyond the system owner's control.

Can either be drawn after an initial information/data collection phase, or constructed 'live', by working together with the providers of the information.



Can inform development of a root definition by identifying ownership, beneficiaries and constraints.

Example context diagram



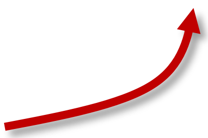
Family Car: to provide safe, flexible and cost effective transport for the family

Family Car Functions:

- Vehicle status
- Load Passengers and Luggage
- Drive to destination
- Survive accident
- Security, alarm

Cognitive maps

Cognitive maps are a means of representing relationships between a series of ideas, issues or 'concepts.' Used in an 'influence' context, they can provide users with the ability to explore the perceptions, beliefs and grievances of individuals or groups of people. They reflect our thought process of how we think something works in the real world



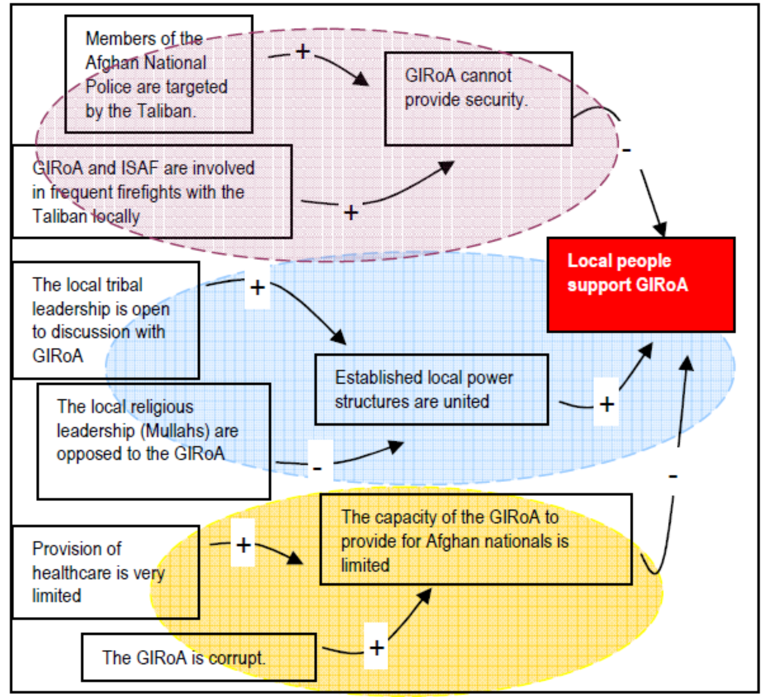
Seeks to explore 'cause and effect' linkages between concepts associated with a central issue (for example, 'the law', 'security', or 'jobs'). Can be captured as a hierarchical structure (capturing chains of information/argument) or unstructured.

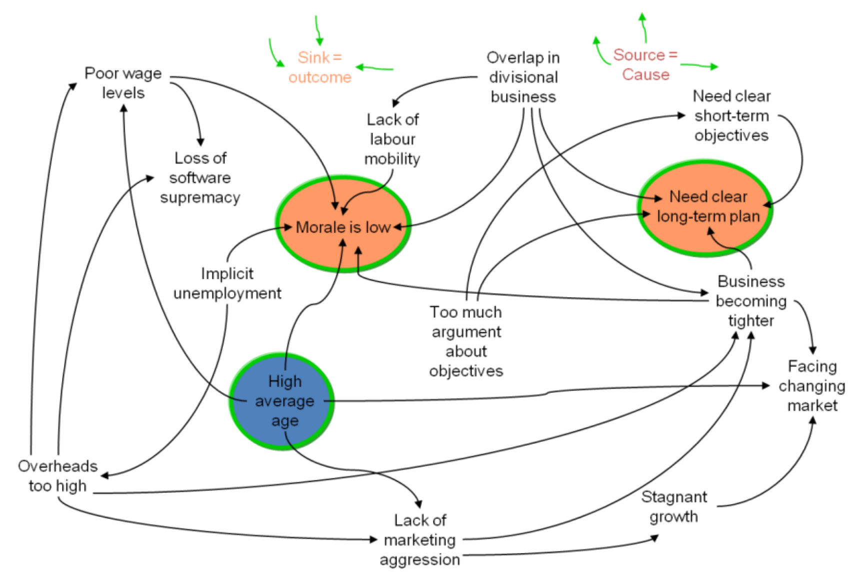
Can be used to identify leverage points where a specific action or series of actions can have a wider effect – through which problematic issues can be addressed

Can either be built and drawn after an initial information/data collection phase, or constructed 'live', by working together with the providers of the information.

Cognitive mapping

- Break problem into constituent elements (usually distinct phrases of 10-12 words; retaining the languages of the person providing the information). These are the concepts
- Draw the concepts then draw "means-end" links between the concepts based on the status of one concept relative to the other
- For hierarchical approach major, strategic effects or goals should appear on the right of the map. Key factors should appear in the middle. Supporting facts and concepts should appear on the left.
- Meaning is related through the context

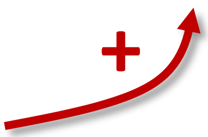




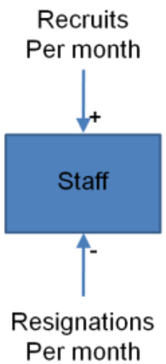
Example from Colin Eden Strathclyde University

Causal loop and influence diagrams

Causal loop diagram is more rigorous than a cognitive map but less rigorous than an influence/stock and flow diagram as used in system dynamics models.



It captures the relationships between different variables (represented as nodes). The arrows connecting the nodes indicate a positive or negative relationship between the variables.



Influence diagrams, as used in system dynamics models, are a more rigorous version of a casual loop diagram as they pay strict attention to the rates and the level of variables in relation to a particular problem.

Both types of diagram enable us to think about how feedback, delay and non-linearity contribute to system behaviour

Coupling in causal loop and influence diagrams

Components of a system are said to be coupled if when one is changed it affects the other.

Positive coupling – an **increase** in one of the coupled elements **increases the other *or* a decrease** in one of the elements results in a **decrease in the other.** Nomenclature used is either a "**+**" or an "**S**" for same direction.

+

Births ⟶ Population

S

An increase in births causes an increase in the population
A decrease in greenhouse gases causes a decrease in global warming

Negative coupling – an **increase** in one of the coupled elements results in a **decrease of the other** or vice versa, i.e. the strength of the change is decreased.

-

Deaths ⟶ Population

O

An increase in deaths causes a decrease in the population
A decrease in sweat causes an increase in body temperature

Feedback loops in causal loop and influence diagrams

Feedback occurs when there is a causal loop of couplings i.e. a change in the initial component ripples back through the loop to affect the original component.

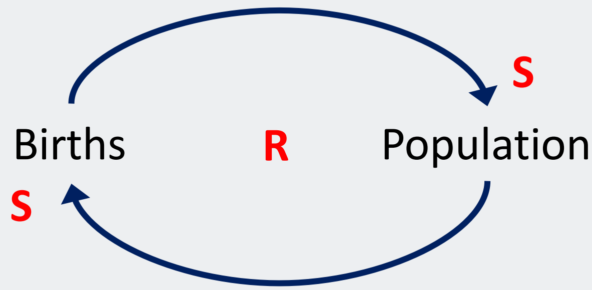
Types of behaviour arising from feedback loops:

- reinforcing (R) behaviour, where an initial increase in the first component is further increased, also referred to as positive feedback, growing action and a virtuous cycle
- reinforcing (R) behaviour, where an initial decrease in the first component is further decreased, also referred to as declining , decaying or a vicious circle
- balancing (B) behaviour, where the initial change is counteracted, also referred to as negative feedback or goal seeking. Balancing loops can calibrate a system and enable it to stay in equilibrium

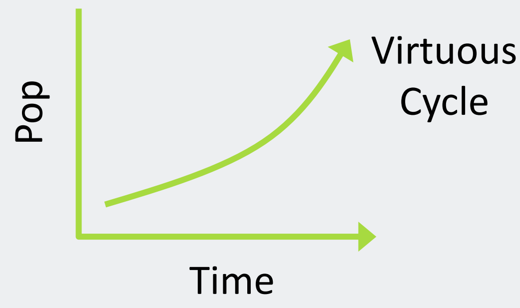
Beware the language!

Do not confuse "positive feedback" or "reinforcing feedback" with a desirable result or an increase in the initial variable!

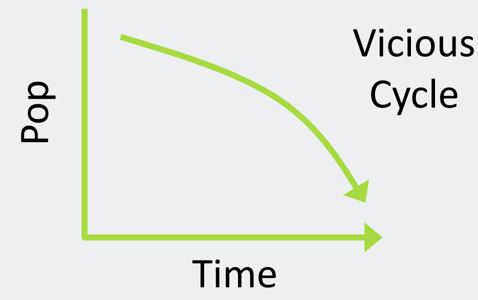
Example feedback loops



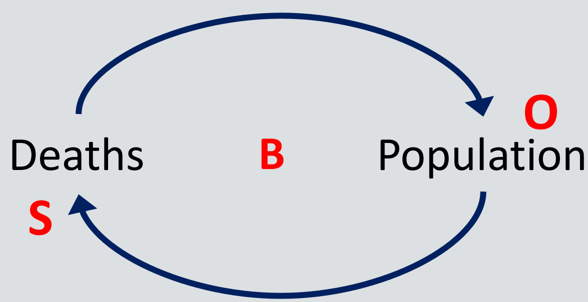
Rates of change in the variables "births" and "deaths" are a key determinant of system behaviour

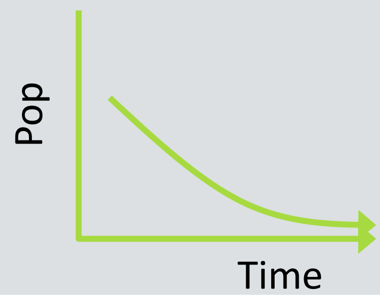


If births increase, over time the population increases, increasing the number of births .....



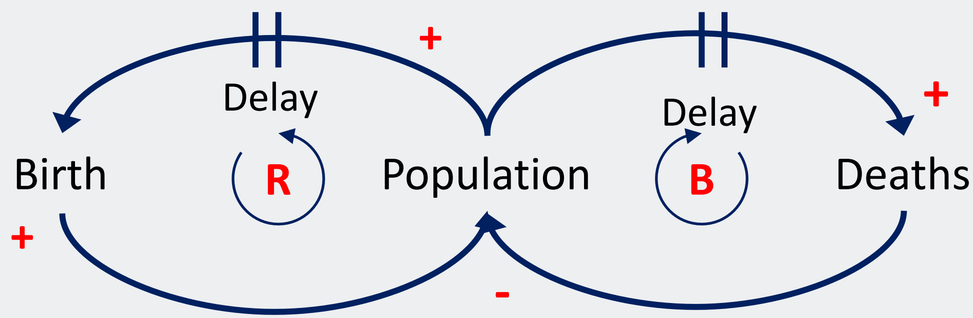
If births decrease, over time the population decreases, decreasing the number of births…





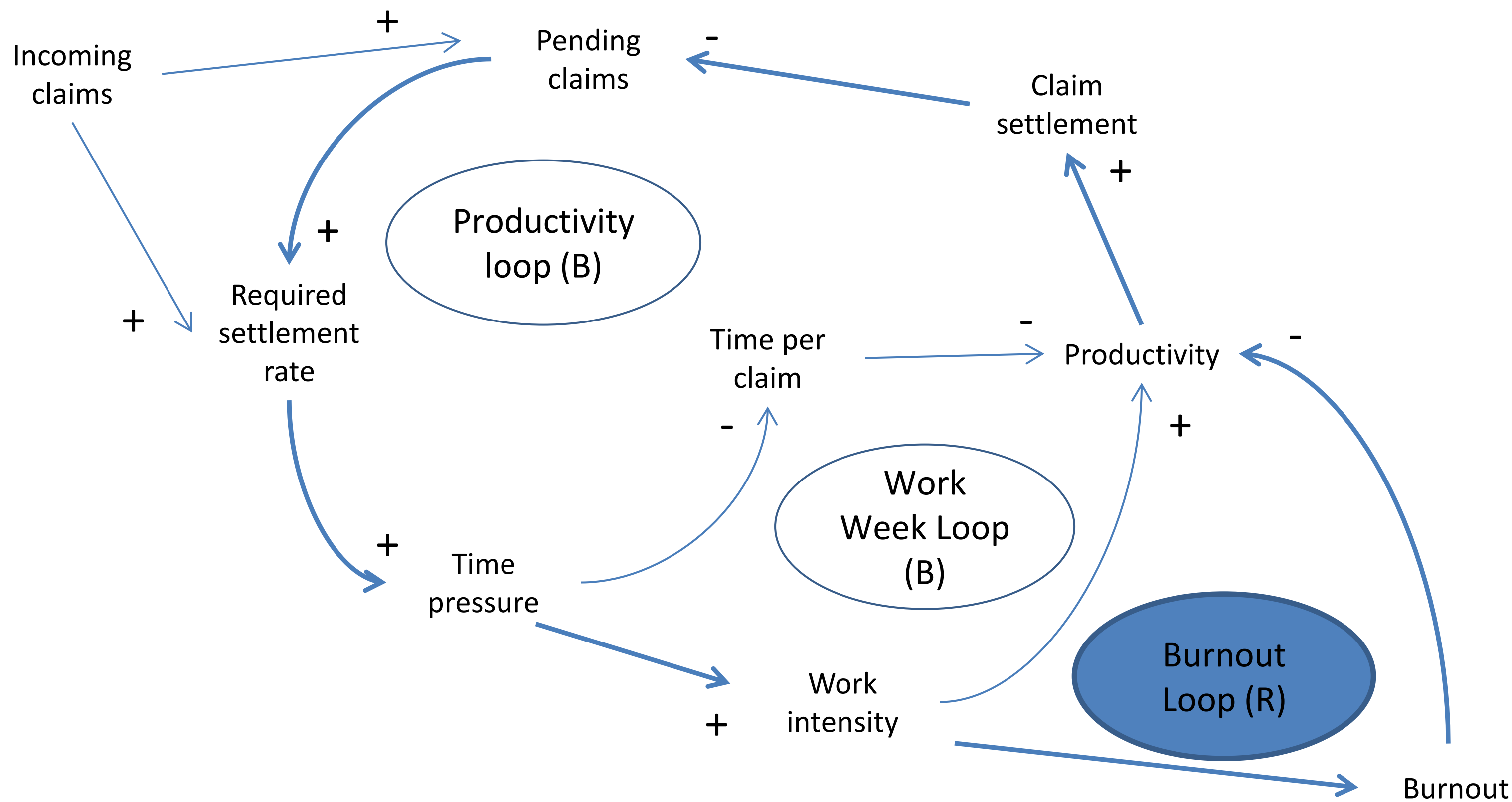
If deaths increase, over time the population decreases

Balancing loops are created when there are an odd number of negative couplings



Multiple loops can intersect one another and may have time delays. These delays may affect the strength of the interaction

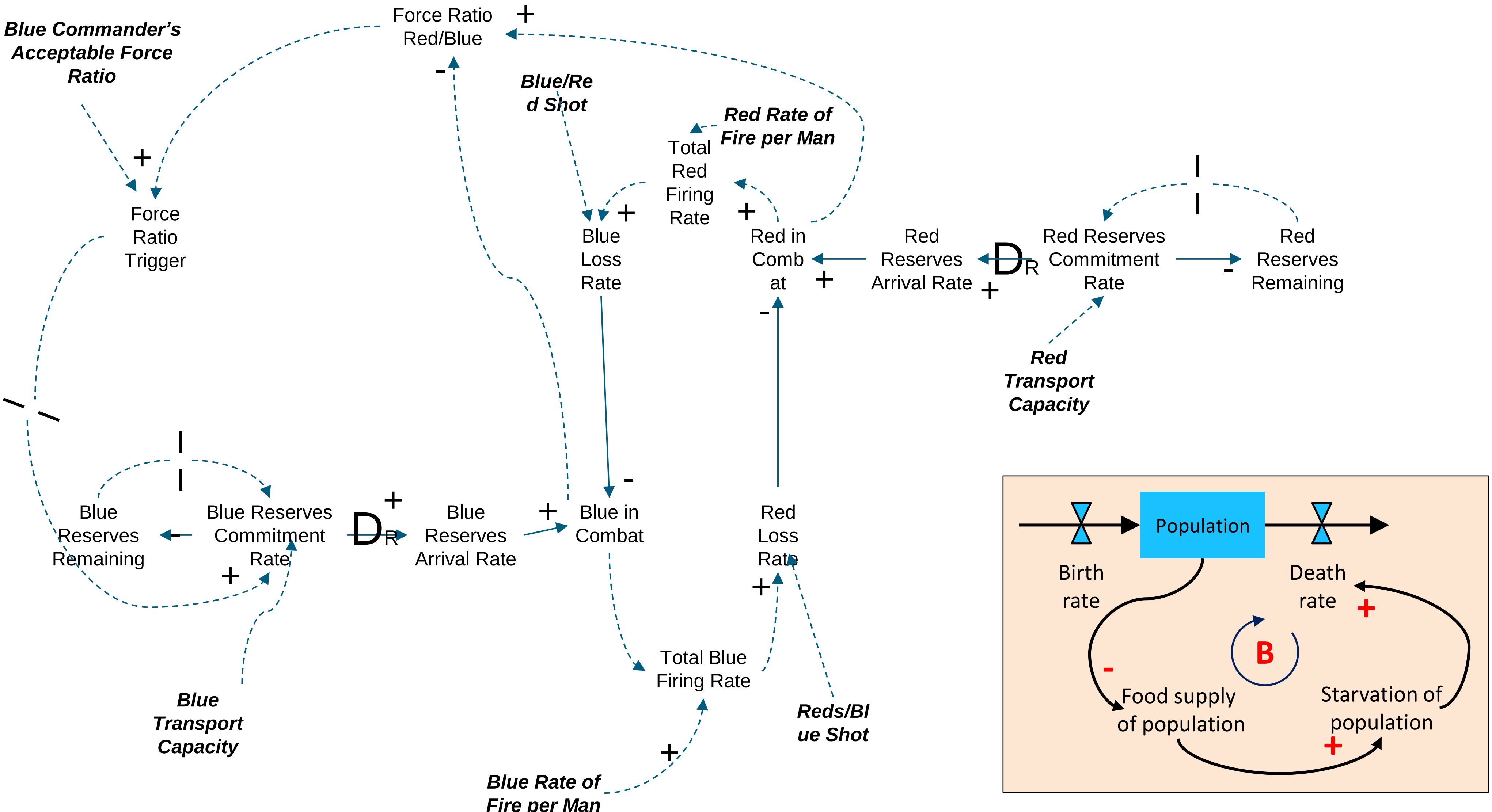
Example causal loop diagram



In complex systems it is the presence of multiple elements, multiple interactions and multiple intersecting feedback loops, of different types and acting at different rates, that give rise to behaviour that is difficult to predict

From reference 9

Example influence map



From reference 10

Soft systems methodology

(SSM)

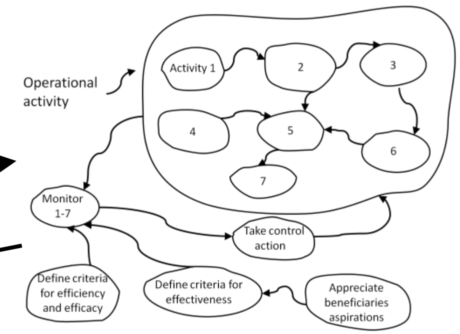
Soft Systems Methodology- process of inquiry[11]

After Checkland

Perceived real world problematical situation

Perceived differently by different people with different world views

Build purposeful activity models based on declared world views



Contains people trying to act purposefully

Use models to source questions about the problematical situation

Structured discussion about change/ opportunity (may repeat SSM with Wilson's Approach)

Action to improve/transform

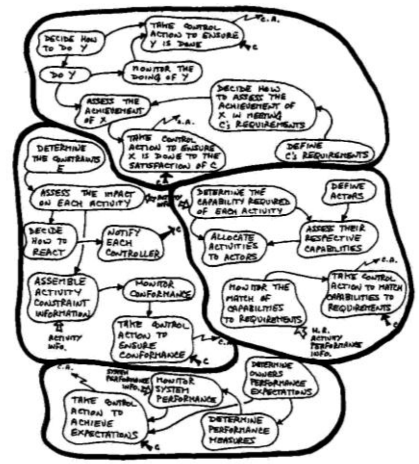
Soft Systems Methodology- process of inquiry[12]

After Wilson

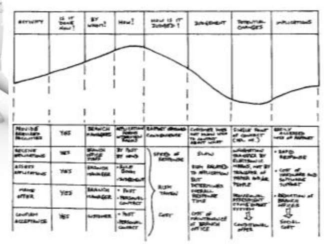
Perceived real world problematical situation

Perceived differently by different people with different world views

Build purposeful activity models
(Enterprise/Consensus, Primary Task/ Issue-based)



Develop and apply framework for enquiry into situation



Contains people trying to act purposefully

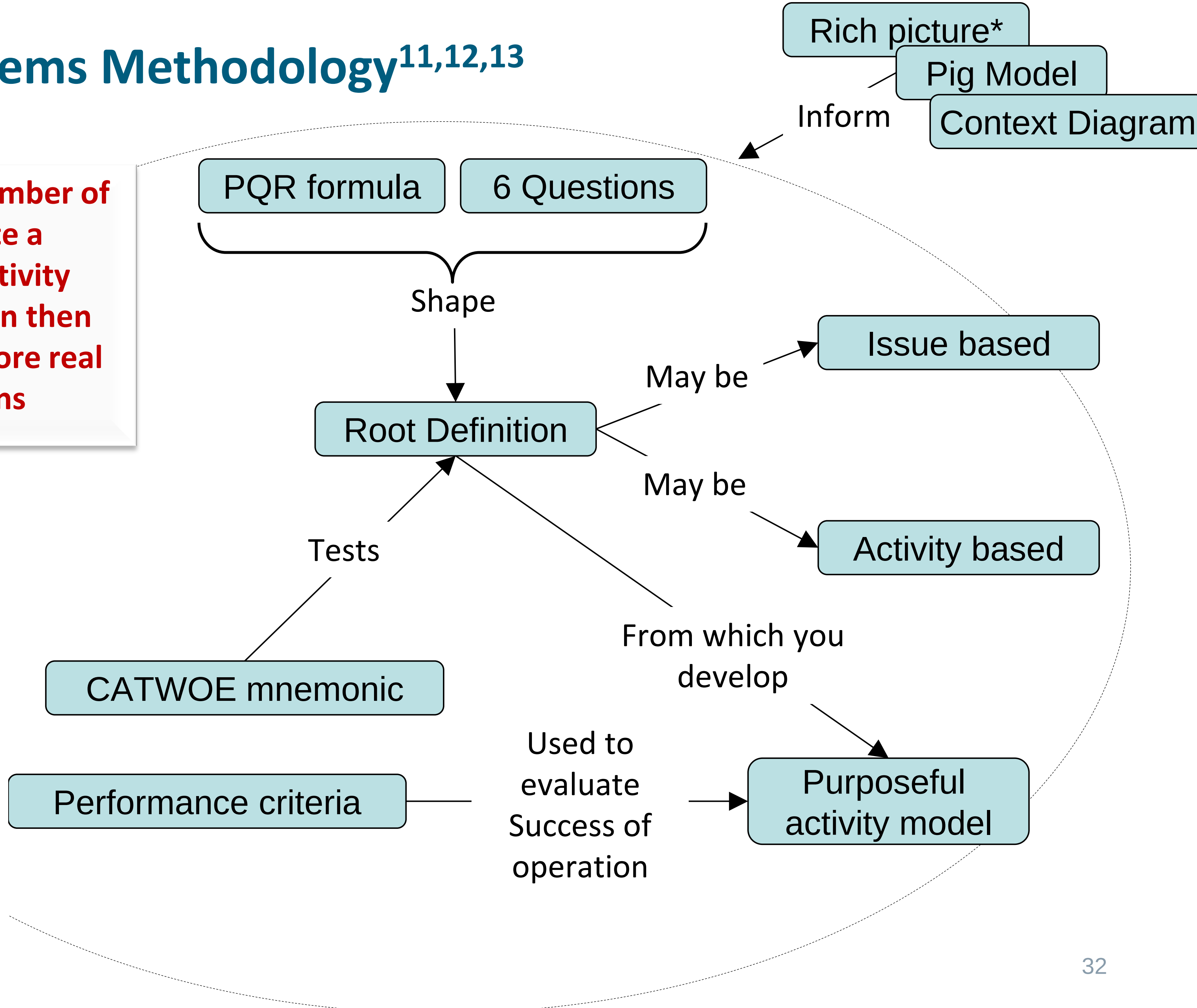
Detailed analysis

Development of detailed design, requirements, etc
(RACI, Information Needs, Process Specs, etc)

Action to improve/transform

Soft Systems Methodology[11,12,13]

SSM uses a number of ‘tools’ to create a ‘purposeful activity model’ that can then be use to explore real world situations



*Whilst drawing a rich picture is the first part of SSM it is also a useful, stand alone tool for problem understanding so rich pictures are described in the first section (p 10)

PQR formula

A system to do <what, P> by means of < how, **Q** >in order to < why, **R** >

6 Questions

1. What are you (we) trying to achieve?
2. What do you think you (we) need to do to achieve it?
3. Who's going to do it?
4. Who benefits or is impacted by it?
5. Who owns it (can start/stop it)?
6. What constraints apply?

Root Definition

Structured description of a system with clear statement of activities which take place (or might take place).

A system to do **P**, by (means of) **Q**, in order to achieve **R**

W is the belief that doing P by means of Q will achieve R

Checkland

Root Definition

Structured description of a system with clear statement of activities which take place (or might take place).

A system owned by **O**, operated by **A** to do **X**, by (means of) **Y**, for the benefit of **C**, within the constraints of **E**

Where T = X and W is the belief that doing Y will achieve X

Wilson

Root Definitions (both styles) tested with CATWOE mnemonic

The Root definition should contain the T and W as a minimum

- **C** Who benefits from the transformation (customers)
- **A** Who does the transformation (actors)
- **T** What is the output of the transformation
- **W** What makes the transformation meaningful (worldview)
- **O** Who are the owners of the transformation
- **E** What other elements effect the transformation (environment)

The following Performance Criteria should be considered when analysing the models to source questions

- **E1** Efficacy – will the system achieve the desired effect under ideal conditions?
- **E2** Efficiency – does the system achieve the results with minimum use of resources
- **E3** Effectiveness – does system achieve the overall business objective

PQR analysis

The ladder abstraction technique can help derive a more effective PQR statement (pgs 12-13)

Considers the essence of the problem situation to derive a statement which identifies what needs to be done, how it will be done and why it is important to do it.

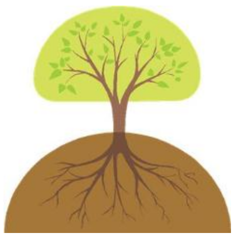
A system to do <what, P> by means of < how, **Q** > in order to < why, **R** >

Check:

- can you do Q?
- by doing Q, will you achieve P?
- by doing P, will you achieve R? (sequential order)
- is R a good thing to do?
- what worldview or perspectives legitimizes this activity (P&R)
- what other assumptions are there?

"A system to provide the armed forces with defence and security capabilities by delivering pan-DLOD equipment and support programmes which protect the national security of the United Kingdom."

Building the Root Definition



Built on the understanding derived from problem understanding activities such as rich picture, Pig Model, Context Diagrams, 6 Questions and PQR analysis.

Gives a structured description of a system which may be:

- **activity-based**, e.g. "*a system to ensure the availability of relevant stock to support production operations*". The Root Definition(s) (and subsequent models) remain valid until purpose changes;

- **issue-based** �, e.g. "*a system to deliver an operational information system to support warehouse management*". The Root Definition(s) (and subsequent models) are only valid whilst exploring the problem and developing a plan of action.

*CATWOE is used either to test the statement generated from PQR and/or 6 questions; note that in older texts Checkland used X, Y and Z instead of P, Q & R. See reference 12

Root definition - examples

A <Owner> owned system, operated by <Actors> , to do <Transformation> by <Worldview of how transformation should be achieved> within the following <Environmental constraints>

After Checkland:

A <company> owned and <staffed> system, to (do) <operate wealth-generating operations> <supported by enabling support systems which tailor their support> through <developments of particular relationships with the main operations>

C: Company
A: Company staff
T: Need for supported wealth generation -> need met via a structure of main operations and enabling support
W: by transferring basic materials according to derived specifications and assembling service requirements, while exploiting developments in technology and appropriate best practice as a means of enhancing overall performance
O: Company
E: Structure of main operations plus support; company ethos

After Wilson:

A <CEO> owned system, operated by <suitably skilled and experienced personnel> to (do) <satisfy customer requirements for a range of products and services in a profitable manner and within a competitive marketplace > by < transferring basic materials according to derived specifications and assembling service requirements, while exploiting developments in technology and appropriate best practice as a means of enhancing overall performance > whilst <acting appropriately upon external influences and recognising constraints arising from available finance, company policy, and relevant industry regulations and standards, while ensuring that company developments and policy lead to an adequate return on investment >

C: Implied within "Customer" in RD above
A: text in this colour above
T: text in this colour above
W: text in this colour above
O: text in this colour above
E: text in this colour above

Note that the Checkland style RD identifies a key <Customer> , however there are likely to be many beneficiaries or victims of the particular T

CATWOE

Customer - directly affected by the '**T**' as beneficiaries or victims

Actor - those who will undertake the activities that achieve '**T**'

Transformation - the transformation or outcome perceived as being required:

- issue based – the transformation needs to tackle a perceived problem and is short-lived
- activity based – the need to achieve a particular purpose is persistent

Worldview - the assumptions that '**T**' is based on:

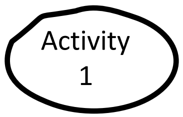
- the worldview / perspective that legitimises the activities to achieve 'T'
- why R is believed to be a good thing to achieve

Ownership - those who can start and stop the achievement of '**T**'

Environmental constraints - those things that affect the achievement of '**T**' and are taken as given:

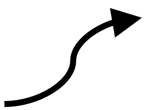
- rules, laws, regulations, limited resources……..

Activity modelling



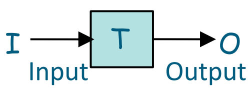
Activities are derived purely from the **Root Definition(s)**

Draw the activities you believe are necessary to achieve the **Root Definition** (what needs to be done to bring the systems into being?)



Draw the logical dependencies between the activities

Activities include those:

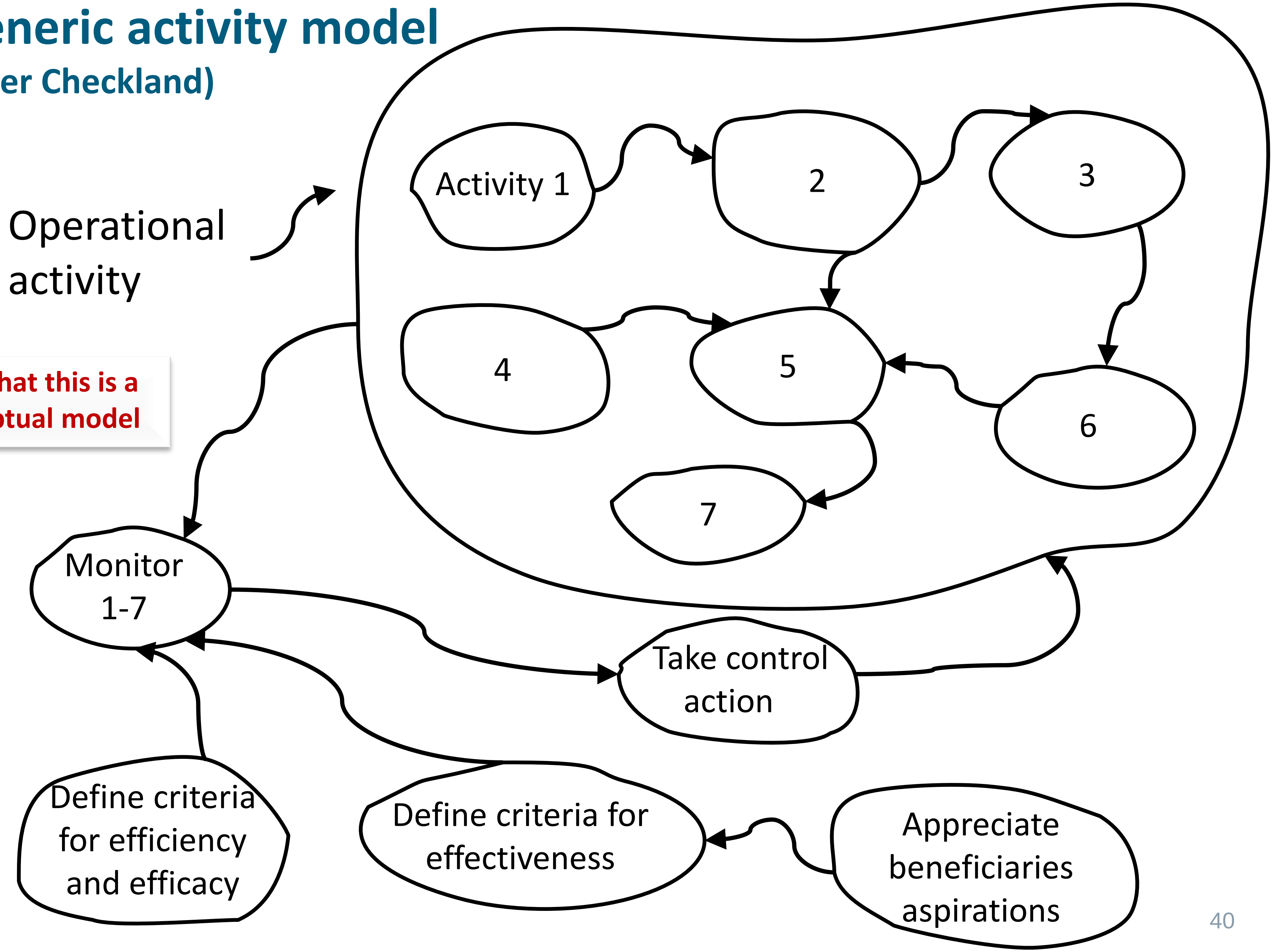


- relevant to acquiring the inputs
- required to achieve the T, therefore based on the W
- dealing with the outputs, including the transformed entity
- related to the needs of the owner, actors and environmental constraints
- that monitor, assess and control

Use verbs in the imperative

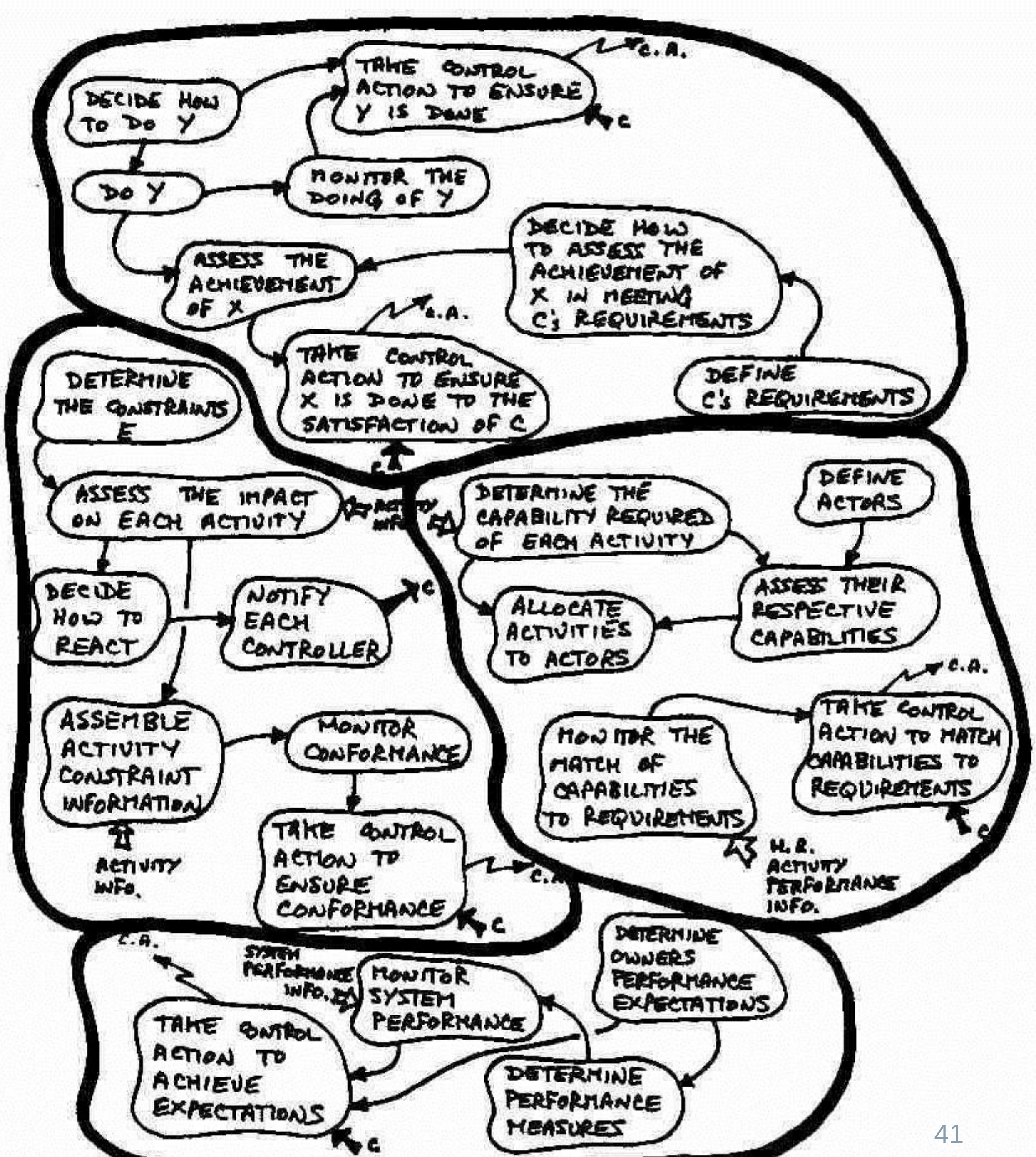
Generic activity model
(after Checkland)

Note that this is a conceptual model



Generic activity model (after Wilson)

A model of **T** and **W**, incorporating **C, A, E** and **O** decomposed into subsystems



Reference 14

Relationship between ‘T’ and the 3Es

When using the Activity Model to source questions , they should include Efficacy, Efficiency and Effectiveness

Efficacy

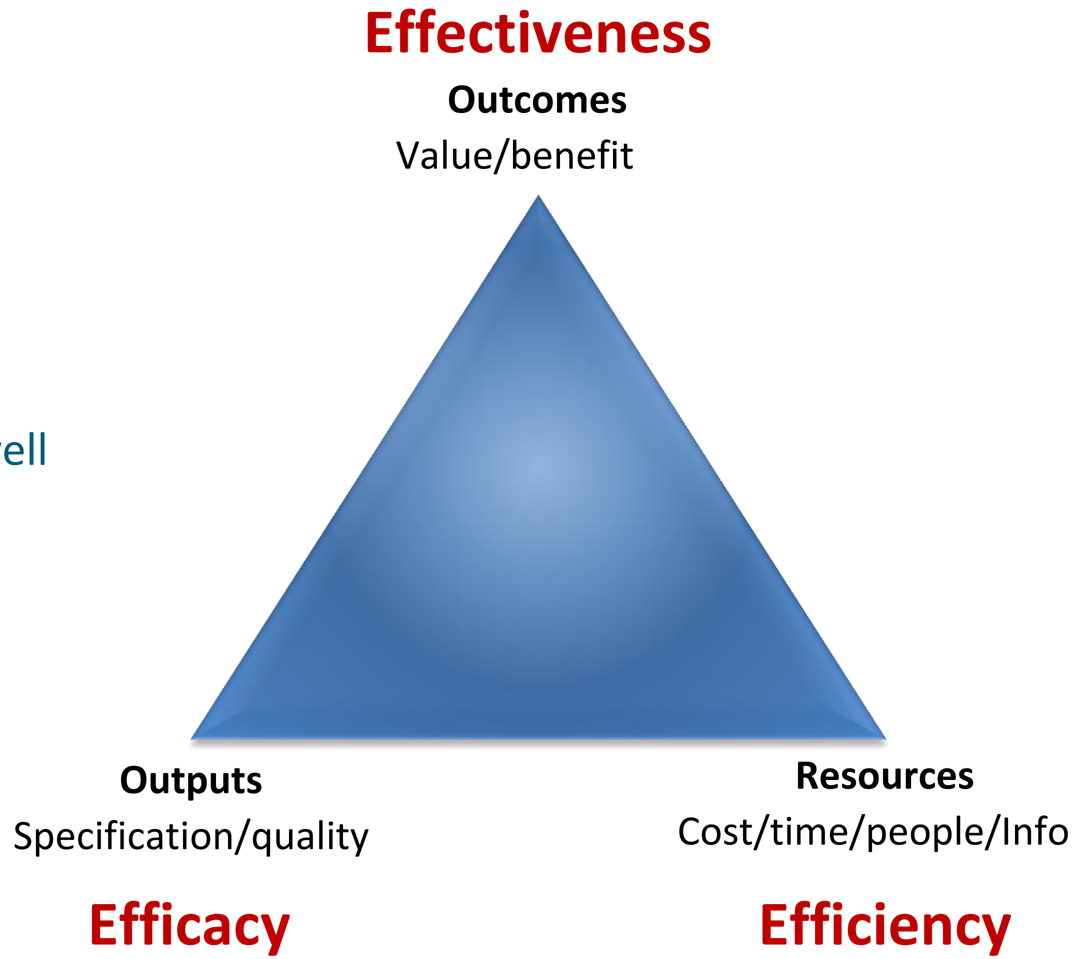
- is ‘**T**’ working?
- is it producing the intended output?

Efficiency

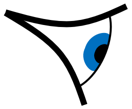
- is '**T**’ using the minimum resources?
- does the ‘Owner’ judge the resources well used?

Effectiveness

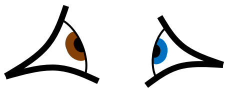
- is this the right thing to do?
- is '**T**' contributing to the wider, longer term objectives?



Tools for discussion



PQR, 6 Questions, RD, CATWOE and activity models will all be based on a particular perspective.



Repeating the analysis using different perspectives can be used to explore the proposed transformation from different viewpoints in order to check assumptions and gain insights as to feasibility and intervention options. A consensus may be achieved through the discussions.

Analyse the models with respect to the real world and check that it makes sense, developing the models further if required:

- evaluate the feasibility and desirability of implementing new ideas and designs
- reach a consensus or an accommodation between stakeholders
- plan an appropriate set of actions that will achieve the desired outcome(s)

The analytical tools can be used to understand the “as-is” baseline and/or identify suitable operational designs and structure the discussion.

Taking action

Concrete plan for action is developed and implemented. Progress is monitored.

Thinking about desirable and feasible change[12]:

- what needs to be changed in terms of structure, process and attitude?
- why?
- how can it be achieved?
- what enabling action is also required?
- who will take the actions?
- when?
- what criteria will judge success/lack of success?
- what criteria will indicate completion?

The models can be used to assess how successful the transformation programme and develop strategies for dealing with implementation problems encountered during the transformation (models may be refined).

Viable Systems Model

(VSM)

Material from this section has been abstracted from Jon Walker's VSM guide[14]

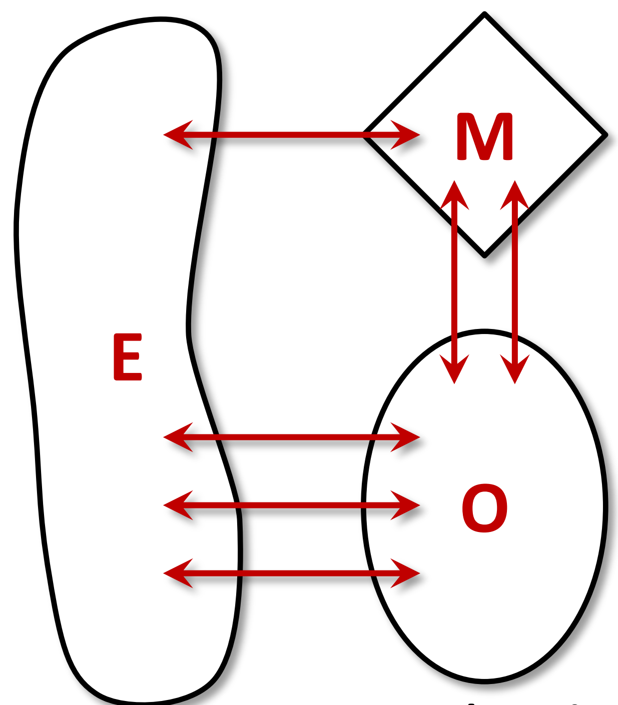
Viable Systems Model - three elements

VSM looks at an organisation interacting with its environment. The organisation consists of two parts: the operational part which does the basic work and the part which provides a service to the operation by ensuring the organisation works together as an integrated, harmonious whole.

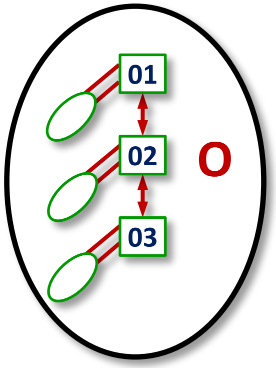
Three elements of the VSM are:

- The operation
- The metasystem
- The environment

All three are in continuous interaction

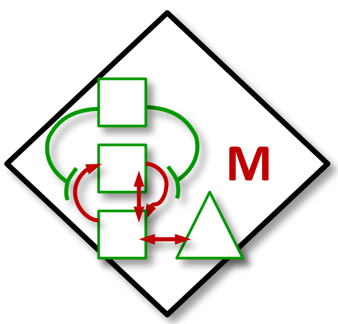


Viable Systems Model - O and M



The operational element (**O**) is composed of sub-units that do the work (may be people, departments, divisions or separate companies depending on scale of observation).

The operational units (OU) are viable systems in their own right, i.e. the model is recursive – the same principles of organisation recur regardless of scale.



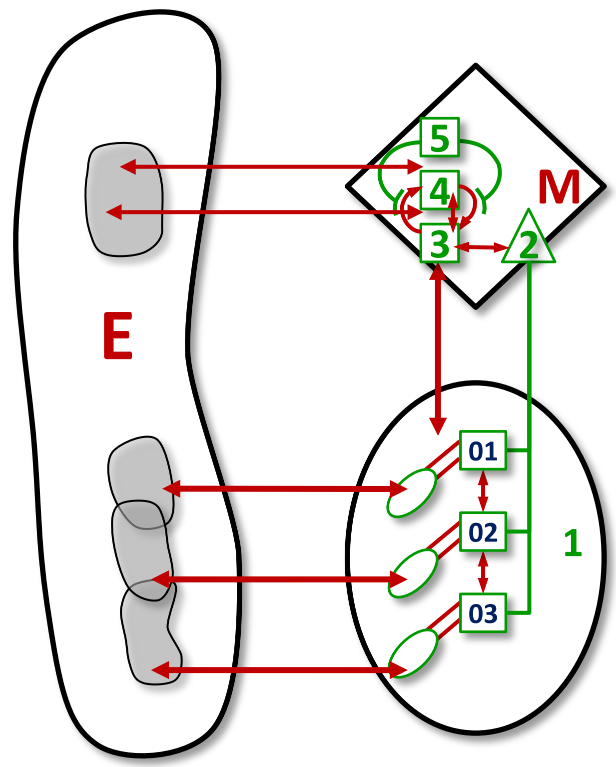
The metasystem (**M**) provides a service to the operational units – ensuring that they work together and also comprises a number of sub-systems.

It establishes design and operational rules that achieve stability, optimisation, future planning to ensure adaptation to a changing environment and a way of ensuring all the various parts work together with the same basic ground rules.

Viable Systems Model - five systems

The **O** and **M** elements break down into five systems which are fundamental to system viability.

System 1	Entire collection of operational units	Primary activities
System 2	Responsible for stability and resolving conflict between operational units	Conflict resolution, stability
System 3	Responsible for optimising/ generating synergy between op units. Acts as the internal eye – looks at "inside and now"	Internal regulation, optimisation, synergy
System 4	Responsible for developing future plans and strategies. Acts as the external eye, assessing threats and opportunities in the environment & makes plans to ensure that the organisation can adapt to a changing environment. Looks at "outside and then"	Adaptation, forward planning, strategy
System 5	Responsible for developing ground rules and policy	Policy, ultimate authority, identity



The essence of metasystem interactions is to balance data coming from the external environment into S4 with information coming in from internal environment into S3 and plan accordingly. S5 oversees the whole process and only steps in if policy is flaunted.

A method for using VSM as a tool for diagnosis (1)

Preliminary diagnosis seeks to identify if the five systems are present and functioning effectively. If there are functions in an organisation that sit outside the five systems then they are unlikely to be crucial for viability.

Step 1 Define the system to be diagnosed – clarify the boundaries of the SoI

- map recursions immediately above and below to ensure you are clear about what is in and out of the SoI
- record the purpose of the system
- list all parts of the SoI as you see them

Step 2 Draw the outline model to depict an overview of the SoI in its totality

- Draw the Write the mission of the SoI or aims and objectives
- Draw the shapes for the three elements E, O and M

Step 3 Add the operational units to the model

- Using the list generated in step 1, identify those parts of the SoI which undertake S1 activities and add to model
- When defining S1 activities ask the question "*are they part of what the organisation is really about or are they back-up, facilitators or support?*". If the latter then they are not S1.
- Draw links to external environment specific to each operational unit

A method for using VSM as a tool for diagnosis(2)

Step 4 Add S2 to the model

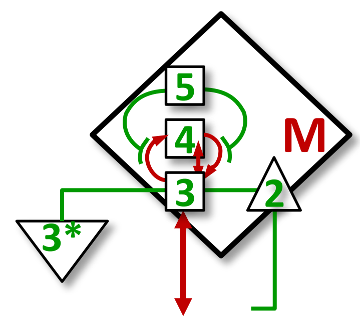
- Identify those elements on the list created in step 1 that resolve conflict, deal with problems and create stability
- Add to the model

Step 5 Add S3 to model

- Identify those elements on the list created in step 1 that create synergy, generate an overview of the entire collection of OUs, look at ways the OUs interact, optimise efficiency of OUs, allocate resources or intervene when the OUs act outside of policy
- Add to the model
- Draw line ↓ from S3 through all the OUs and annotate with mechanisms used to communicate and enforce mandatory S3 matters for OU
- Draw line ↑ from OUs to S3 and annotate with mechanisms by which OUs demonstrate to S3 that they are doing jobs agreed with allocated resources

Step 6 Add S3* to model

- Identify that sub-element of S3 that ensures that the S3 systems has sufficient information to know what is going on in the OUs and identify any signs of stress in the organisation (e.g. tops up S3 information with audit and survey data)
- Add to model as 3*



A method for using VSM as a tool for diagnosis (3)

Step 7 Add S4 to the model

- Identify those elements on the list created in step 1 that are concerned with future planning and strategies for OUs, in the context of the environment.
- Add to the model, identify links to environment and add to model

Step 8 Add S5 to model

- Identify those elements on the list created in step 1 that are responsible for policy matters i.e. ground rules
- Add to the model

Step 9 Review the VSM in its entirety and consider implications

- Take the list complied in step 1 and cross out all items that have been transferred to model
- If there are any items on the list question how critical they are to system viability or is it that the function isn't well understood?
- Identify if there are any missing systems
- Identify whether any links or information flows are missing
- Do systems and links work effectively?

Viable Systems Model – questions to aid diagnosis

- Is each OU clear about its role? Does it have a mission statement?
- Is there a mechanism for the OUs to demonstrate that they are carrying out the mission?
- Are the OUs free to do what needs to be done without interference from anyone as long as:
  - It continues to function as part of the integrated whole
  - It does not threaten survival of the whole organisation?
- Does each OU have the budget it needs to carry out its mission?
- Does each OU account for its performance on a continuous basis to justify the use of its allocated resources?
- Does S3 monitor performance to ensure resources are being consumed in an optimum way?
- Are the protocols in place which can deal with deterioration in performance?
- Are performance standards clearly defined?
- Are the terms for dealing with any severe problems clear and agreed?
  - Are the intervention rules clear?
  - Do they allow sufficient time to deal with problems (is autonomy given time to work)
  - Are they designed to ensure survival of the whole enterprise
  - Only a severe decline in performance
- Are the limits to autonomy clear and agreed?

Viable Systems Model – principles for design (1)

Design for autonomy

- Operational units must have as much autonomy as possible so they need:
  - individual mission statements
  - budgets for the resources they need to carry out this mission
  - an agreement that they can decide on their own internal development as long as they are working to the agreed mission
- Operational units must not threaten the viability of the system, thus:
  - they must be accountable and able to demonstrate they are working to the agreed plan
  - there must be pre-agreed intervention rules which means that autonomy if forfeit if certain conditions are met

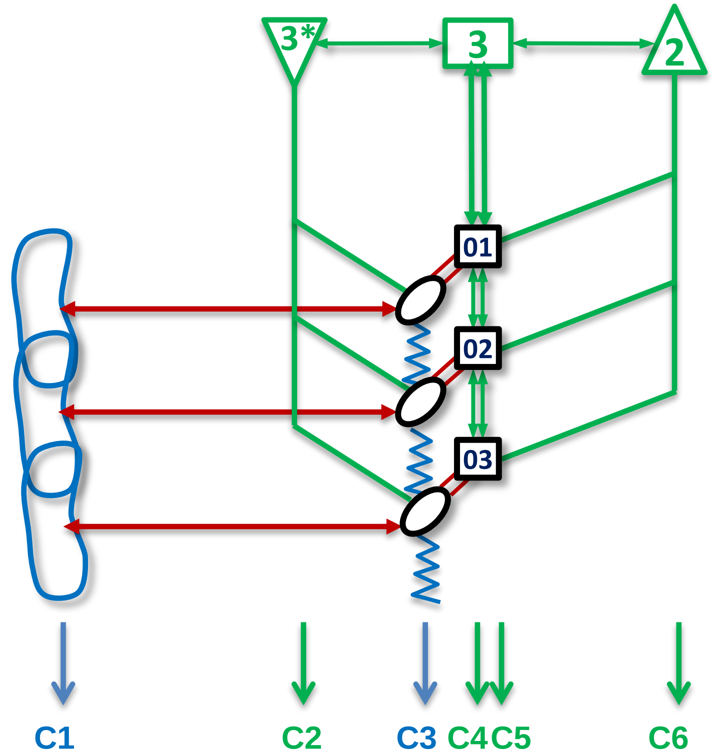
Balancing the internal environment

- Ensure that the operational units have the right capabilities to function properly over time
- Optimise the exchange of goods and services between the operational units
- Improve the links to the external environment peculiar to each operational unit
- Optimise the allocation of resources to the Operational units. It may be possible to cut back in one unit and re-invest in another, thus creating synergy in the whole system
- Ensure that the metasystem is able to undertake the oversight of operations effectively

VSM - Six vertical channels balance the internal environment

C1 – Environmental Intersects
C2 – Audits & Surveys
C3 – Operational Interactions
C4 – Mandatory S3 Information
C5 – Negotiated S3 Information
C6 – S2 (Stability) Information

Black, Red, Blue are operational and environmental interactions



Viable Systems Model – principles for design (2)

Information systems

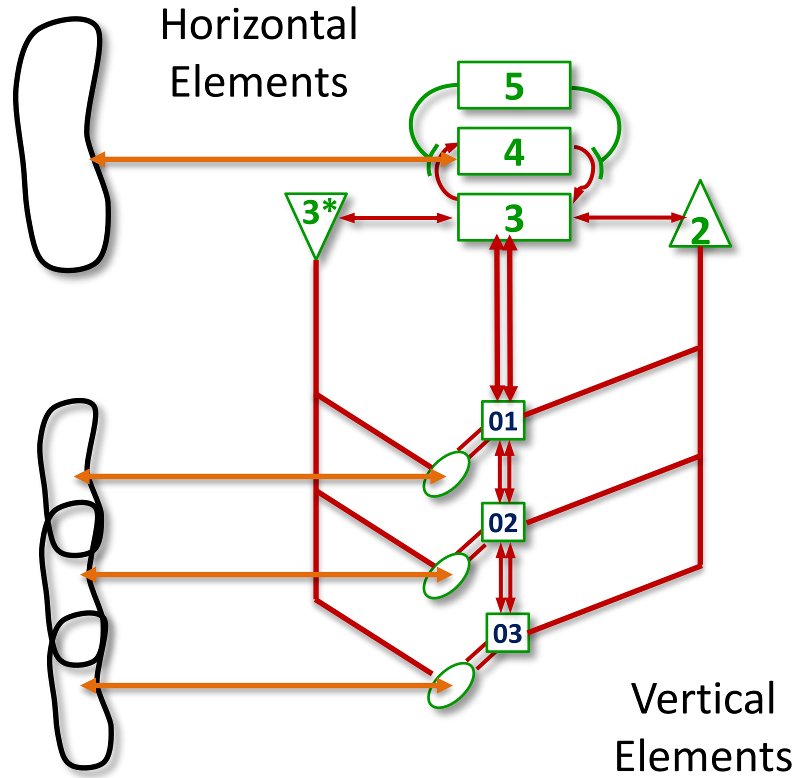
- Ensure that the information systems which inform the Metasystem provide complete, accurate and timely information
- The only information required is if something changes
- Changes which could threaten the viability of the system should be notified immediately
- Operational units must have the information they need to learn and adapt to environmental changes

Balancing with the Environment

- Ensure that the future planning system has the capabilities to:
  - examine and find the relevant information
  - plan and simulate various options
  - understand the capabilities of the various operational units and develop strategies in this context
  - agree and implement its plans through the connections with the operational units
  - function within the policy guidelines

VSM - Balancing the viable system

- System 1 - 3 operational units interacting with environments
- Systems 2 & 3 overseeing and dealing with stability and optimisation
- System 4 looking at external environment for opportunities &/or threats and interacting with S3 and S5
- System 5 monitoring the whole thing to ensure it is all within policy constraints
- All of these interacting on a continuous basis
- The essence is the balance between internal (S1 – S3) and external (S3, 4 & 5)



References

1. Hitchins D. K. 2003. Advanced systems thinking engineering and management. Boston, MA, USA: Artech House
2. R.L. Flood, and M. C. Jackson, Creative Problem Solving : Total Systems Intervention, 1991, Chichester, John Wiley & Sons John Wiley and Sons
3. Hitchins D.K., Putting Systems to Work, John Wiley & Sons 1992.
4. System Boundaries of Engineered Systems, Social Systems, and Natural Systems. A guide to the Systems Engineering Body of Knowledge v1.0, INCOSE, accessed 11/10/2012 http://sebokwiki.org/1.0/index.php?title=File%3AScope_SystemBoundaries.png
5. Open University on Rich Pictures, http://systems.open.ac.uk/materials/T552/pages/rich/richAppendix.html accessed 13/09/2013
6. Morgan G., Imaginization: New Mindsets for Seeing, Organizing and Managing, (new management edition) San Francisco: Berrett-Koehler, 1997
7. Couger J.D, Flynn P. and Hellyer D., 1-01-30 Creativity Training for IS, http://www.ittoday.info/AIMS/Information_Management/1-01-30.pdf accessed 13/09/2013
8. "Novak, J. D. & A. J. Cañas, The Theory Underlying Concept Maps and How to Construct and Use Them, Technical Report IHMC CmapTools 2006-01 Rev 01-2008, Florida Institute for Human and Machine Cognition, 2008, available at: http://cmap.ihmc.us/Publications/ResearchPapers/TheoryUnderlyingConceptMaps.pdf
9. Maani, K.E., & Cavana, R.Y., Systems Thinking and Modelling, Prentice Hall, 2002
10. Coyle, R.G., System Dynamics Modelling, Chapman & Hall/CRC, 2001
11. Checkland, Peter B. & Poulter, J. (2006) Learning for Action: A short definitive account of Soft Systems Methodology and its use for Practitioners, teachers and Students, Wiley, Chichester. ISBN 0-470-02554-9
12. Wilson, B. Soft Systems Methodology, John Wiley & Sons Ltd, 2001
13. Checkland, P., Soft Systems Methodology: A Thirty Year Retrospective, Systems Research and Behavioral Science 17, S11–S58 , 2000
14. Walker J., The VSM Guide, An introduction to the Viable System Model as a diagnostic & design tool for co-operatives & federations Version 3.0 (2006), http://www.esrad.org.uk/resources/vsmg_3/screen.php?page=home

From http://www.watersfoundation.org/webed/mod2/downloads/habits.pdf