

'Controlling' Edge Organizations: Exploiting Emergent Phenomena

Presentation to ICCRTS 2005

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13 June 2005

Agenda

- Starting Points - Edge Organisations and CAS - Implications
- Features of Emergence
- Shaping and Tuning - Top Down
- Regulatory Mechanisms - Self-adjustment
- Exploiting Phenomena - Bottom-up
- Realities and Observations

Starting Points - Claims for Edge (1)

- To achieve Edge Organizations:
 - "P2E involves a fundamental change in culture ... about value propositions ... desirable behaviours ... relationship between self and non-self .. the way the enterprise is motivated ... re-educate and retrain". [p180/1]
 - The extent of the transformation implied in this section is considerable and pretty well revolutionary [it implies we can't get there just by tinkering with what we have].

Starting Points - Claims for Edge (2)

- Edge Organizations and Emergence:
 - "importance of developing an understanding of the nature of complex adaptive systems ... optimization is not even an option ... keeping the situation within the bounds is the mission ... control is not something that can be imposed on CAS* but rather emerges from influencing the behaviours of independent agents ... NCW is a form of emergent behaviour ... Control is not function of command, but an emergent property ... a function of the initial conditions, the adversaries and the environment", [p206 / 7]
 - How and where do we need to exert appropriate influence?
 - How do we find out what 'appropriate' is?
 - What mechanisms are available to us? How do we deal with the fact that everything will be changing all the time? Need to embrace run-time adaptation as the norm ...

Starting Points - 'Controlling' Edge

- Three aspects:
 - Top-down - by the 'directing mind', shaping and tuning
 - Autonomic - self-adjustment through regulatory mechanisms
 - Bottom-up phenomena - emergence and spontaneous-organisation
- Factors to consider:
 - What precursors need to be in place?
 - How do we 'grow' the necessary structures / how much do we let them emerge?
 - How do we deal with the many levels at which interactions take place and the degrees of 'coupling' between these levels?

Implications - Precursors

- Heterogeneous components with properties which enables them to be composed / aggregated in various ways - either on demand or spontaneously (cf organisational units)
- Components should have:
 - a persistent identity over time supported by learning and adaptation
 - the ability to sense, be aware (self and non-self) and reason
 - the ability to manipulate resources / artefacts and effect change
 - the ability to converse / interact with each other and form relationships (persistent over various lengths of time)
 - variable degrees of autonomy
 - the ability to respond to external influence (directed or otherwise)
- An environment co-evolved to support such components and their interactions and adaptation

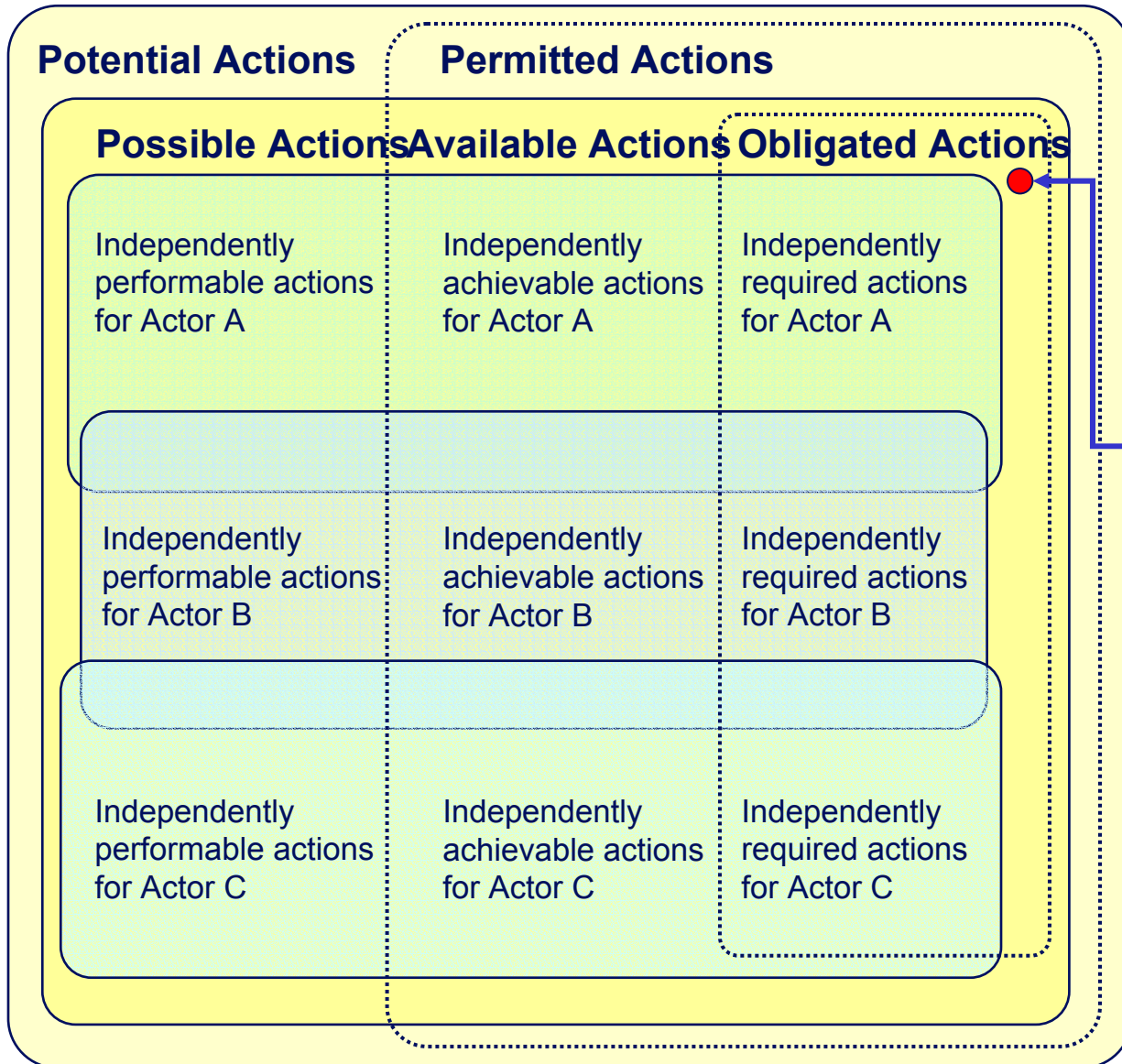
Implications - Growing

- "In future platforms will evolve to organizing efforts involving packs or swarms ... will become less mechanical and more organic ... less engineered and more grown .. exerting the power of the network and not of the nodes" [p169]
- UK General Sir Rupert Smith talks about having "the ability to organise" available to him based on the "interactions which need to occur and the relationships that need to be supported".
- Considering how to recover from dislocation / dysfunction is one way to understand 'growing' Edge Organisations
- Growing should encompass the ability to make smooth transitions between forms and structures (purposeful / self-determined or triggered)
- More medicine than engineering

Implications - Levels of Interaction

- Edge Organizations are, simultaneously a single entity and a colony / community / swarm. They will be characterised by:
 - interaction networks existing at many levels of abstraction
 - a great deal of iteration / causation between the macro and the micro
 - many similar classes of interaction - context different in every case
- At any point in the organisation, there will be a 'view from here' with its own self-awareness and context:
 - peers, sub-structures, super-structures (many emergent) - structure arise from dynamic relationships or be based on existing templates / patterns
- Challenge is - enabling cohesive, purposeful behaviour across the community, whilst simultaneously supporting degrees of freedom / adjustable autonomy etc ...

Dimensions of Adjustable Autonomy



Example: When an obliged action is not performable, do we increase the range of performable actions or decrease the range of obliged actions?

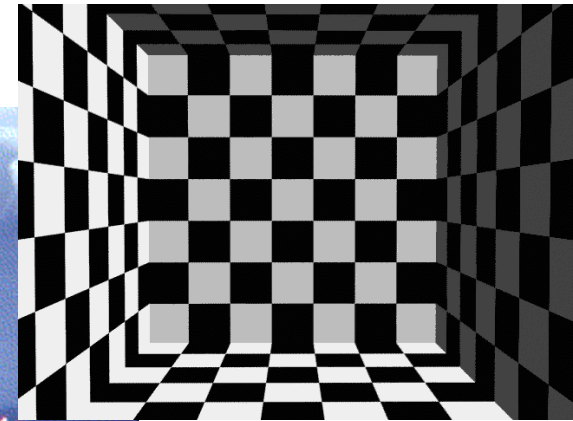
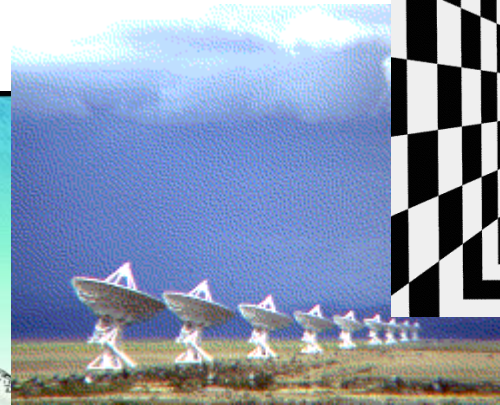
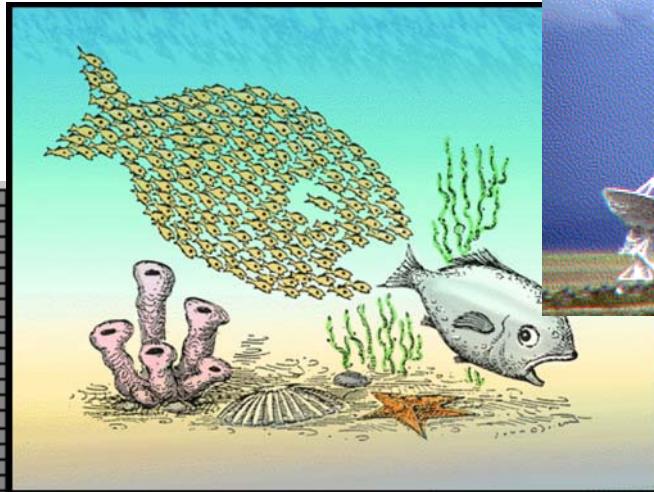
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Emergence and Self-organisation

- A definition: Tangible or intangible patterns that persist over time - even though the generators of the patterns are continually changing.

" ... the crowd panicked ..."



" ... the swarm got the bird and dragged it ..."

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Implications - Shaping and Tuning (1)

- P2E asserts that there will be no single locus of command for Edge Organizations and that leaders will emerge
- We assert that in addition there will be a 'controlling mind' working with the self-organisation etc. That mind (and the leaders) will want to manipulate various 'levers' and phenomena to shape and influence, to:
 - set context and purpose (shared intent)
 - shape organisational structures, force mixtures and allocate power
 - tune interactions and relationships, degrees of freedom (clamp etc)
 - alter priorities, constraints, authorisations, obligations, incentives etc
 - foster repair and recovery
- How should Edge Organisations operate so that they 'expose' the necessary levers?

Implications - Shaping and Tuning (2)

- Work with the mechanisms of CAS (cont'd) ...
- Unfitness and fitness landscapes (including opponents etc):
 - what do we value? where is our comfort zone?
 - effects-based: push the opponent to where mal-adapted
 - can we change the operational environment to coerce other actors?
- Population variety / diversity:
 - set our force mix, decide on degree of specialists / generalists
 - destroy key components of the adversary's capabilities
 - add / involve other actors to alter the social dynamic
- Learning and adaptation:
 - knowledge as power or shared? Also, selection, training, competence, scope allowed for adaptation, command style, ethos etc

Implications - Shaping and Tuning (3)

- Work with the mechanisms of CAS (cont'd) ...
- Interaction tuning, relationships and 'social' networks:
 - activate 'market forces', create an asymmetric gradient
- Sources of power: Who has it? How did they get it / how do they maintain it? How do you take it away? Four main types of power:
 - Positional Power - ie, rank or authority (from a commander to soldier)
 - Expert Power - ie, having an expertise which you expect the person to exercise (eg doctor, lawyer) probably on your behalf (trust is key)
 - Reward and Punishment Power - ie, as incentives or otherwise (money, medal, promotion, imprisonment, setting boundaries)
 - Referent Power - ie, given power by sub-ordinates and circumstance (celebrities, role models, religion? etc). Hard to remove it
 - Power must work within a 'Surveillance System' which can report the 'external truth' to enable suitable social or organisational controls

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Implications - Regulatory Mechanisms

- Edge Organizations will be 'autonomic' by definition (self-healing and sustaining in the face of damage) and will have regulatory mechanisms that respond to the damage / discomfort
- This is not just about homeostasis:
 - not just about the 'nature of the kicking', its about the effect of it
 - it is also about boundary between self and non-self
 - is about having form and purpose (and knowing that you have it)
 - it is also about 'receptivity' to damage, assessing what it will do to your unfitness (local and global) as an being a trigger for response
- Repair involves having reversionary modes and an appropriate 'level of the fight' in the context of repair:
 - it involves some notion of how the effects of the damage might propagate and adapting or invoking 'imprinted' behaviours
- Responses are predicated on interactions ...

Implications - Regulatory Mechanisms

- What types of interactions are possible, in which domains and for what purpose (because there are interdependencies)?
- Agility in part comes from the ability to make and break relationships on-the-fly; determined by plasticity and degrees of freedom:
 - Partly set by controlling mind [RS list]
 - Partly determined by nature of components and their 'interfaces':
 - hard wired based on IERs
 - dynamically discovered at run-time (buffers / 'fly-by-wire')
 - determined by circumstance locally (mission command)
- Relationships will be built from sustained interactions over time:
 - maintaining relationships at all costs vs knowing when to cut and run

Implications - Regulatory Mechanisms

- What is the scope of what is being regulated? (local / global):
 - what resources do you have?
 - what is your degree of tolerance / resilience?
 - how closely do you have to regulate?
 - as part of regulation, how expendable are:
 - the individuals: you / they? (can you partition us from them?)
 - the team / infrastructure?
 - the tasks?
 - may have to be a command decision
- Patterns (rules and templates) help with regulation:
 - fall back to known defined behaviours
 - partition the behaviour space (cf different positions in rugby / UK Army in Aden - sticks and bricks)

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Implications - Phenomena

- Edge Organizations are complex adaptive systems so various phenomena will arise spontaneously / be manifested:
 - attractors, emergence, reverberatory structures, catastrophe landscapes, co-evolution
 - I would assert that these are essential to the way that Edge Organisations will function and, as such, are not optional add-ons
- Key dimensions of agility [p128] are all emergent: robustness, resilience, responsiveness, flexibility, innovation and adaptation
 - There is no such thing as static agility - so where are our tools and methodologies for dynamic systems? [See paper]
- Our knowledge of how to proactively employ / influence emergence is minimal - yet edge-ness seems to demand it ...

Implications - Phenomena

- Substrate [not edge-specific]:
 - the environment supports 'coupling' between the actors / entities / artefacts - it is only through the coupling that interactions can be sustained such that emergence is manifested
 - in edge terms, the physical world is the substrate (encompasses cyberspace and cultural aspects and other abstractions)
- Components:
 - anything capable of interacting - in the edge context:
 - devices, software entities
 - people, operating units, multiple operating units, communities, nations
 - components are **expendable** (swarm etc) their individual demise **does not** 'collapse' the phenomena

Implications - Phenomena

- Attractors: in edge nothing is stable for long, attractors are more likely in the more static parts of the organisation (convergence of procedures, complacency, mal-adapted habits etc)
- Emergence: as before plus - law of unintended consequences (cascades of effects), swarms and mobs, self-organisation
- Reverberatory structures: these remain after the trigger has gone - panic / 'headless chicken' mode (self-inflicted denial of service attack), alertness following some indicator
- Co-evolution: with the opponent (as in trench warfare), with self (battlefield smoke triggering rain)
- Catastrophe landscapes: change forced by endless increase in tempo, step change 'at the edge' ...

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Realities (1)

- Specifying precursors not an exact science
- Growing is mix of top-down controlling hand working with [well understood] bottom-up self-organisation
- Various phenomena will arise - are they ephemeral or a necessary part of the functioning of Edge?
- Regulatory mechanisms, built on appropriate precursors and able to sense discomfort, will be at work to enable 'autonomic' behaviour - they may self-organise and / or be imposed
- Understanding the complex social network of relationships and interactions that are implied is a key challenge ...

Realities (2)

- We know you can shape overall behaviour but what 'handles' must be exposed:
 - can you enable them on demand, are they designed, do they grow?
 - exploiting emergence is certainly one positive strategy that we will need to use more effectively
- Most representations do not give the sense of the iterative, dynamic and multi-level nature of fully operating Edge Organisations
- More work is needed to formally characterise the 'life' of edge organisations so that we can reason about all the matters mentioned previously - suggest it is called "Run-time Science"

Observations

- Edge Organisations de-facto complex adaptive systems
- Good commanders already employ many of these mechanisms (because conflict is human-centred and largely 'natural')
- Need to extend this understanding into the technical domain ...

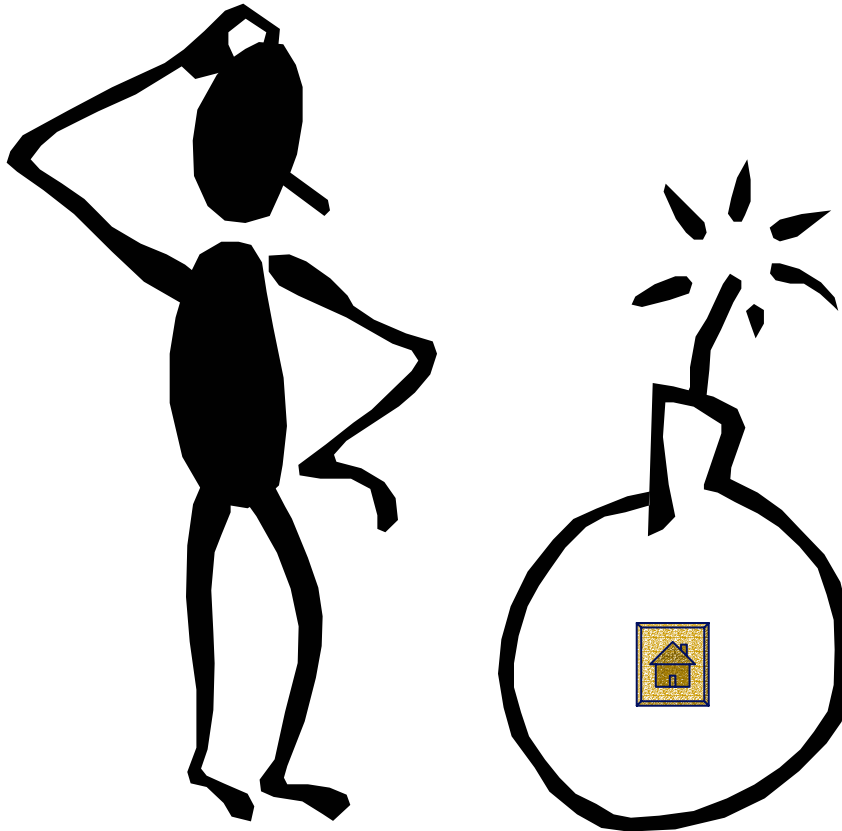
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Questions Please ...

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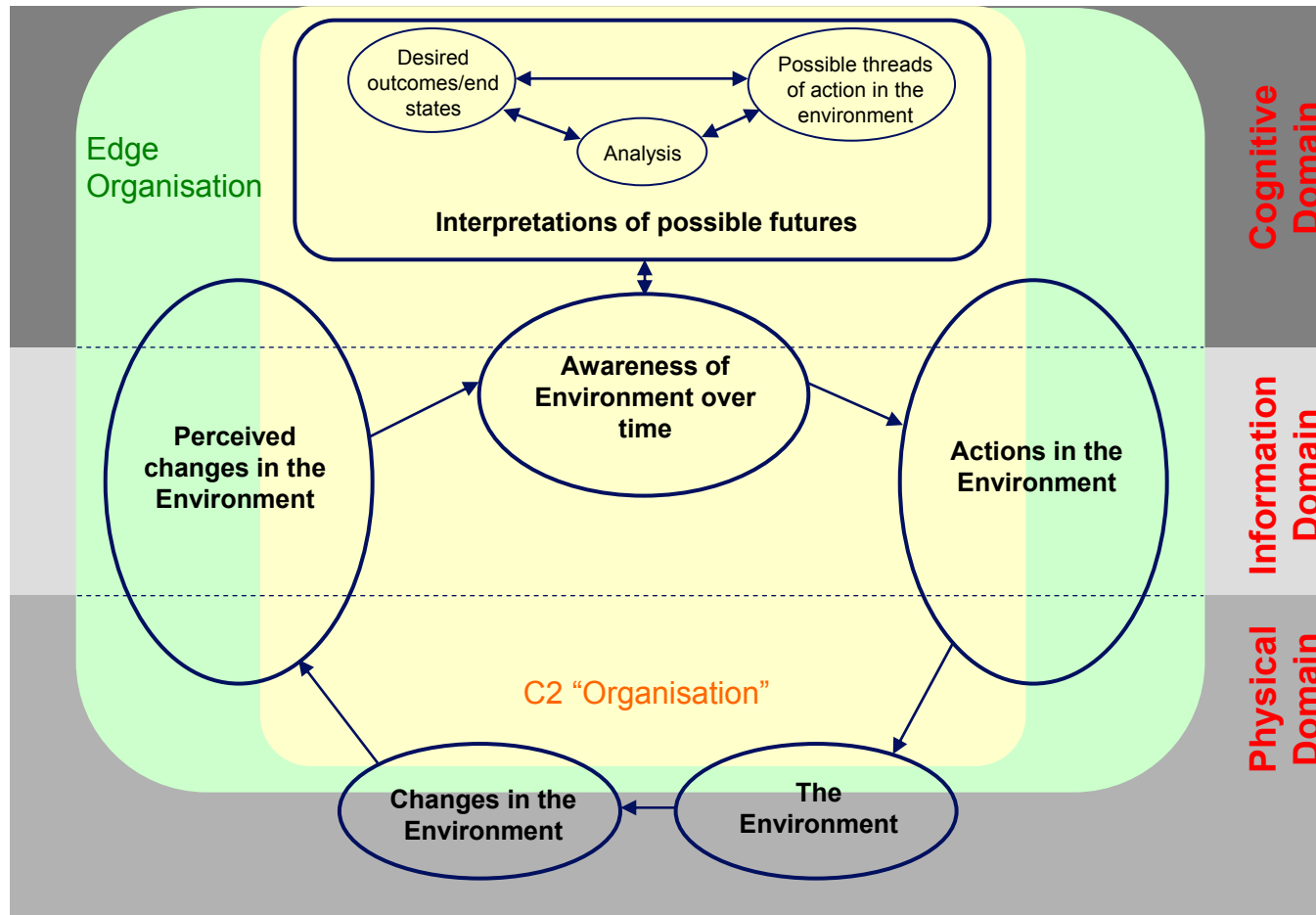




Business 2002



Edge Organisation Framework





C2 Characterisation

Awareness of environment over time

Self-awareness (us, super-us and sub-us)

- Value system
- Personality
- Capability

Awareness of others (them, super-them, sub-them)

- Value system
- Personality
- Capability

Awareness of relationships (us-us, us-them, them-them)

- Social constructs
- Conversations
- Characteristics

Understanding the environment

- Past
- Current
- Change sensing
- Sharing mechanisms

Learning

Stored information

- Sharing mechanisms

Stored knowledge

- Sharing mechanisms

Interpretations of possible futures

Desired Outcomes/end states

- Way of command
- Problem formulation
- Problem solving
- leadership

Intent

- Sharing mechanisms
- Desired states
- Goals

Analysis

- Way of command
- Problem formulation
- Problem solving
- leadership

Monitoring actual against expected

Decision-making

Tasking

Possible threads of action to possible futures

- Way of command
- Problem formulation
- Problem solving
- leadership

Potential courses of action

- Tasks
- Sequencing
- De-confliction
- Prioritisation

Actions in the environment

Execution

- Effects
- Contention mechanisms
- Team building
- Tasks
- Sub-tasks
- Co-ordination
- Synchronisation

Team

- Value system
- Membership
- Cohesion
- Leadership
- “Personality”

- Tasking
- Capability/skills

Way of command

- Problem formulation
- Problem solving
- leadership

Means

- Diversity
- Infrastructure
- Assets

The environment

Actors

- Own organization
- Components
- Structure

