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ISTAR and C2- a holistic view

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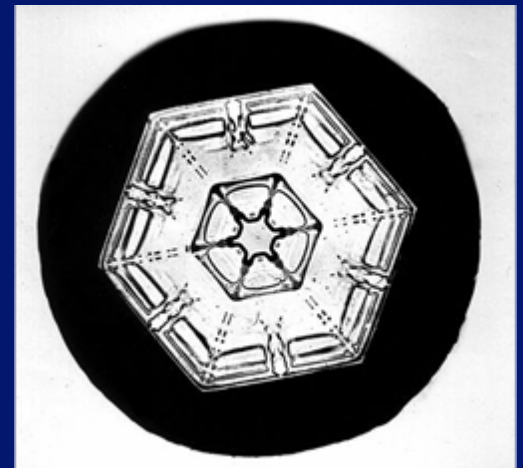
Introduction – the need

- “... there will be major discontinuities between the Command and Control concepts and practices being taught and practiced today and those of tomorrow.” (Understanding C2)
- Perhaps we need to develop more suitable ...
- Underpinning science (Holism)
 - “... in war more than in any other subject ... the part and the whole must always be thought of together” (Clausewitz).
- Metaphors
 - *“One of the most of important of these Information Age skills will be exploiting the power of metaphor.”* UK Jt HLOC
- And apply to C2-ISTAR

Water as a metaphor for C2

Liquids as a metaphor

- Networks are an accepted model for C2
- C2 is thought about in terms of complexity, dynamics and emergence
- Large C2 are systems of systems
- Fluids are networks with agility. Liquids are also cohesive and sustainable
- The same for water. Being liquid is the key emergent property. Water is currently better understood than C2.
- Water, as systems of systems of atoms, is currently better understood than C2

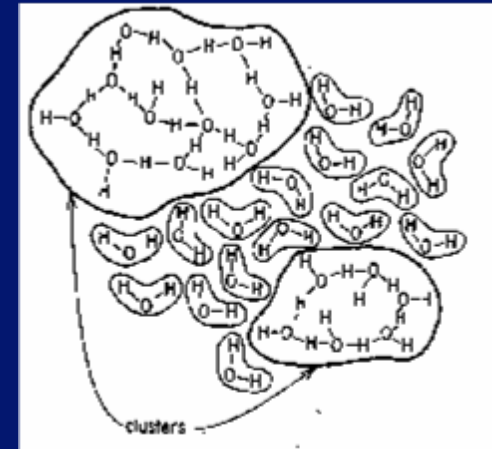


snowflakebentley.com

Water as a metaphor for C2

Liquids as a metaphor - continued

- Water is (very) complex
 - More so than many academic ‘complex systems’
- Water doesn’t have a classical molecular structure. It is heterogeneous in its micro-structure, impacting on its macro-structure
 - Like a snowflake
- Water is agile yet cohesive
 - Water enables life
- ‘Liquid’ can also be used to mean ‘fluid with cohesion’
 - Liquid networks
 - Liquid games and dramas
 - No fixed rules or scripts

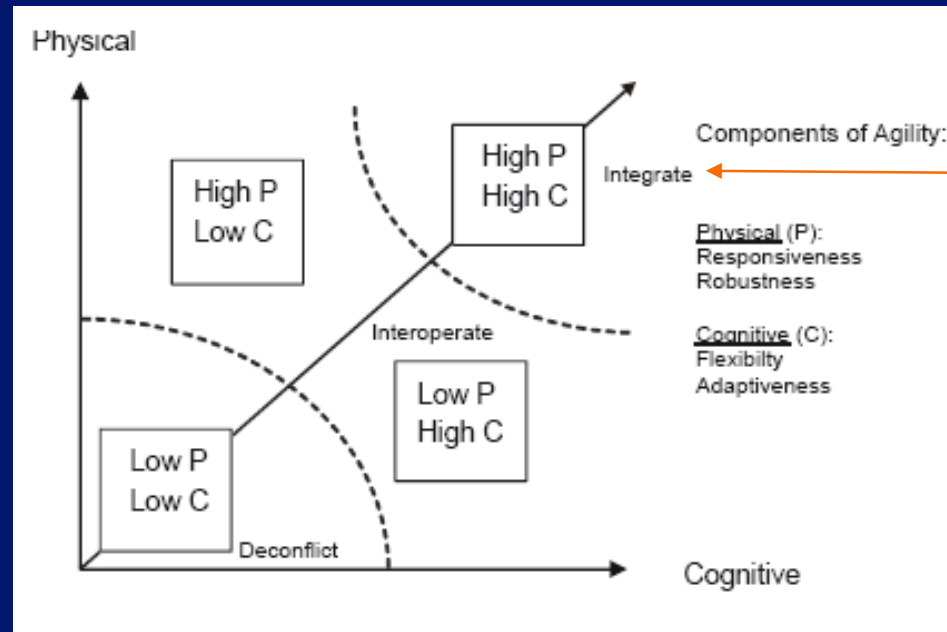


<http://www.chem1.com/acad/sci/aboutwater.html>

Water as a metaphor for C2

UK Jt HLOC quote

“the power of metaphor.”



*‘Combine
or be combined with
to form a whole’.*

Components of Agility

High agility calls for being highly *liquid* – physically and cognitively.

Water as a metaphor for C2

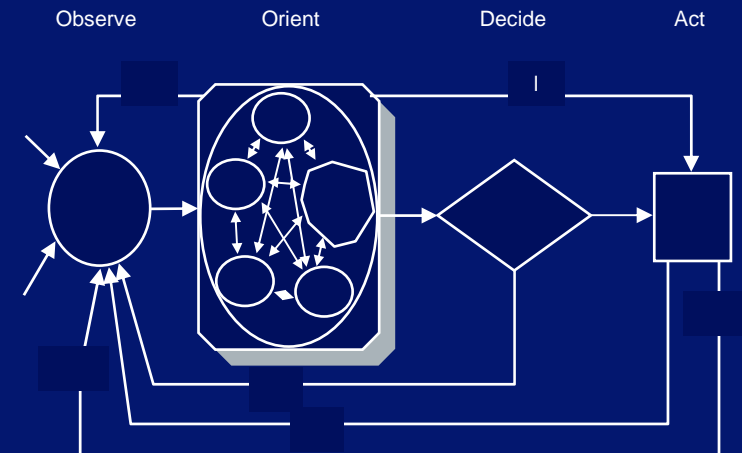
Are military forces liquid?

- In the Great War, locally organised troops (gases) couldn't muster enough concentration, while lines of troops (solids) broke as they came against focussed resistance (strongholds).
- 'Liquid' forces can form solid-like waves but then can flow over and around strongholds, washing away resistance, and then regroup in more solid forms.
- John Desmond Bernal ('the Sage')
 - Science adviser to General Montgomery
 - Worked on liquid crystals (designed liquids), developed the structural theory of cells
 - Adopted the logician Whitehead's holistic theory of emergence

Water as a metaphor for C2

A comparison: Bernal and Boyd

- J.D. Bernal:
 - "Life is a partial, continuous, progressive, multiform and conditionally interactive self-realization of the potentialities of [atomic electron states]."
- J.R. Boyd:
 - "Note how orientation shapes observation, shapes decision, shapes action, and in turn is shaped by the feedback ... Also note how the entire 'loop' (not just orientation) is an ongoing many-sided implicit cross-referencing process of projection, empathy, correlation, and rejection."



Attrition vice manoeuvrist approach

- Boyd says that the manoeuvrist warfare calls for a different intellectual carpet-bag from attritional warfare.
- Bernal developed his holistic approach as an alternative to the then dominant functionalist approach
 - The functionalist attempt to model life and other interesting processes failed
 - The holistic approach has had more success, although it does need to be adapted with care
- The liquid metaphor may help us select the right approach and tools.
 - E.g. how far can one understand HQ activity in terms of a functional model?

Water as a metaphor for C2

Open questions for water - and C2?

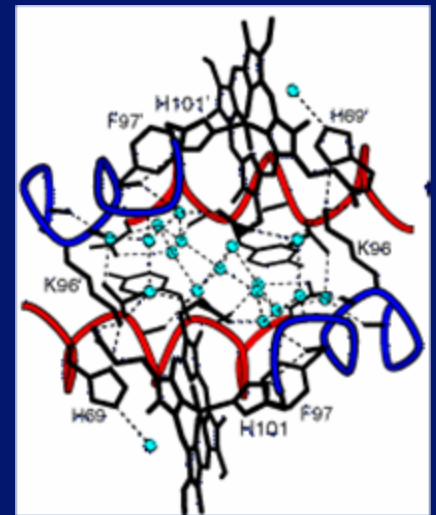
- How do you distinguish the members of a “[community]” from adjacent [entities] that are not in that [community]?
- ... individual [communities] are continually breaking and reforming on a [relatively short] time scale ... whereas "structure" implies a [C2] arrangement that is more enduring.
- The possible locations of neighboring [units] around a given [unit] are limited by energetic and geometric considerations, ... It is not clear, however, to what extent these structures interact as the size of the [force being considered] is enlarged.”
- Thus, unlike some other metaphors, a water metaphor doesn't suggest spurious veracity. It leaves lots of scope for commanders and researchers!



Water as a metaphor for C2

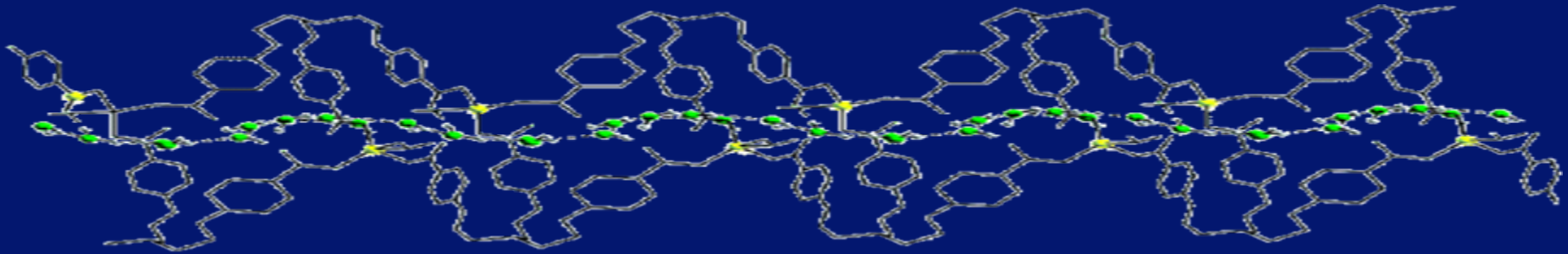
Fluidity with cohesion: water and life

- Water is *chemistry*, not biology, water is not alive
- But water has *unique properties* that *enable* life
- Life *emerges* from water, and water *infuses* life
- Are there properties that machines might have, which would facilitate agility in the humans?
- “Enlightenment comes from an understanding that water molecules form [a] hydrogen-bonded network with localized and structured clustering. The middling strength of the connecting hydrogen bonds seems ideally suited to life processes, being easily formed but not too difficult to break.”



Water as a metaphor for C2

Implications



- This has implications for:
 - Coherence vice cohesion
 - The nature of Information
 - Equivocality and Evidence
 - ‘Sharing’ ‘Situation awareness’
 - Edgeness

Implications

Coherence vice cohesion

- Users often *call for coherence* (consistent underlying logics)
- But they also *need cohesion* (sticking together)
 - According Whitehead, Bohr, Boyd et al, in complex situations coherence and cohesion need to be traded-off
 - Thus a coalition might be cohesive but not entirely coherent
- To a chemist, pure solids are *coherent*, making them *fragile*
 - E.g., one adds impurities to iron to give it greater *resilience and toughness, at the expense of coherence*
 - Even pure liquids cannot be coherent
- So *we do not want coherence* in the systems engineering sense.
 - *We need to translate* between the pure, homogenous, *coherent appearance* and the heterogeneous *cohesive reality*
- We want *agility with cohesion: being liquid*

Implications

The nature of information

- 'Understanding C2' distinguishes between Information position (within a given context) and familiarity (and hence understanding) of the context.
- These seem to correspond to Whitehead's 'recognition' or 'measurement' versus 'indicative feeling'; Shannon & Weaver's 'information' versus 'meaning'; and the dictionary 'describing' versus 'shaping'.
- But do we know what they really mean? How do they relate to efficiency and effectiveness?

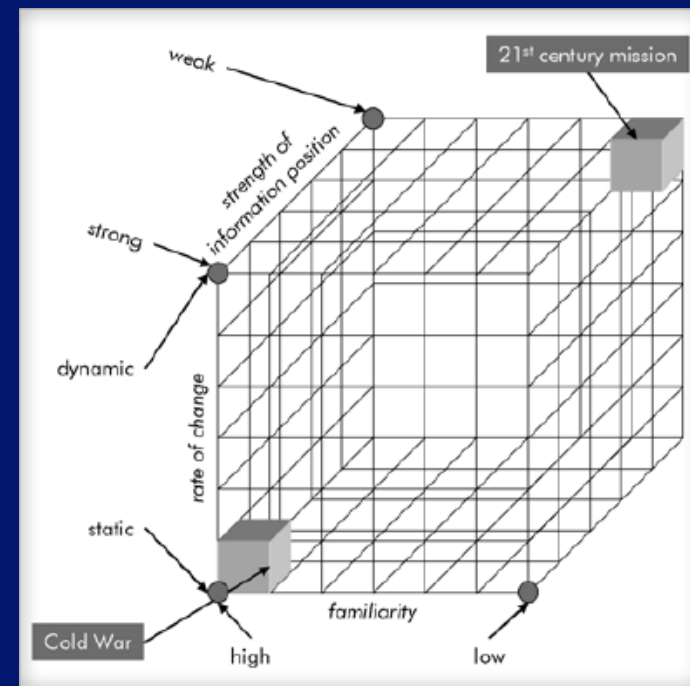


FIGURE 12. THE C2 PROBLEM SPACE

Implications

The right sort of information

- Much C2 thinking seems to be focussed on the information position (and efficiency), whereas commanders seem more concerned with meaning (and effectiveness).
- But the liquid analogy suggest that there may be nothing to describe – so it is the shaping and meaning that matters.
- It often seem to be supposed that improvements in our information position capability always gives benefits.
- Yet the liquid metaphor links to a body of theory (such as Whitehead, Bohr, Boyd, and Shannon & Weaver) that suggest that there may be a trade-off, so that attempts to improve the information position could be detrimental to our overall understanding.
 - ‘Can’t see the wood for the trees.’

Implications

Equivocality

- “Equivocality exists when a commander can map multiple mental models onto the ... information in the future ... it is likely that more information will create more equivocality. This may lead to ... ‘decision paralysis’.”
- “... future commanders need ... to deal with equivocality, in a similar way that current commanders have learned to deal [with] ambiguity.”
- Describing information resolves ambiguity
- What resolves equivocation?

Implications

Evidence

- Raw data (such as an image) is context independent, but bulky and needs specialist interpretation. Describing information is less bulky but is context-dependent
- We need something more compact than the raw data that addresses equivocality, e.g. from which information can be derived for different contexts
- Whitehead's student Keynes developed the theory of weights of evidence (woe), a generalisation of the legal concept of evidence. Whitehead's grand-student Turing (with Good) applied it at Bletchley Park.
- ISTAR can collaborate on hypotheses, evidence and weights of evidence with little coupling
 - 'information' and 'shared awareness' would then be generated according to the relevant mission context

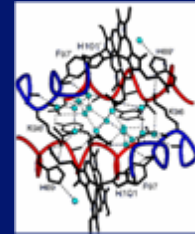
Implications

Complex situation awareness

- Having the information for a decision in a complex situation.
- A liquid approach would be to allow autonomous missions and only cohere awareness where the missions need to be cohered
 - *“The battlespace could be configured for efficient information sharing by identifying communities of interest within which information flows are matched to reflect different needs” UK’s Jt HLOC*
- This allows both decision quality and speed across a force, by trading-off coherence
 - Ameliorating Boyd’s law
- But it requires the communities to be managed (commanded)
 - as appropriate to the higher mission and context
 - and so it is only ‘Power to the Edge’ in the sense of subsidiarity (the higher authority does the absolute minimum – but no less).

Implications

Edginess



- ‘Understanding C2’ says of *complexity*
 - “braided or entwined together, inseparable, or interdependent. ... cannot be deconstructed into ... manageable or predictable pieces”.
 - Murray Gell-Man noted that “effective complexity can be high only in a region intermediate between total order and complete disorder.”
- According to Ashby, C2 can only be effective in complex situations by harnessing the complexity of its ‘pieces’.
- ‘Power to the Edge’ focuses on decisions being made at organisational edges. This is not conventional, nor is it complex.
- Liquids are neither centralized solids nor totally decentralized gases.
 - Holism emphasises the need for an appropriate balance between the parts and the whole, between the edge and the centre.
- Thus if more ‘Power to the edge’ is the aspiration, Holism could provide the guide, drawing on the liquid metaphor.

More implications

Implications for our models

- We normally think of *drinks from a consumer's* viewpoint, but the *chemist's view is very different* (“water molecules form an infinite ... network ...”)
- So there may be *gaps to be bridged* between the users' ‘C2ISTAR business models’, the systems of systems architect's ‘C2ISTAR business model’ and the system engineers' ‘C2ISTAR business models’.
- This is a key area where C2ISTAR systems of systems have been found wanting.
- As in ‘Understanding C2’ and Jt HLOC, a common ‘intent’ seems to be that C2ISTAR should have a clear split between the Cognitive and Physical components, separating the human sciences from systems engineering. This is inconsistent with Holism.

Extending the metaphor

The human body

- The human body is a machine, animated by mind. The individual joints have limited movement, yet the whole can be moved like a liquid: very fluidly, but with cohesion.
- As we learn repetitive activities, they move from being conscious activities to being autonomous. Thus, in a sense, the body is liquid and the mind / body interface is liquid.
- Suppose that we do have a human – machine split. How closely will humans be coupled to machines? To each other?
- If the couplings are balanced, the systems as a whole could fragment
 - i.e., the system of systems is not cohesive
- Who could manage this? Unless we couple the management?

Conclusion

- Some of our C2I problems seem symptomatic of a flawed approach, and not amenable to common-sense solutions. The problems are greatest where agility is required.
- A liquid metaphor may be helpful, both in identifying areas where common-sense may be unreliable, and in suggesting solutions. Some implications for C2ISTAR as a whole have been discussed. However, the implications for ISTAR are more significant, because of its more substantive nature.
- The nature of information, the intelligence product and the use of evidence have been briefly discussed. It is suggested that a proper understanding of the nature of information is essential
 - to support equivocality
 - to be able to support all of the information needs, shaping as well as describing, to cope with complex situations
 - to support effective command ISTAR interworking and networking



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ISTAR and C2- a Holistic view: Questions?

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