PHASE SPACE SHIFTS IN COMMAND STRUCTURES IN NETWORKED SYSTEMS

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Overview

- ELICIT paradigm
- Modelling in C2
- NATO SAS-050 Phase Space Cube
- From Approach Space to Phase Space
- From Typology to Taxonomy
- Multi-National Experiment
- Conclusions
Factoids provided at outset of trial, then on two further occasions.
Architecture

Factoid → Inbox

“Add” → My Factoids

‘Websites’

Who  What  Where  When
Architecture

Inbox

Factoids

Websites

Who
What
Where
When

"Post"

"Add"

"Add (Copy)"
Sharing

1

2

Who
6

7

8

3

What
9

10

11

4

Where
12

13

14

5

When
15

16

17
Sharing

Only have access to respective who/what/where/when ‘websites’
Have access to all who/what/where/when ‘websites’
Modelling command structures

Chain  Y  Circle  Wheel  All-connected
Octant Archetypes

NATO Approach Space
Approach Space to XXXX

Match the position of a network structure in the Approach Space with the corresponding task type or problem in the Problem Space. This will increase understanding of agility and focus for NEC organisation.
Centrality:
- Unitary decision rights = a few highly central agents.
- Peer-to-peer decision rights = greater number of central agents.

Patterns of Interaction:
- Hierarchical interaction = bigger diameter.
- Distributed interaction = smaller diameter.

Distribution of Information:
- Broad dissemination = more dense.
- Tight control = less dense.
Measures of Agility

Challenge:
• Lack of appropriate Agility metrics to describe the changing shape of the organisational structure.

We proposed 2 metrics to analyse Agility:
1) Volume
2) Deviation
Volume

- The larger the volume the greater the space covered by a given network structure.

- The hypothesis is therefore that the volume delineates agility in that the greater volume covered the greater flexibility of the network.

\((\text{AoDR Max} - \text{AoDR Min}) \times (\text{PoI Max} - \text{PoI Min}) \times (\text{DoI Max} - \text{DoI Min})\)

- Where AoDR is 'Allocation of Decision Rights', PoI is 'Patterns of Interaction' and DoI is 'Distribution of Information'.

- The point is to subtract the minimum and maximum values for each of the dimensions (to give length, width and height) and then multiply the resulting numbers together (to give the volume of the cube).
In-house Baseline Study

Background
- This study compares two network structures; traditional C2 and Edge (peer-to-peer).
- Sample of 34 postgraduate students; 17 in C2 and Edge

Aim
- To populate the NATO Approach space with empirical data to represent the movement of the networks over time.
- Explore which theory of SA; Shared SA or Distributed SA which provide the most insight into the actual functioning of the networks in terms of Situation Awareness.

Development of the Log Analyzer
- Data analysed using the Log Analyzer
  - Developed the Log Analyzer with the DoD software provider to allow sharing behaviour to be analysed at specific time intervals
- Development allows us to extract the data needed to calculate SNA metrics which in turn allows us to place the network structures in the NATO cube.
  - The time interval also shows a measure of agility in the networks behaviour across task involvement

Analysis
- EAST; ELICIT measures such as situation awareness, time to complete, correct identify and sharing behaviours; NATO Approach Space coordinate calculation and representation.
- Most of the analysis is complete; remaining analysis to focus on Distributed Situation Awareness.
Meta-analysis

• Meta-analysis of international ELICIT baseline data conducted.
• Data acquired through the ELICIT user community
• Meta-data sample contains 16 data sets: 8 C2 and 8 Edge.
  – Inclusion of Naval Postgraduate School, United States
• 5 countries of origin: Portugal, Singapore, Canada, United States (West Point Military Academy and Boston University, Naval Postgraduate School) and the United Kingdom (Cranfield Defence Academy UK and Southampton University).
Performance of the networks
Sharing, posting and pulling
Allocation of Decision Rights
Patterns of Interaction
Distribution of Information

Organisational Type
- C2
- Edge

Distribution of Information

Organisational Type
- C2
- Edge
The data from the In-house Baseline ELICIT Study and Meta-analysis date was further analysed in terms of the agility metrics identified:

- Calculation of Volume for the movement of an N’s sample data within the NATO Approach Space
- Volume compared across N’s for C2 and Edge conditions.
Portugal

Portugal, C2

Volume = 15682.75

Portugal, Edge

Volume = 10670.99
Singapore

Volume = 2.1793

Volume = 2927.989
United Kingdom

Cranfield, UK, C2

Volume = 3506.316

Cranfield, UK, Edge

Volume = 7.96
United Kingdom
Canada

Volume = 15956.12

Volume = 2412.093
United States

West Point, US, C2
Volume = 46863.21

West Point, US, Edge
Volume = 21884.92
United States

Boston Uni, US, C2
Volume = 16612.18

Boston Uni, US, Edge
Volume = 807.5316
United States

Volume = 3430.809

Volume = 8302.56
Volume by type

Organisational Type
- C2
- Edge

Volume

Organisational Type
- C2
- Edge
Volume by organisation

![Bar chart showing volume by organisational type and group name.

- Group names: Portugal, Singapore, Cranfield, Southampton, Canada, West Point, Boston Unit, Naval Postgraduate School.

- Organisational types: C2, Edge.

- Y-axis: Mean Volume

- X-axis: Organisational Type]
## Summary Table

### Volume

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<th>N</th>
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<th>AoDR</th>
<th>Pol</th>
<th>Dol</th>
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Octant Archetypes

NATO Approach Space
Meta-data overview

International meta-data

- Singapore Edge
- Singapore C2
- Canada Edge
- Canada C2
- Boston Edge
- Boston C2
- Cranfield Edge
- Cranfield C2
- Portugal Edge
- Portugal C2
- Southampton Edge
- Southampton C2
- West Point Edge
- West Point C2
All information exchange types
Conclusions

- The data to fall into just one of the octants (the star octant).
- Two types of organisations (C2 and Edge) drift toward the same point in the NATO phase space.
- The phase space distinguishes between different organizational structures.
- A problem with the entire ELICIT paradigm is raised.
- What structures might have emerged in the Edge condition if there was an evolving task with no fixed end-state, a task which required teams to continually adapt and evolve with their environment?