Defining and illustrating core issues in C2: The Convoy card game

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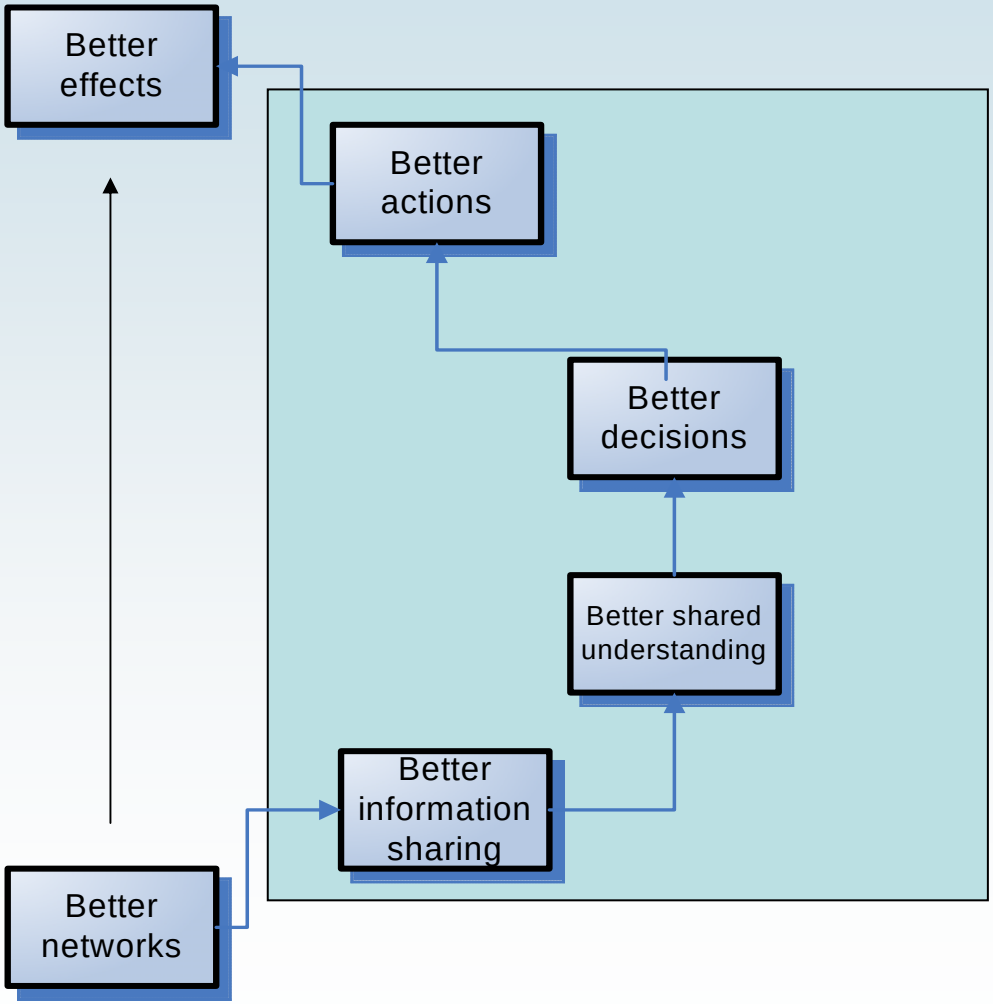
Overview

- Why a minimalist approach?
- Requirements and design considerations
- The Convoy card game
- Some preliminary experimental results
- Some conclusions

Future systems: an irony

- **Experimentation with regard to future systems generally requires those systems to exist**
  - Prototypes embody decisions and assumptions already made
  - Issues of cost and timeliness
  - Central role of human factors in NEC/NCW
    - Cognitive technologies vs. Physical technologies

NEC Benefits Chain



Sociotechnical system design

- **Task, Technology, People, Structure & Environment**
- **User-centred approaches**
  - User vs. “User”
  - New concepts can be a barrier to meaningful participation
- “**Minimal Critical Specification**” = minimal game?
  - What not How

Training and education

- **Challenge of the network paradigm**
  - “Doing things better and doing better things”
- **Dynamic nature of networks**
  - Work concept vs. specifics
- **Mental models of the network**
  - HCI literature
  - Transactive memory systems
    - Possibility of modelling real network relations
- **Experiential learning**
  - Differing perspectives
  - Tactical decision exercises
    - Networks & objectivity

Requirements 1

- The game should be portable and playable without computers.
- The game should be relatively simple and quick to play.
- The game should not require specialist domain knowledge from players but optimal outcomes should result from skilful play.
- The game should be to some extent generic and capable of being reworked for different scenarios and audiences (e.g., civilian emergency services)

Requirements 2

- Optimal play should result from co-operation, communication and the application of various C2 high-level concepts (such as shared situational awareness, promulgation of command intent, trade-offs between diversity and accuracy of shared knowledge etc.)

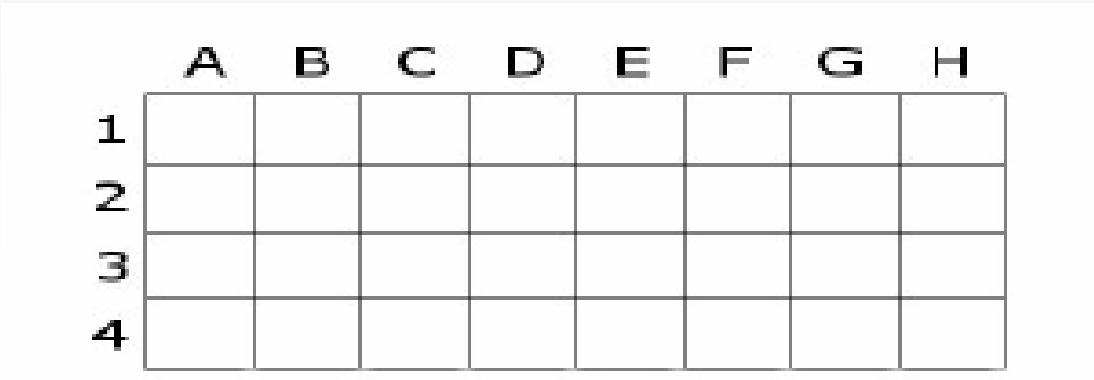
- Management of uncertainty should be present as a major factor in decision making

Scenario

- *Your force has been charged with protecting a land convoy of time-critical humanitarian aid. In [so many] turns, the convoy will have to pass through a city known to harbour enemy forces that will seek to plunder the convoy. Therefore, before the convoy reaches the city your unit has been issued the mission of seeking out a safe path through the city and neutralizing threats as necessary to reduce the risk to the convoy when it arrives. The end product of your activities will be to hand a route plan to the convoy as it enters the city depicting what you have established as the best route to take and indicating what "hotspots" remain to help the convoy's escorts plan their operations.*

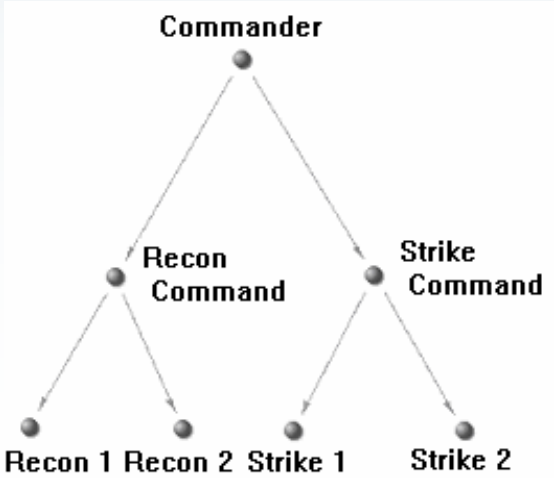
Nature of the game

- **Aim is to find the best route from one side of a 4 x 8 grid to the other**
  - Combination of avoiding problems and dealing with the problems en route that cannot be avoided
- **Each square contains “threat” points**
- **Limited number of turns**



Game roles

- **Players have different roles in a team**
  - RECCE: Can find out how many threat points are in a square.
  - STRIKE: Other players can remove threats in a square
    - Small stock of “strike” cards, so you cannot deal with everything: priorities need to be thought about.
  - COMMAND: Other players make decisions or pass on information.



Granularity of information

- **Command centre as a cognitive system**
  - Decision making
  - Memory
  - Evaluation
  - Communication (perception/action)
  - Sensemaking
- **Different roles interact with different types of information**
  - Big picture vs. detail
  - In Convoy information needs to be fused/summarised

Game mechanics

STRIKE 1 LEVEL	STRIKE 2 LEVEL	TRUMPS →	THREAT 1 LEVEL	THREAT 2 LEVEL

FROM _____ TURN #

TO _____

One choice only:

A. BLOCK _____ THREAT LEVEL _____

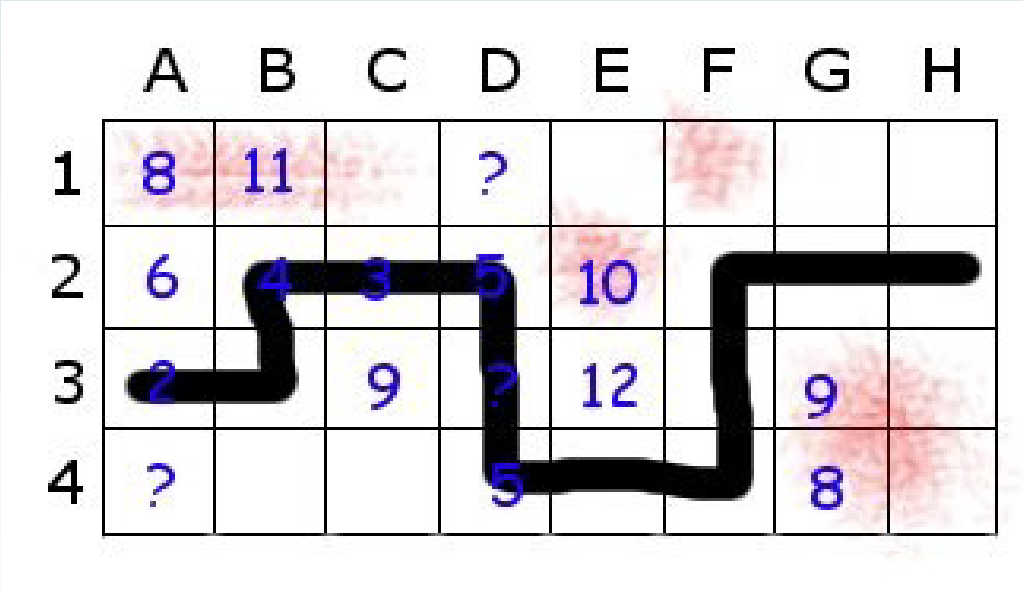
B. NO ACTION

C. TEXT MESSAGE (must fit on the line)

_____

Performance metrics

- Sitrep (every five turns)



Simple metrics / NEC concepts

- **Performance:**
  - Threat dealt with, threat remaining, threat left on final chosen path
- **Team SA**
  - Agreement between player sitreps (“sharedness”)
  - Agreement between sitreps and ground truth (“awareness”)
  - Individual and group awareness scores
- **Tempo**
  - Rate of action, threat dealt with per turn, ratio of comms events to action events.

High level concepts

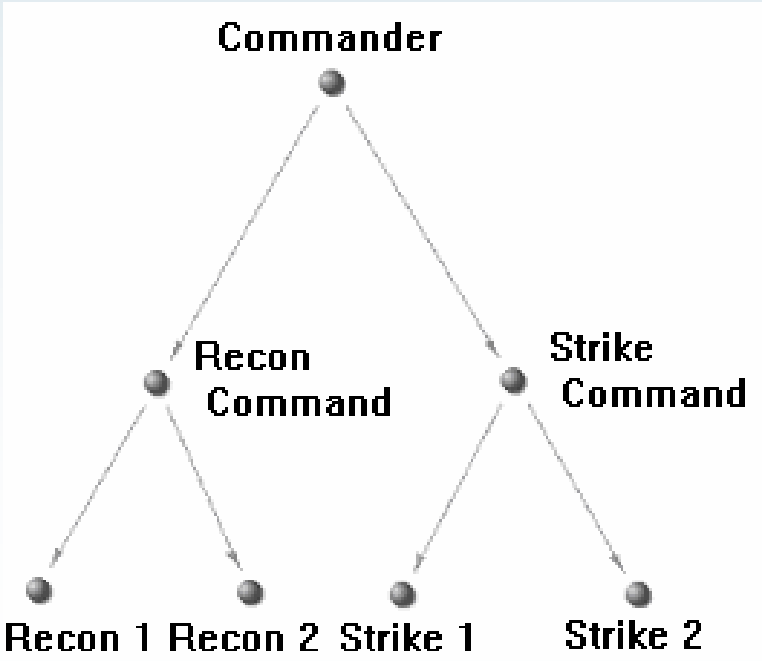
- Co-ordination of teams
- Planning / promulgation of intent
- Shared awareness
- Resource management
- Threat assessment
- Tension between MoPs and MoEs
- Tempo
- *Complexity arising from a handful of rules and constraints*

- Experimentation with new “systems” is intuitive
  - E.g., OHP as shared view

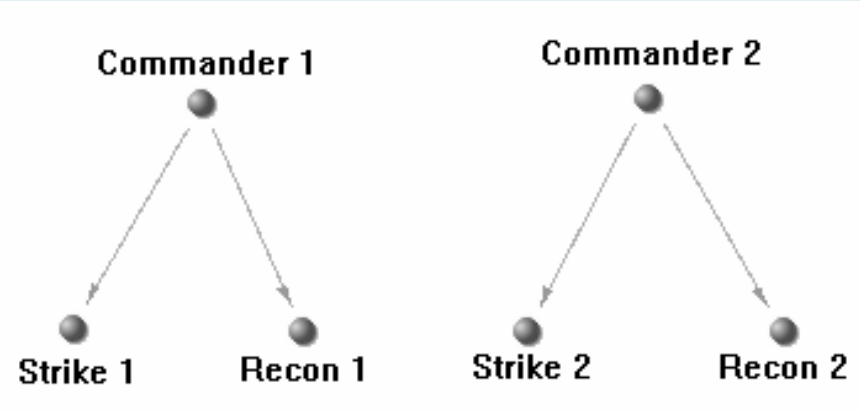
Experiment

- Contrast two simple networks
  - “Strawman” experiment

Hierarchy

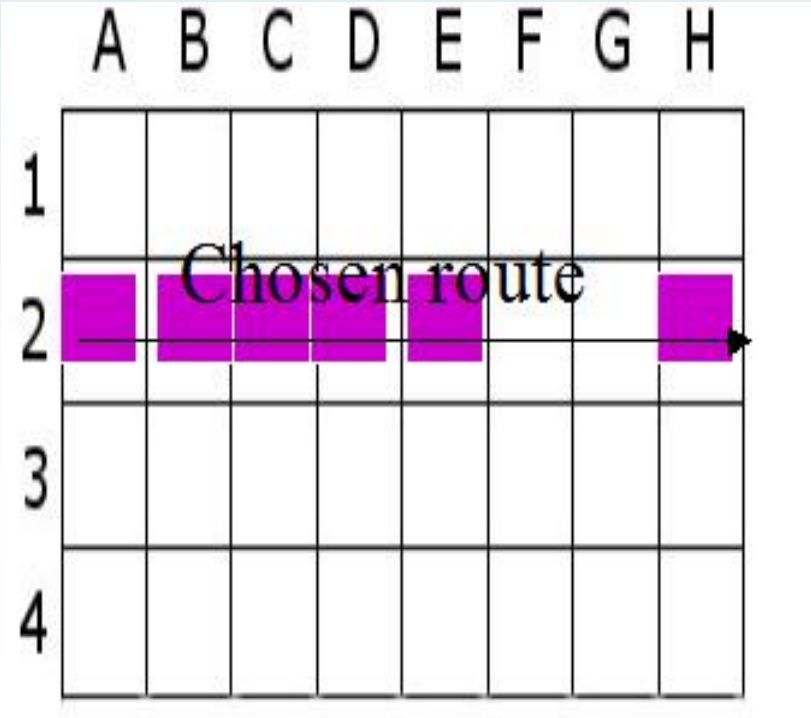


Distributed



Results (SSA & path chose)

Hierarchical



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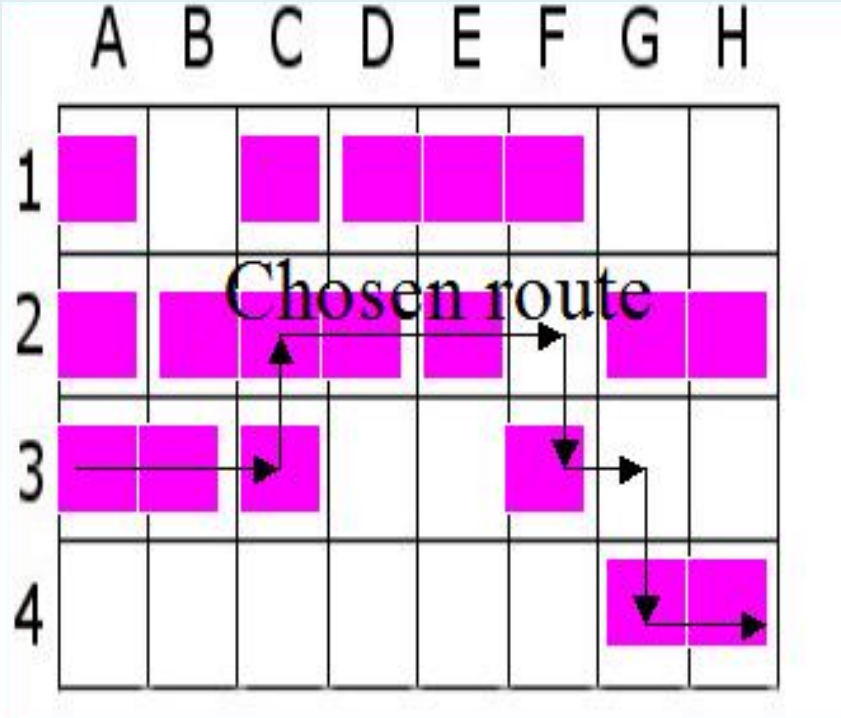

Results (other metrics)

METRICS	Hierarchy	Decentralised
Threat detected	54	84
Redundant threats	0	49
Points per turn	4	6
Agreement on route	100%	70%
Threat remaining	30	35
Commander awareness	29	0 and 11
Strike awareness	29	0 and 24
Recon awareness	33	35 and 35

Unpacking the results

- **Hierarchical**
  - Good: Highly coordinated, little waste, unanimous agreement on plan
  - Bad: Relatively slow
  - Awareness lag due to the distance between units
  - “Like an oil tanker”
- **Distributed**
  - Good: Rapid, tight awareness loops within teams
  - Bad: Uncoordinated, wasteful
  - “Like a dog chasing its own tail”
- Overall performance of both teams was similar but was caused by very different processes

Experiment conclusions

- **Different network types**
  - Engender very different team behaviours
  - Different patterns of performance
- Paradigm is sensitive enough to give sufficient context as to “why” different behaviours cause different levels of performance.
- Experience of playing stirred debate amongst players in “after-action” debriefing regarding C2 themes that they were initially unfamiliar with.
  - Discussion utilised high-level concepts by name
  - “Commanders” not necessarily the most vocal (!)

Conclusions

- **Minimal games have something to offer**
  - Discussion starters
  - Basic science, esp. human factors issues
  - Promoting inclusion in socio-technical design/user centred approaches
  - Demonstrate complexity can arise very rapidly even from very simple rules and constraints
  - Caveat: ecological validity
- All required materials are in the appendix...

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