9th International Command and Control
Research and Technology Symposium

A Conceptual Model of Organisational and Social Factors in HQ

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QinetiQ

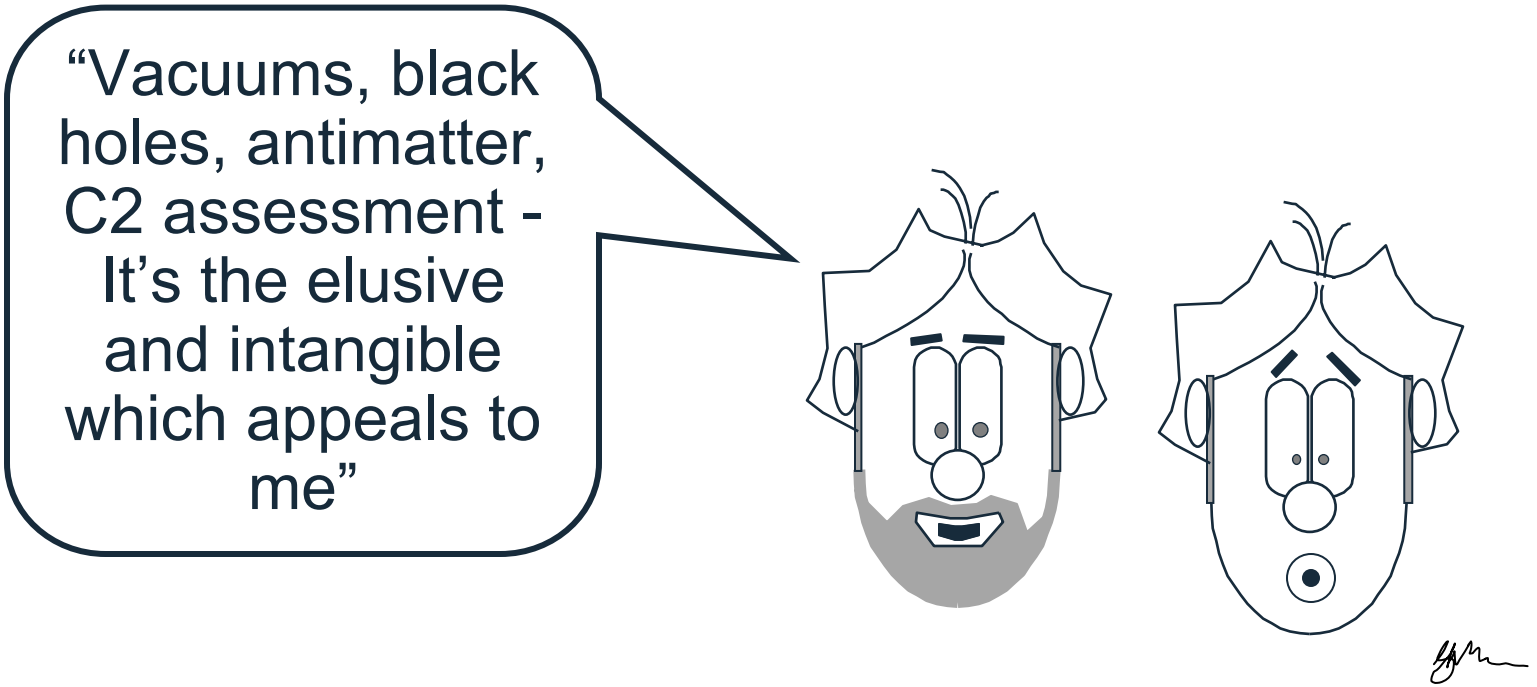
Structure of presentation

- Introduction
- Case study to illustrate issues
- Current knowledge
- Building the conceptual model
- Practical simulation methods
- Implications of success (or failure)

Introduction

- Information Age technologies enable collaboration at a distance, inviting military to adopt agile mission grouping.
- Assuming Commanders are not willing to allow total self-organisation, they will need agile HQ organisations as part of the wider development of Information Age C2.
- BUT, the HQ agility depends upon much more than shared understanding arising from information sharing
- Paper explores the implications of HQ agility from the standpoint of organisational and social science, and how the relevant issues might be handled by modelling

C2 problems tend to be complex and poorly defined



Case study to illustrate issues

- HQ reachback - Simple case with rich implications
- Three "options" for HQ reachback are considered:
  - No reachback - full HQ co-located in theatre;
  - In-theatre reachback - Core HQ forward; staff unit in rear;
  - Homeland reachback - Core HQ forward; staff unit in homeland.
- Potential benefits - smaller, more agile deployed element; staff in richly networked info environment
- Potential dis-benefits - loss of coherence and shared awareness, affecting motivation and performance

Current knowledge

- Much of the knowledge needed to understand agility in HQ's is already well established in the human sciences
- But HS disciplines not a coherent body of knowledge.
- Military OR needs to integrate disciplines like organisational theory, information theory and cognitive psychology - exploiting wide range of mature knowledge

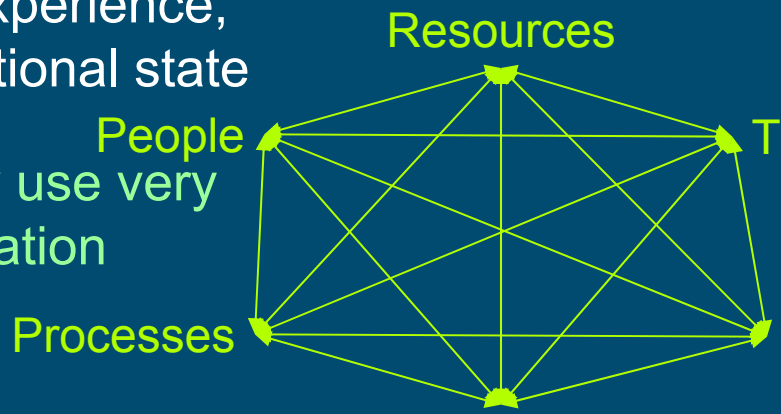
Things we know about socio-technical systems

Organisation size correlates with formality of interactions

Degraded comms system performance can lead to improved information service

People process information according to their culture, experience, expectation, emotional state

Technical system performance can critically depend upon human social phenomena



Humans naturally use very little of the information available to them

People create and use informal structures, which can be more influential than the formal ones

Even in safety-critical organisations, people do not consistently follow formal processes

It takes years to change an organisational culture without wholesale re-staffing

Structures emerge in organisations despite the intentions of the people involved

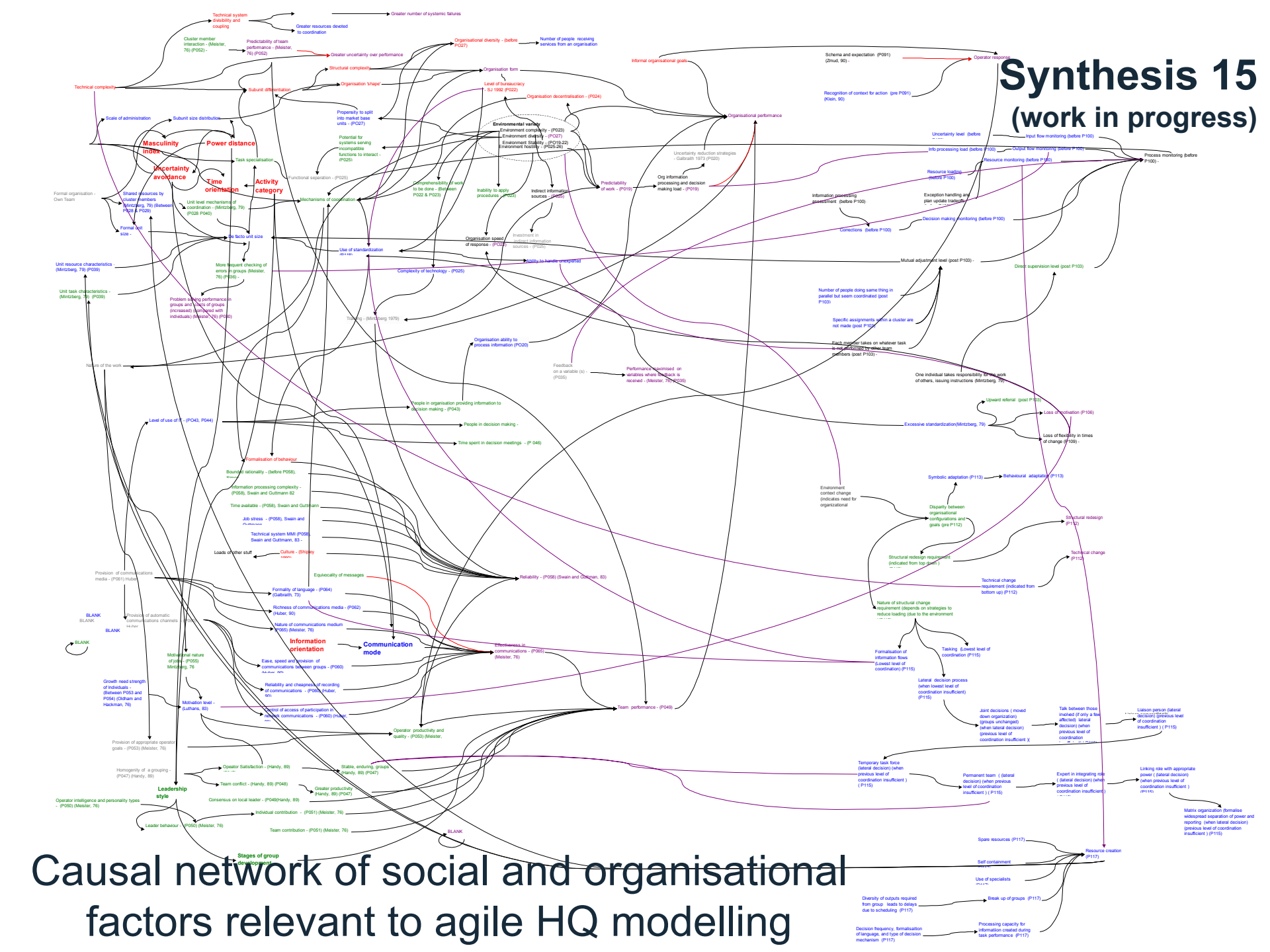
‘Reachback’ factors and impacts

FACTOR	IMPACT AREA
• Co-location	• Teamworking
• Use of computer-mediated communication	• Understanding and trust within teams and mission groups
• Leadership	• Participation and morale
• Use of information technology	• Participation in decision-making
• Formal roles and structures	• Team behaviour

KNOWLEDGE AREAS: Social network theory, Organisational science, Cognitive psychology, Teamworking research, ...

Building the conceptual model

- UK is seeking to develop a demonstration of requisite modelling of an agile HQ, which includes social, cultural and organisational variables and effects.
- Synthesis of a wide range of scientific theory is needed, covering social (including organisational) and cognitive theories and constructs, to complement conventional informational and physically-based modelling.
- Proposed architecture balances breadth and depth, as well as being sensitive to danger of too much complexity.


Synthesis 15
(work in progress)
Causal network of social and organisational factors relevant to agile HQ modelling
Technical complexity
Subunit differentiation
Scale of administration
Subunit size distribution
Masculinity index
Power distance
Uncertainty avoidance
Time orientation
Activity category
Task specialisation
Functional separation - (P025)
Mechanisms of coordination
Formal organisation - Own Team
Shared resources by cluster members (Mintzberg, 79) (Between P028 & P029)
Unit level mechanisms of coordination - (Mintzberg, 79) (P028 P040)
Formal unit size -
De facto unit size
Unit resource characteristics - (Mintzberg, 79) (P039)
Unit task characteristics - (Mintzberg, 79) (P039)
More frequent checking of errors in groups (Meister, 76) (P036) -
Problem solving performance in groups and levels of groups (increased) compared with individuals) (Meister, 76) (P036)
Nature of the work
Level of use of IT - (PO43, P044)
Formalisation of behaviour
Bounded rationality - (before P058),
Information processing complexity - (P058), Swain and Guttmann 82
Time available - (P058), Swain and Guttmann
Job stress - (P058), Swain and
Technical system MMI (P058), Swain and Guttmann, 83 -
Loads of other stuff
Culture - (Shipley
Provision of communications media - (P061) Huber
BLANK
BLANK
Provision of automatic communications channels - (P061)
Huber
BLANK
Motivational nature of jobs - (P055) Mintzberg, 76
Growth need strength of individuals - (Between P053 and P054) (Oldham and Hackman, 76)
Motivation level - (Luthans, 83)
Provision of appropriate operator goals - (P053) (Meister, 76)
Homogenity of a grouping - (P047) (Handy, 89)
Operator intelligence and personality types - (P050) (Meister, 76)
Leadership style
Leader behaviour - P050) (Meister, 76)
Stages of group development
Operator Satisfaction - (Handy, 89)
Team conflict - (Handy, 89) (P048)
Consensus on local leader - (P049)(Handy, 89)
Individual contribution - (P051) (Meister, 76)
Team contribution - (P051) (Meister, 76)
Stable, enduring groups (Handy, 89) (P047)
Greater productivity (Handy, 89) (P047)
Technical system divisibility and coupling
Greater number of systemic failures
Greater resources devoted to coordination
Cluster member interaction - (Meister, 76) (P052) -
Predictability of team performance - (Meister, 76) (P052)
Greater uncertainty over performance
Structural complexity
Organisation 'shape'
Organisational diversity - (before P027)
Number of people receiving services from an organisation
Organisation form
Level of bureaucracy - S.J 1992 (P022)
Organisation decentralisation - (P024)
Propensity to split into market base units - (PO27)
Potential for systems serving incompatible functions to interact - (P025)
Environmental variety
Environment complexity - (P023)
Environment diversity - (P027)
Environment Stability - (P019-22)
Environment hostility - (P025-26)
Comprehensibility of work to be done - (Between P022 & P023)
Inability to apply procedures - (P023)
Indirect information sources - (P020)
Predictability of work - (P019)
Organisation speed of response - (P020)
Investment in indirect information sources - (P020)
Use of standardization
Ability to handle unanticipated
Complexity of technology - (P025)
Training - (Mintzberg 1979)
Organisation ability to process information (PO20)
Feedback on a variable (s) - (P035)
Performance optimised on variables where feedback is received - (Meister, 76) (P036)
People in organisation providing information to decision making - (P043)
People in decision making -
Time spent in decision meetings - (P 046)
Reliability - (P058) (Swain and Guttman, 83)
Equivocality of messages
Formality of language - (P064) (Galbraith, 73)
Richness of communications media - (P062) (Huber, 90)
Nature of communications medium - (P065) (Meister, 76)
Information orientation
Communication mode
Effectiveness in communications - (P065) (Meister, 76)
Ease, speed and precision of communications between groups - (P060)
Reliability and cheapness of recording of communications - (P060) (Huber,
Control of access of participation in network communications - (P060) (Huber,
Team performance - (P049)
Operator productivity and quality - (P053) (Meister,
Informal organisational goals
Schema and expectation (P091) (Zmud, 90) -
Operator response
Recognition of context for action (pre P091) (Klein, 90)
Organisational performance
Uncertainty reduction strategies - Galbraith 1973 (P020)
Org information processing and decision making load - (P019)
Uncertainty level (before
Input flow monitoring (before P100)
Info processing load (before P100)
Output flow monitoring (before P100)
Resource monitoring (before P100)
Process monitoring (before P100) -
Resource loading (before P100)
Information processing assessment (before P100)
Exception handling and plan update trackers
Decision making monitoring (before P100)
Corrections (before P100)
Mutual adjustment level (post P103) -
Direct supervision level (post P103)
Number of people doing same thing in parallel but seem coordinated (post P103)
Specific assignments within a cluster are not made (post P103)
Each member takes on whatever task is not performed by other team members (post P103) -
One individual takes responsibility for the work of others, issuing instructions (Mintzberg, 79)
Upward referral (post P103)
Loss of motivation (P106)
Excessive standardization(Mintzberg, 79)
Loss of flexibility in times of change (P106) -
Environment context change (indicates need for organizational
Symbolic adaptation (P113)
Behavioural adaptation (P113)
Disparity between organisational configurations and goals (pre P112)
Structural redesign (P112)
Structural redesign requirement (indicated from top down) (
Technical change (P112)
Technical change requirement (indicated from bottom up) (P112)
Nature of structural change requirement (depends on strategies to reduce loading (due to the environment
Formalisation of information flows (Lowest level of coordination) (P115)
Tasking (Lowest level of coordination P115)
Lateral decision process (when lowest level of coordination insufficient) (P115)
Joint decisions (moved down organization) (groups unchanged) (when lateral decision) (previous level of coordination insufficient)(
Talk between those involved (if only a few affected), lateral decision) (when previous level of coordination
Liaison person (lateral decision) (previous level of coordination insufficient) (P116)
Temporary task force (lateral decision) (when previous level of coordination insufficient) (P115)
Permanent team ((lateral decision) (when previous level of coordination insufficient) (P115)
Expert in integrating role ((lateral decision) (when previous level of coordination insufficient)
Linking role with appropriate power ((lateral decision) (when previous level of coordination insufficient) (P116)
Matrix organization (formalise widespread separation of power and reporting (when lateral decision) (previous level of coordination insufficient) (P115)
Spare resources (P117)
Self containment
Use of specialists
Resource creation (P117)
Diversity of outputs required from group leads to delays due to scheduling (P117)
Break up of groups (P117)
Decision frequency, formalisation of language, and type of decision mechanism (P117)
Processing capacity for information created during task performance (P117)

Empirical evidence

- Anecdotal evidence from experienced military officers covering Op TELIC and earlier conflicts
- Human science analysis from Op TELIC Lessons Identified
- Consideration of specific case study examples covering reachback, network fires, and service provision

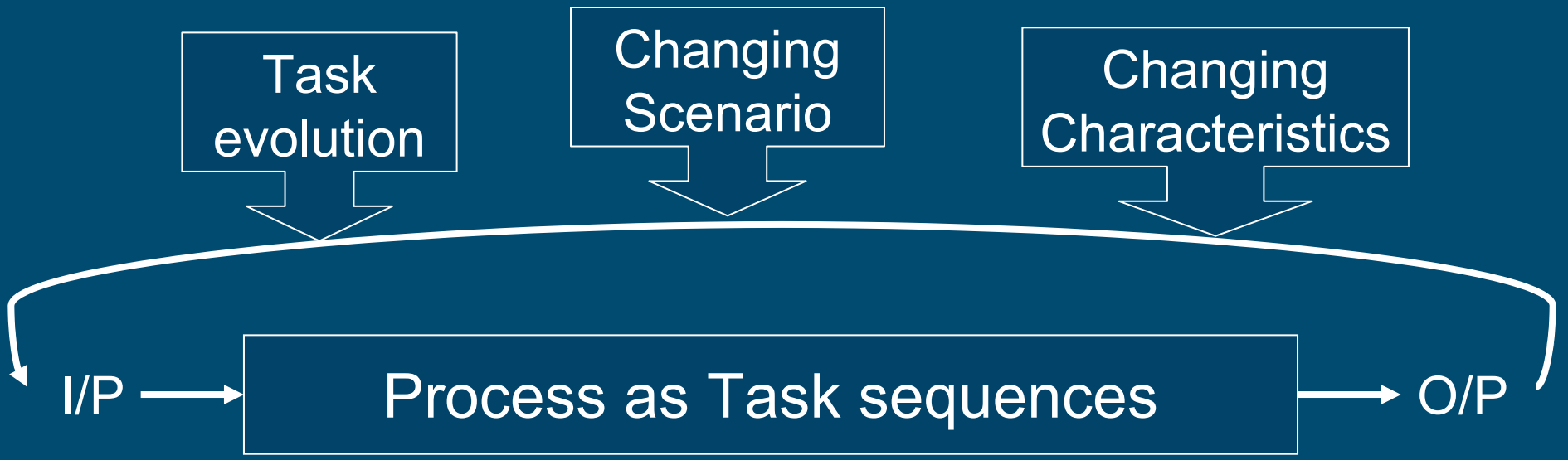
➔It is concluded from the empirical evidence that it is important to include the full breadth of factors identified in the theoretical work, despite the resulting scale and complexity of the HQ conceptual model that this implies

➔This is a challenge – 'best' advice from academe is to narrow the focus to a few nodes and links, which is unacceptable to OR

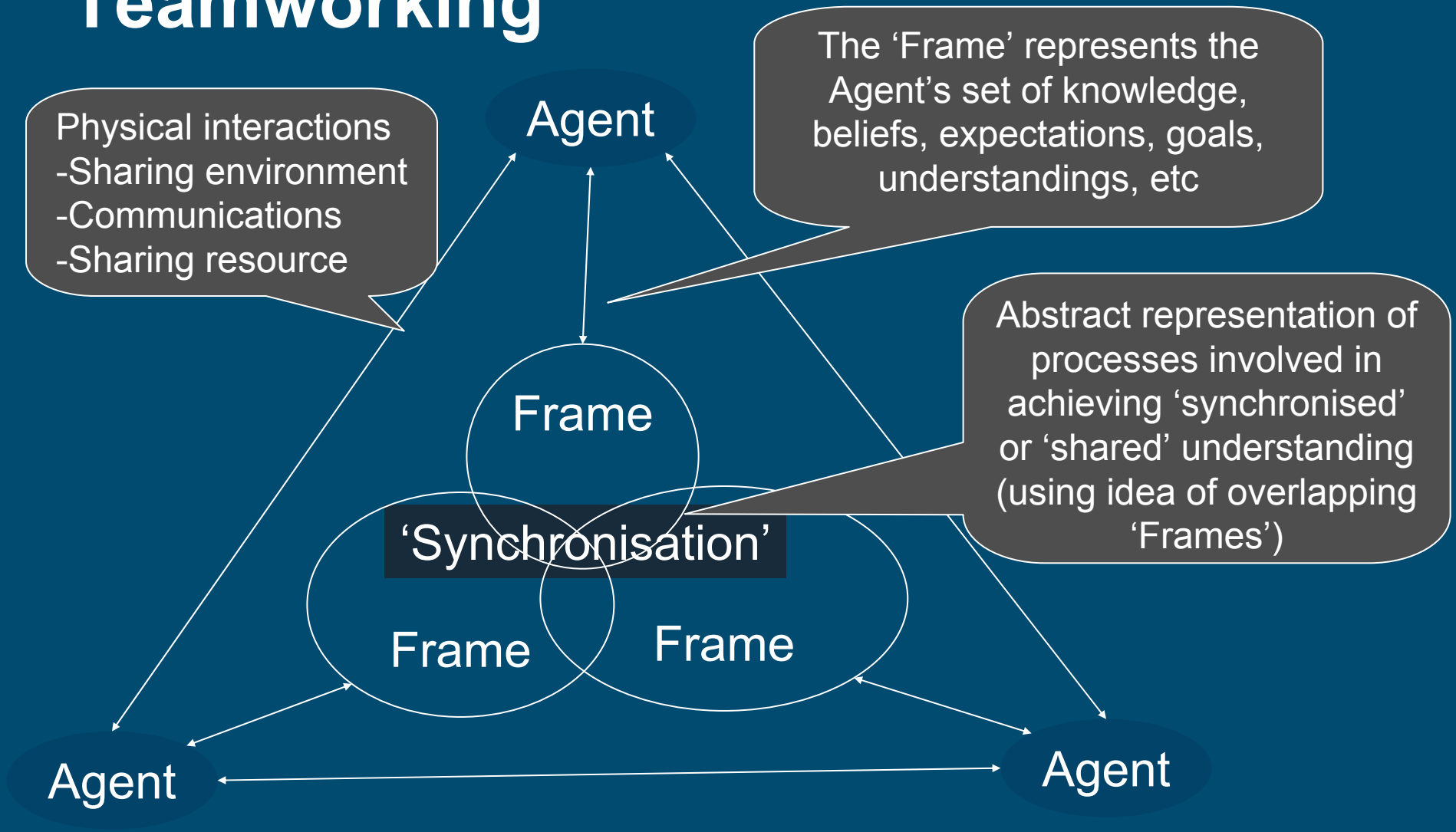
The emerging simulation design...

- To provide a vehicle for representing the breadth of variables identified in the theoretical work, any simulation will need to allow for variables associated with:
  - Taskwork (including process variability)
  - Interpersonal differences (physical, cognitive and social)
  - Teamwork
  - Organising (including formal and informal structures)
  - Socialising (probably needs to be fairly abstract representation)
- This could, of course, be covered in a federation of simulations, but they need to be integrated not separate

Taskwork (the 'production' process)



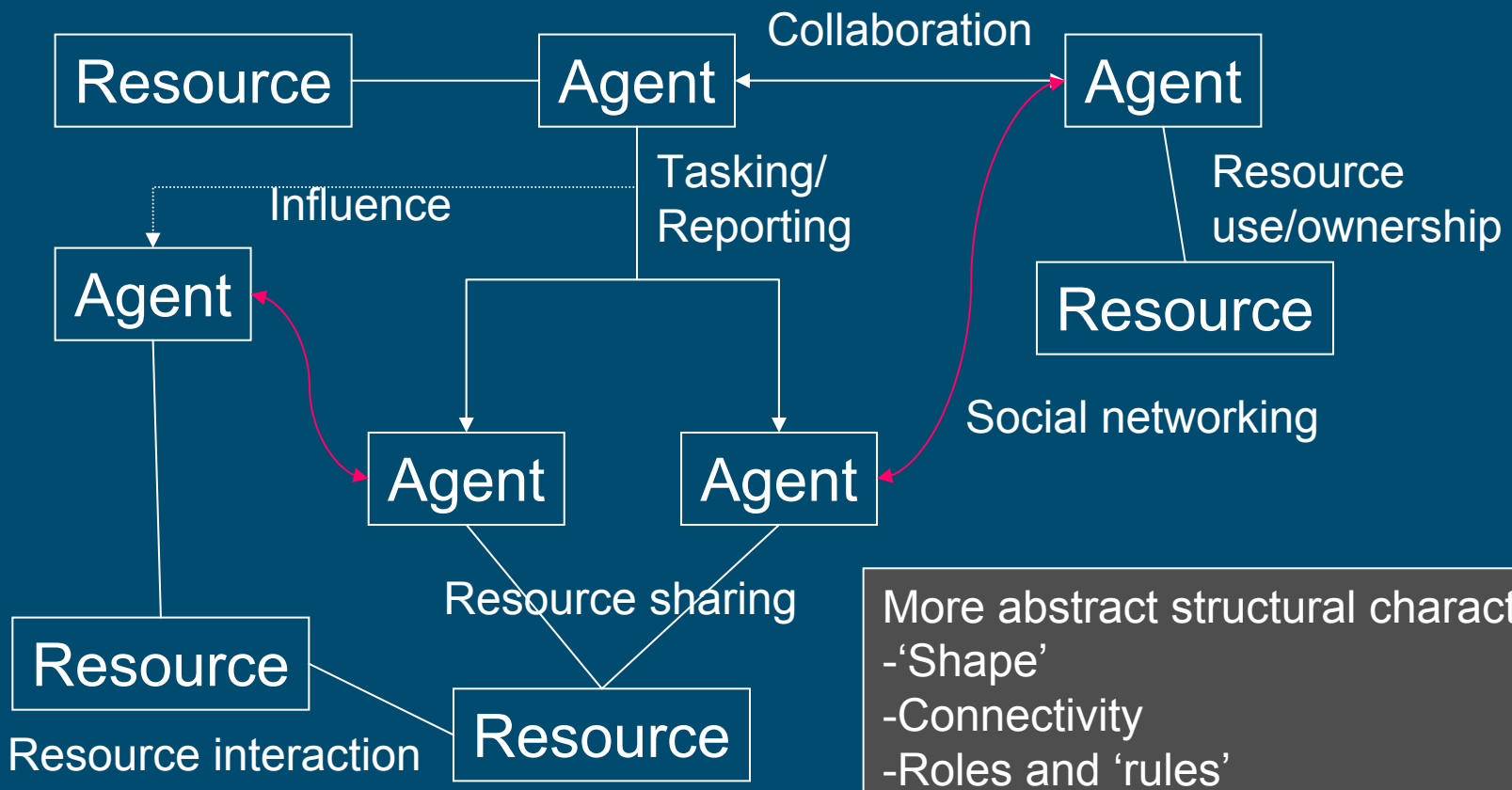
Teamworking



Team knowledge categories (Noble)

Knowledge Enabler	Definition
Goal understanding	Knowing what the customer wants
Understanding of roles, tasks, and schedule	Knowing who's supposed to do what and when, and with what information and resources.
Understanding of relationships and dependencies	Knowing how entities, events, and tasks impact the plan.
Understanding others	Knowing what other team members' backgrounds, capabilities, and preferences are.
Understanding of team "business rules	Having and knowing effective and agreed upon rules for team members interacting with each other.
Task skills	Knowing how to do one's assigned work.
Activity awareness	Knowing what others are doing now and current need for doing it.
Understanding of the external situation	Knowing status of people (including client), things, and events of the world outside of the team and projecting future changes.
Current task assessment	Keeping tasks on track, knowing how well own and other's tasks are progressing, and when to offer help.
Mutual understanding	Knowing what other team members understand now and knowing if they agree or disagree.
Plan assessment	Predicting whether the plan will still enable the team to achieve its goals.
Understanding of decision drivers	Judging and applying the criteria for selecting an action.

Structure view



More abstract structural characteristics
-'Shape'
-Connectivity
-Roles and 'rules'
-…

Emerging meta-model

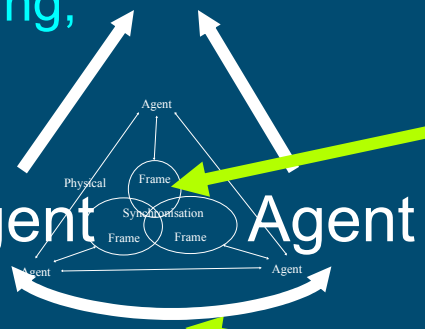
HQ Process as Task transition network

Team knowledge determines whether team is forming, storming, norming, or performing

'Working together'

Teamwork/Taskwork 'balance' affects task performance/efficiency

Task 'team'



Gross Social processes influencing knowledge in agent and team Frames

'Being together'

Teamworking processes influencing knowledge in agent and team Frames

Gross Structure processes influencing agent relationships and links to/between resources

Practical simulation methods... (WIP)

HQ

Finite state transition model
Process modelling

ork

Team knowledge determines whether team is forming, storming, norming, or performing

Working together'

Teamwork/Taskwork 'balance' affects task performance/efficiency

Task 'team'

Agent modelling
Knowledge state

Gross Social processes

Social network model
Mathematical modelling

'Being together'

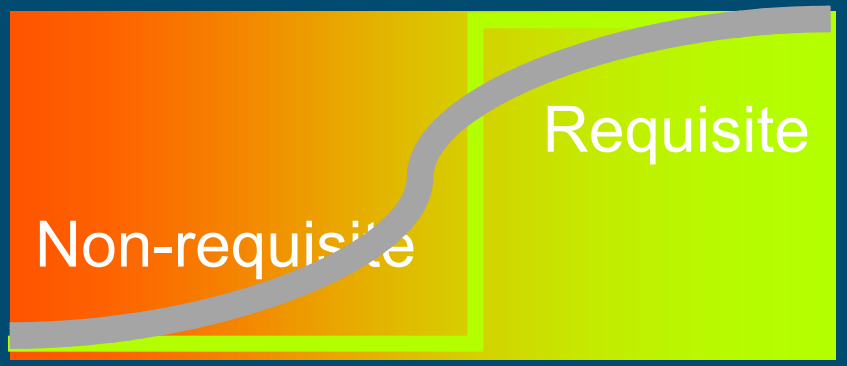
Teamworking processes influencing knowledge in agent and team Frames

and links to/between resources

Consequences of success (or failure)

- Success
  - Coherent, integrated analysis to support NEC/NCO decisions
  - Holistic treatment of critical human and organisational issues
  - Effective balance of investment across Lines of Development
- Failure
  - More unreliable cost-effectiveness assessments
  - Limited ability of OR to handle capability-based assessment
  - Need for a more risk-taking, experimental approach to capability acquisition and support to operations, with less use of models

Some definitions and declarations



- Models are abstract representations
  - descriptive/explanatory
  - conceptual/practical
- Requisite *(adj) made necessary by particular circumstances* (Concise Oxford)
- Requisite model is minimum that is fit for purpose
- Requisite model:
  - Contains all critical factors which may determine the study conclusions (e.g. factors significantly affecting option rank ordering)
  - Can be defined in relation to an isolatable sub-problem (i.e. one in which a sub-set of factors are not too dependent on others)
- Non-requisite, by implication, means not fit for purpose
  - Using non-requisite models carries risks. When is the risk too high?

Levels in Operational Analysis

- Level 1: Policy and Capability Studies
  - Campaign effectiveness, whole force, strategic planning and BoI
  - Resolving C2 effects across the whole network
- Level 2: System Studies 
  - Mission effectiveness, multi-system/platform, capability planning and COEIA support
  - Resolving processes and components within C2 systems
- Level 3: Acquisition Support Studies
  - System effectiveness, usually single system/platform project
  - Resolving C2 technologies and system design options