Australian Government
Department of Defence
Defence Science and
Technology Organisation

Network Centric Warfare and the New Command & Control: *An Australian Perspective*

Celina Pascoe
Irena Ali
Defence Science and Technology Organisation
Australian Department of Defence

This paper is based on data collected by the Human Dimension Concepts Team in DSTO. The authors would like to acknowledge the input of members of that team Derek Bopping, Dennis Hart, and Leoni Warne

The NCW literature[1] tells us that:

Information technology is creating a new C2 that will improve speed of response

speedier information-gathering cycles

more actionable knowledge

speedier decision-making cycles

1 For instance, Alberts, Garstka & Stein 1999; Alberts, Garstka & Hayes 2001; Albert & Hayes 2003; Department of Defense 2001; 2005

What does this mean?

NCW transforms information into combat power (i.e. brings power to the edge) with:

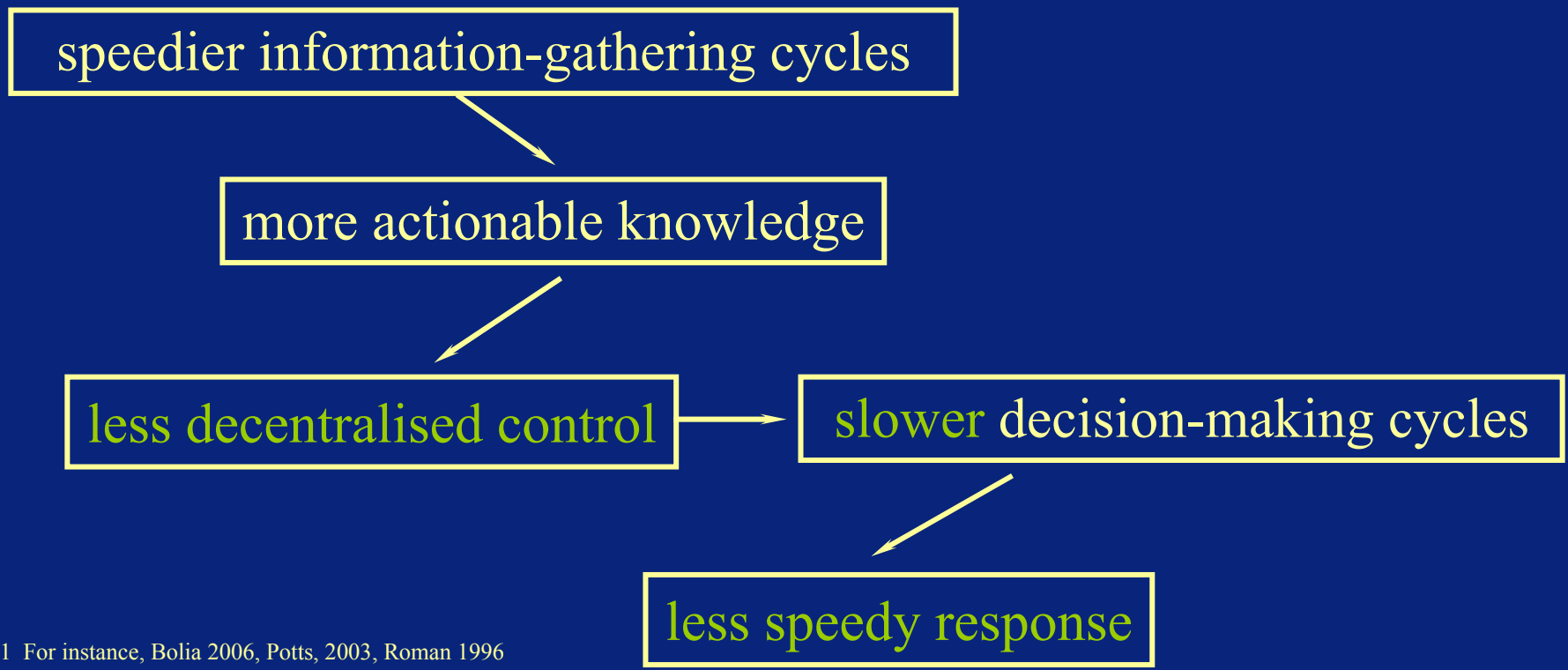
- Information & Communication Technology (ICTs)
- Devolved authority

C2 is a driving factor in this transformation

Provides the authority by which speedier responses are effected
Provides the unifying concept of commander's intent

(Enabling Future Warfighting, 2004, para 2.9, page 2-4)

But some[1] argue that NCW tends to attract greater decentralised control



1 For instance, Bolia 2006, Potts, 2003, Roman 1996

What does the evidence say:

- Are ICTs facilitating speedier information-gathering cycles and providing more actionable knowledge?

- Is authority being devolved and is this enabling speedier decision-making cycles?

Australian Government
Department of Defence
Defence Science and
Technology Organisation

What does the evidence say:
Data collection and analysis

Semi-structured interviews used to collect data:

- 99 Australian Defence Force personnel
- across all ranks and services
- served in the Middle East during 2004-5

NVivo used to code and analyse interview data for predominent and emergent themes on various issues including C2

Data collected as part of DSTO's ***Human Dimensions of Future Warfighting*** (HDoFW) Task. Data analysed as part of this task, and also as part of DSTO's *C2 Experimentation* Task in support of Headquarters Joint Operational Command (HQJOC)

Information & Communication Technologies

Improving access to information for decision-making

…a lot of meetings on board…videoconferencing, collaborative tools…opening up the opportunity for more people to be involved in the planning…but [already] more than enough people putting their oar in

These days…email or the sat phone straight away [if a problem comes your way]…so information is…more instant [but] hopefully the right information…because it's a double-edged sword…your decisions have got to be right and more timely…you can't think of things too much

Information & Communication Technologies

Maintaining clarity of intent

…now email is acceptable as an authority…And next thing you know, chat will be too. Except,… is that the admiral on the other end typing it or is it Seaman Bloggs? At least an email comes from the admiral's account…

…could have six or seven chat windows all up at the same time…potential to be overrun by the number of chats…

…at times, difficult to know if I was being ordered to do something or if it was just general conversation…it was resolved by going back to them and saying "Is this an order? Do you want me to do this?"

Devolution of Authority

Personality-based

I went through two different bosses and two different sets of ways of doing it. [With] my first boss…as long as I gave a technical reason and explained it to him, he would say, "No worries, ----, go for it." Largely he left me to run my section. The second boss was not quite so like that.

…and so I began to get emails and direct phone calls at 4 in the morning…Gulf time, from my commander…it made me start second-guessing my decision-making processes.

Devolution of Authority

Lack of resources and experience

…had to try and do a lot on the ground with what they had…would be putting in requests…some of which couldn't be [satisfied]…So a lot of authority was pushed down…to relatively junior folks…

What authority do we have to make stuff that we've never been trained in… We're in war contingencies here and a lot of rules can be broken, that's why we sort of just needed the authority…What role am I playing here? Am I just one of them or can I actually have a role as a higher ranking type person as well?

Inherent conflict between taking power to the edge and maximising coordination/maintaining clarity of intent?

Effective devolution of authority requires strong command *with* autonomy

Pretty much a lot of flexibility…the captain was really good. He had a good understanding of how the [----] worked... A lot of the plans that we brought up to him, he would say "Oh, by the way…this might work a little bit better"…so we would amend them and by the end the flexibility was really good…I was let reign and…you get that level of trust that you could form that bond with command as long as you're doing the right thing.

Inherent conflict between taking power to the edge and maximising coordination/maintaining clarity of intent?

Maintaining integrity of information as it passes through the human communication chain…

…bring reinforcements we're going to advance…

…bring three and four pence, we're going to a dance…

ICTs and devolution of authority are ***necessary, but insufficient***, requirements for power at the edge

Effectively taking power to the edge requires ***awareness of the strong likelihood*** of misinterpretation

An additiononal impediment

Communication between parties from culturally different backgrounds is more prone to misinterpretation

…the same word can mean something completely different

…these responses came right down the chain, and it was vital to take care that the wrong interpretation or a local interpretation of the rules of engagement didn't lead to something escalating beyond the point of which it should have

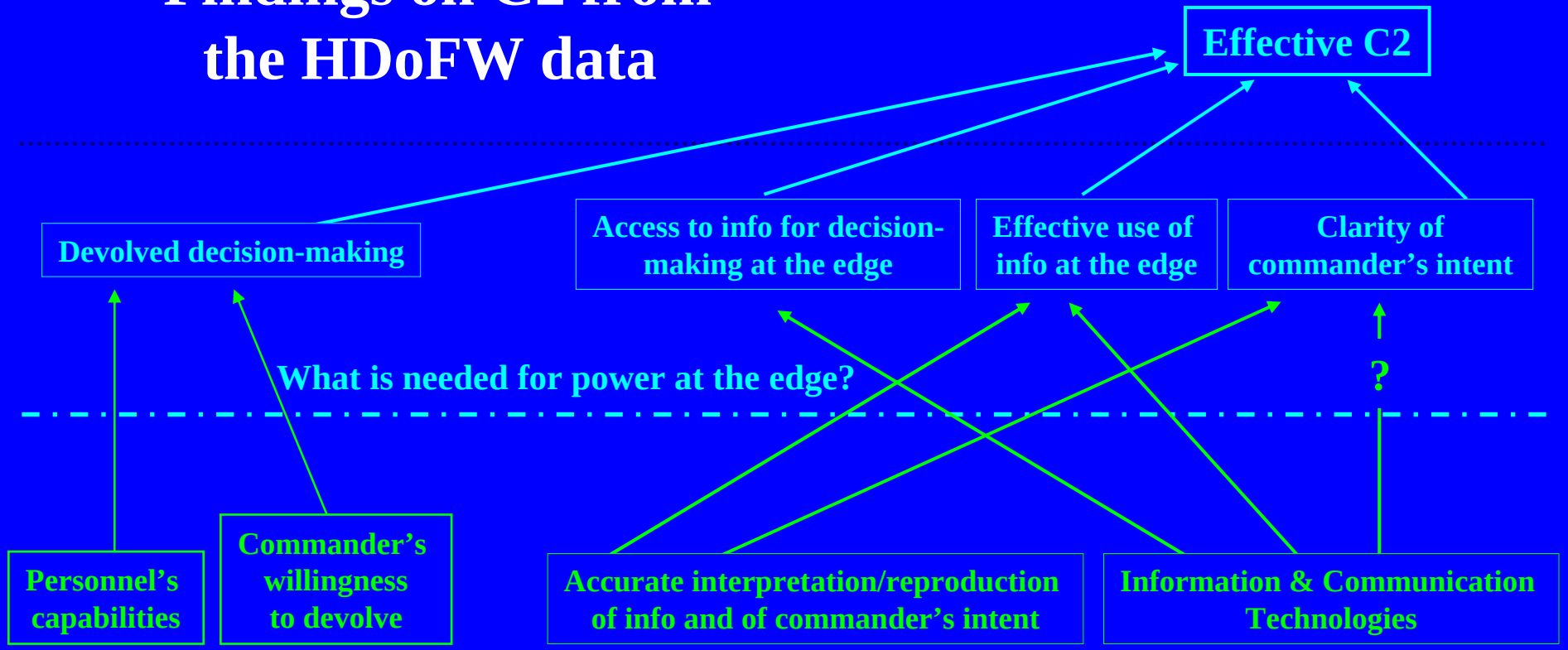
Slippage is *the norm* as a message moves from one communication partner to the next

The longer and more complex the C2 line, the greater the opportunities for minor distortions

and

the greater may be the ***sum*** *of* those distortions

Findings on C2 from the HDoFW data



Findings from HDoFW → possible future research

Some of the implications for experience and training?

- Strong perceptual skills (including tolerance for ambiguity & uncertainty; awareness of the existence of multiple realities)
- Understanding of the Human Information Processing System and its limitations
- Addressing slippage

Future research indicated by the HDoFW study

1. How do differences in C2 philosophy between coalition parties, both military and non-military, influence the achievement of power at the edge and shortened C2 lines?

2. To what extent might informal networks hinder the shortening of C2 lines because they create larger numbers of channels?

3. To what extent might ICTs enable too much information and input into various processes and thereby reduce the efficiency and effectiveness of these processes?

4. To what extent might ambiguity and misinterpretation increase when communication parties have culturally different backgrounds, and does this reduce effectiveness and efficiency of coalition forces, overall?

Australian Government
Department of Defence
Defence Science and Technology Organisation

MEAO Interview Program 2003-2007

Sample

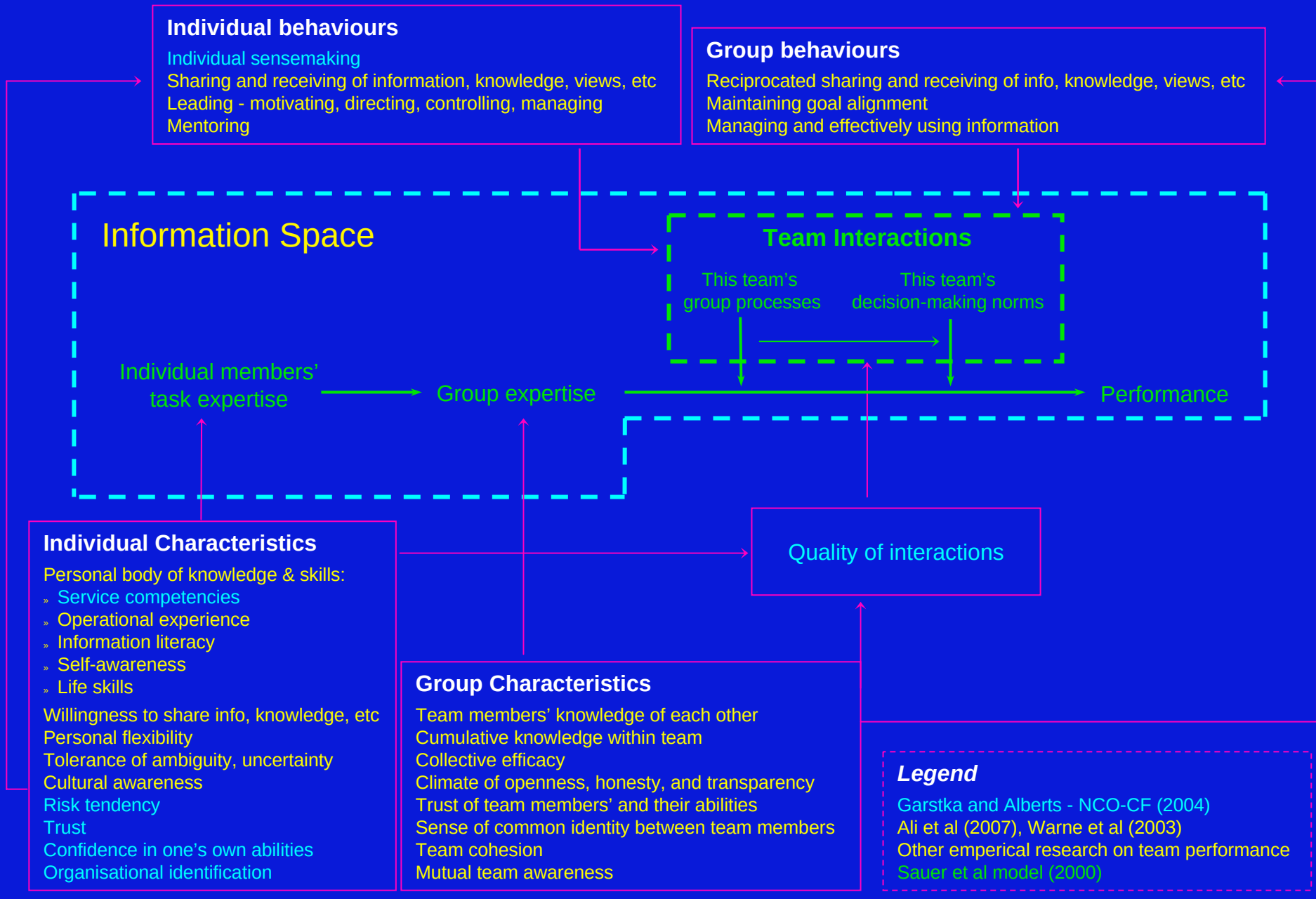
- **130 personnel returned from Middle East**
- **Stratified across ranks, Services, gender**

Interview Focus areas

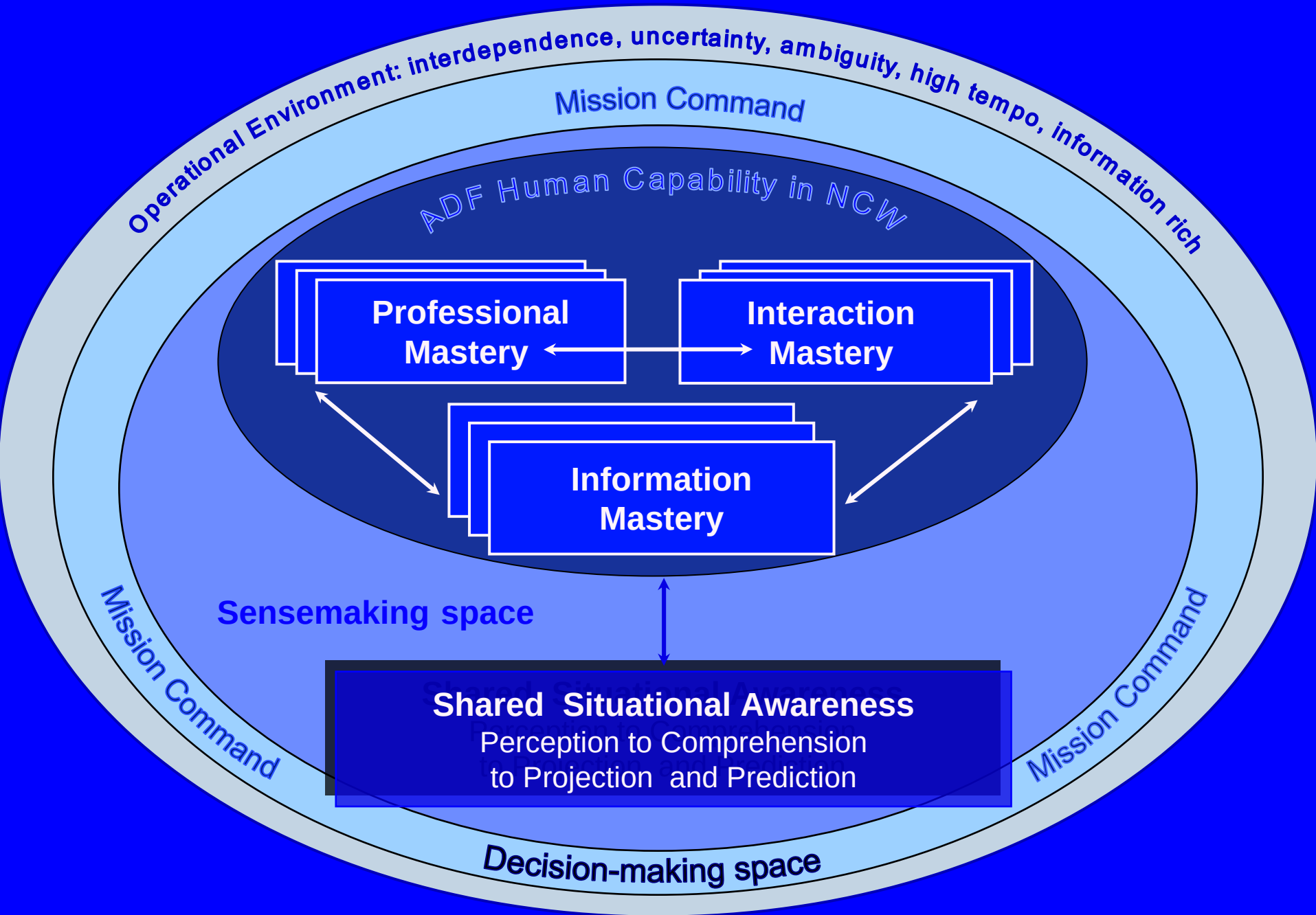
- **Pre-deployment preparation & training**
- **Duties whilst deployed**
- **Decision-making processes**
- **C2 arrangements**
- **Interdependence**
- **Information gathering**
- **Information sharing**
- **Communication flows**
- **Skills and competencies**
- **Lessons learned**

The Human Dimension Model of NCW

(Pascoe, Warne, and Ali, forthcoming, p.20)



Human Dimension Model of NCW



As an Instrument...

EVALUATION TOOL FOR GENERIC HUMAN DIMENSION REQUIREMENTS FOR NETWORK CENTRIC WARFARE

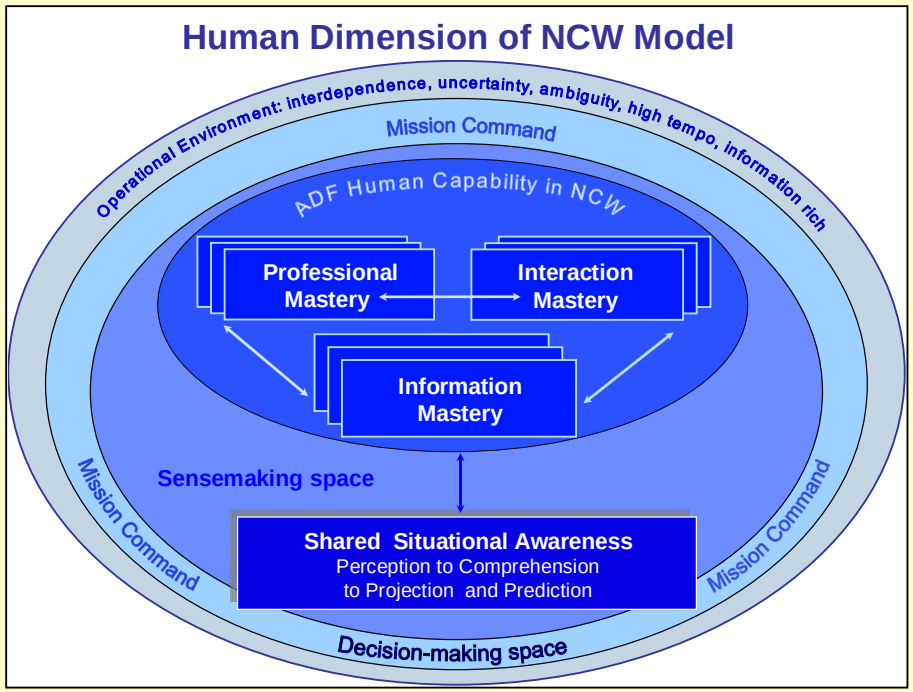


Table of Contents

1 Instructions for Use of Evaluation Tool >>
2 Evaluation Tool >>
3 Audit Trail of the Research Leading to the Development of the Evaluation Tool >>
4 Top Level of the Research Model (Graphic) >>
5 The Full Model (Graphic) - Graphical Representation >>
6 The Full Model (Table) - Definitions of the Elements, Sub-components, Measures and Sources >>

Purpose of Evaluation:

HD Elements	Specific Requirements	Link to further details about this attribute	Priority Low Medium High Not Relevant	Sample Measures Available (click Yes)
Information Mastery Expertise in efficiently acquiring the appropriate information for the task at hand, via electronic, non-electronic, human and non-human sources, and using it to achieve the desired goals	Obtaining information (inlcudes the ability to group information for other groups)	⏩		
	Ability to sort large amounts of information and redirect accordingly (including filtering of information)	⏩		
	Ability to determine the relevance of received information	⏩		
	Ability to establish the reliability of information	⏩		
	Ability to use information to assess the situation	⏩		
	Ability to share information appropriately	⏩		
	Willingness to share information appropriately	⏩		
Interaction Mastery Expertise in efficiently and ethically interacting with military, non-military personnel and civilians in order to achieve the desired goals	Adaptability - ability to rapidly change course of action	⏩		Yes
	Social awareness (ability to sense, understand and react appropriately to others)	8		Yes
	Cultural awareness (includes cultural sensitivity of services/coalition members,/host nation/CIMIC/other agencies and cultural knowledge of host nation)	8		
	Joint service awareness (knowledge of changeability of partners enables rapid change a course of action)			
	Coalition and CIMIC awareness (knowledge of changeability of partners enables rapid change a course of action)			
	Relationship management (the ability to inspire, influence and develop others and manage conflict)	8		Yes
	Goal alignment	8		Yes
Interpersonal capacities	Ability of team members to work together (team cohesion)	⏩		Yes
Team (shared) awareness	Knowledge of fellow team members' skills	⏩		Yes
	Team's shared belief in its ability to achieve the desired outcome	⏩		Yes
Trust	Individual's trust of team as a whole	⏩		Yes
	Individual's trust of another team member's competency	⏩		Yes
	Individual's trust of another team member (i.e. that team members will not act against one anotherÕs interests)	⏩		Yes
Leadership	Willingness to mentor (behaviours that support team members' skill development)	8		Yes
	Maintenance of shared vision	8		Yes
	Willingness to delegate command / authority	⏩		
	Effectiveness in communicating commander's intent	⏩		
Open and honest team climate	Open communication	8		Yes
	Transparent decision-making	8		Yes
	Opportunity to input into decisions as appropriate	8		Yes
Professional Mastery Ability to execute actions in a range of circumstances, have the self confidence to act autonomously, and understand the purpose and consequences of one's actions	Self awareness (understanding one's internal states, preferences, resources)	8		Yes
	Self management (understanding one's internal states, preferences, resources)	⏩		Yes
	Confidence in one's own abilities	⏩		Yes
	Tolerance of ambiguity and change	⏩		Yes
Intra-personal capacities	Ability to adapt to rapidly changing circumstances	⏩		Yes
NCW Service-specific competencies	Effectiveness of Specific Training on NCW	⏩		
	Effectiveness of Exercises in preparing for NCW	⏩		
	Sufficiency of National Exchange programs	⏩		
Individual sensemaking	Individual awareness of the situation	⏩		Yes
	Individual interpretation of the situation	⏩		Yes
	Decision-making ability	⏩		Yes
Achieving and maintaining situational awareness	Perceiving Skills (acquiring the available data / facts)	⏩		
	Comprehending Skills (understanding the facts in relation to oneÕs expert knowledge of such situations)	⏩		
	Projecting Skills (envisioning how the situation is likely to develop in the future)	⏩		
	Predicting Skills (evaluation of how outside forces may act upon the situation to affect your projections)	⏩		

Elements and Attributes	Return to Eval'n Tool ==>	Definition of/Intended use for Attributes	Components of Attributes	Possible measures/Means of evaluation
Goal alignment		Commitment to the team's goals and values	Extent to which individuals' identities align with organisational identities	From Garstka & Alberts (i.e. the NCO-CF) 2004: Sum of individuals team members' organisation identities 1= individual only, . . 5= identifies primarily with team / organization (NCO-CF)
Team adaptability/flexibility		Process by which team members change their behaviour and relationship with other team members according to the changes in the environment or the team (p.43). This comprises the following three components (p.44): Monitoring - oneself and other team members for deficient taskwork and teamwork behaviours Correcting - team members provide feedback to each other to improve performance Backing up - team members with compensatory behaviours	Essens et al 2005 (i.e. the NATO CTEF model) describes the three components of team adaptability/flexibility as: Team members observing and assessing their own and each other's performance Team members offering feedback/ guidance to improve their team mates' performance Team members supporting one another with compensatory behaviours (e.g., assuming duties, offering coaching, feedback, or assistance)	From Essens et al 2005 (i.e. the NATO CTEF model): Assessment of team-focussed behaviours: N.A. 1= very low, 2= low, 3= moderate, 4= high, 5= very high Impact on team effectiveness: -2= very negative, -1= negative, 0= none, 1= positive, 2= very positive
			Group Behaviours	
Reciprocated sharing and receiving of information, knowledge, views, opinions, etc.		This includes openness to receiving as well as sharing of information, knowledge, views and opinions		Taken from the Knowledge Scan (Van den Hooff & de Ridder 2004). Assess group sharing by aggregating individual assessments of sharing: a. Whenever I learn something new I make sure that my colleagues in my department will learn it too b. It is normal in our department to share knowledge c. I share information that I have with others in my department d. I share my expertise with others within my department e. Colleagues in my department share what they know when I ask f. Colleagues in my department share their expertise when I ask g. When I have learned something new I make sure that colleagues outside my department can learn it too h. I share information that I have with colleagues outside my department. I share my expertise with others outside my department i. Colleagues outside my department share what they know when I ask k. Colleagues outside my department share their expertise when I ask 1= strongly agree .., 7= strongly disagree

Australian Defence Forces (2004). *Enabling Future Warfighting: Network Centric Warfare - Australian Defence Doctrine Publication (ADDP) D.3.1*. Canberra, ACT, Defence Publishing Service

Ali, I., Bopping, D., Hart, D., Pascoe, C., and Warne, L. (2007). *The Transition from Network-Centric Warfare to Networker-Centric Warfare: Outcomes of the Human Dimension of Future Warfighting Task* (Restricted Access) DSTO Report CR-2007-0311, Defence Systems Analysis Division, Defence Science and Technology Organisation, Department of Defence, Edinburgh, S.A.

Alberts, D. S. and R. E. Hayes (2003). *Command and Control in the Information Age*. Information Age Transformation Series, CCRP Publication Series, Washington

Alberts, D. and Garstka, J. (2004). *Network Centric Operations Conceptual Framework Version 2,* Evidence Based Research, Inc. Vienna. VA

Bolia, R. S. (2006). Review of Power to the Edge: Command and Control in the Information Age by David S Alberts and Richard E Hayes. Command and Control Research Program Publications in *Air & Space Power Journal*, Summer 2006

Crecine, John P and Michael D. Salomone (1989). "Organization Theory and C3" in *Science of Command and Control: Part II,* Stuart E. Johnson and Alexander H. Levis, eds. (Fairfax, Va.: Armed Forces Communications Electronics Association International Press)

Department of Defense (2005) *The Implementation of Network-Centric Warfare*. Office of Force Transmission, Washington, DC

Department of Defense (2001) *Network Centric Warfare Department of Defense Report to Congress*, Network Centric Warfare Department, Washington, DC http://www.dodccrp.org/NCW/NCW_report/report/ncw_cover.html

Essens, P., Vogelaar, Ad., Mylle, J., Blendell, C., Paris, C., Halpin, S., Baranski, J., (2005). *Military Command Team Effectiveness: Model and Instrument for Assessment and Improvement*. NATO RTO Technical Report, Soesterverg, the Netherlands

Pascoe, C., Warne, L., Ali, I. (forthcoming). The Human Dimension of NCW Model: synthesis of Empirical Findings - CDE 07/0051 Human Dimensions of NCW task report.

Potts, David (2003). *The Big Issue: Command and Combat in the Information Age.* Information Age Transformation Series, CCRP Publication Series, Washington.

Roman, Gregory A (1996). *The Command or Control Dilemma: When Technology and Organizational Orientation Collide*. Research Paper presented to Air Force 2025, Department of Defense, Washington

Salas, E., Dickinson, T. L., Converse, S. A., & Tannenbaum, S. I. (1992). "Toward an understanding of team performance and training". In R.W. Swezey & E. Salas (Eds.), *Teams: Their training and performance* (pp. 3-29). Norwood, NJ: Ablex.

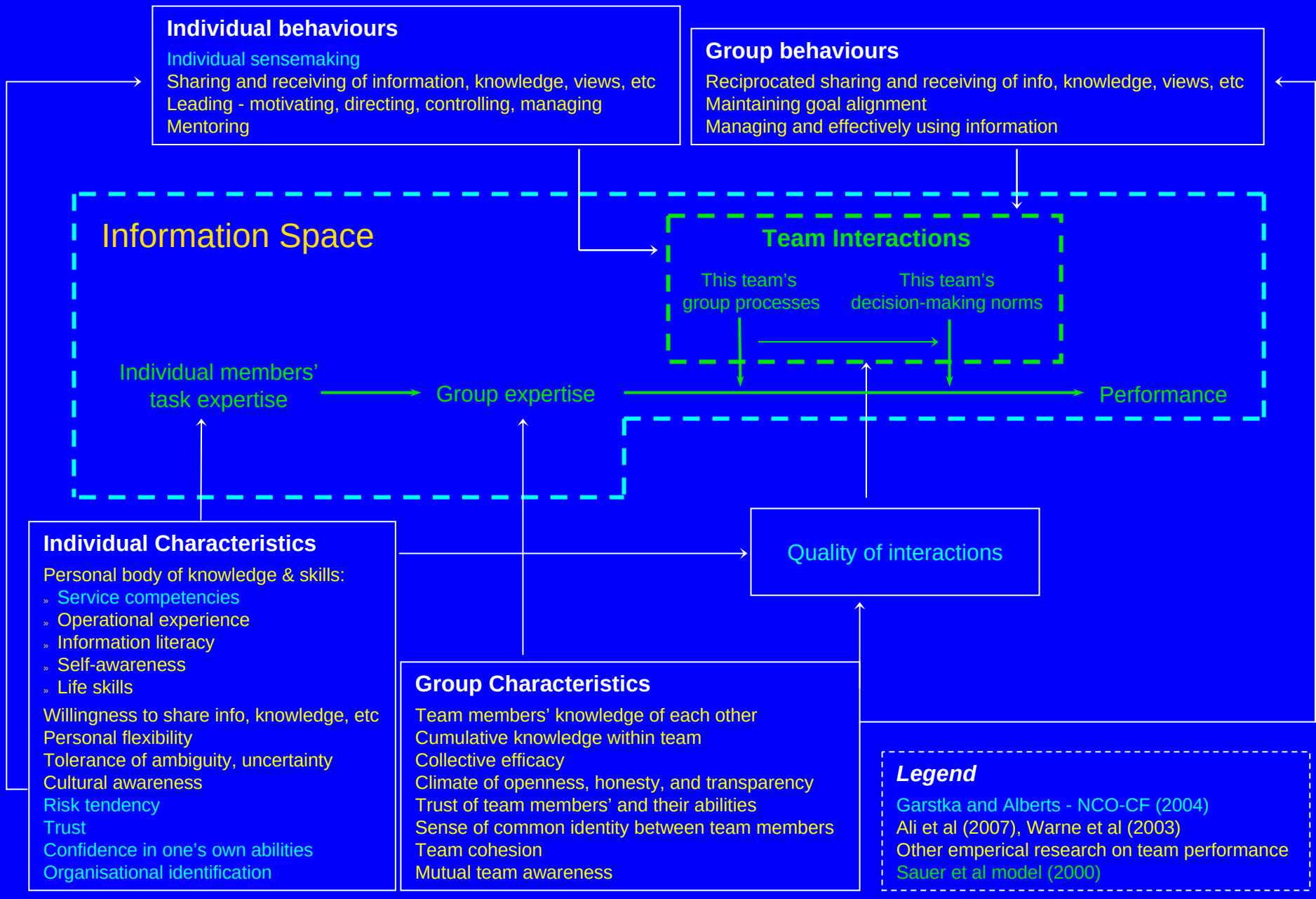
Sauer, C., Jeffery, R., Lau, L. & Yetton, P., (2000). "A Behaviourally Motivated Programme for Empirical Research into Software Development Technical Reviews", *IEEE Transactions on Software Engineering*, 26, 1, (p. 1-14). January.

Shanahan, C., Best, C., Finch, M., Sutton, C., (2006). *Measurement of the Behavioural, Cognitive, and Motivational Factors Underlying Team Performance*. DSTO Technical Report, Edinburgh, South Australia

Warne, L., Ali, I., Pascoe, C., (2003). *Social Learning and Knowledge Management – A journey through the Australian Defence Organisation: final report of Enterprise Social Learning Architectures Task*, DSTO RR 0257

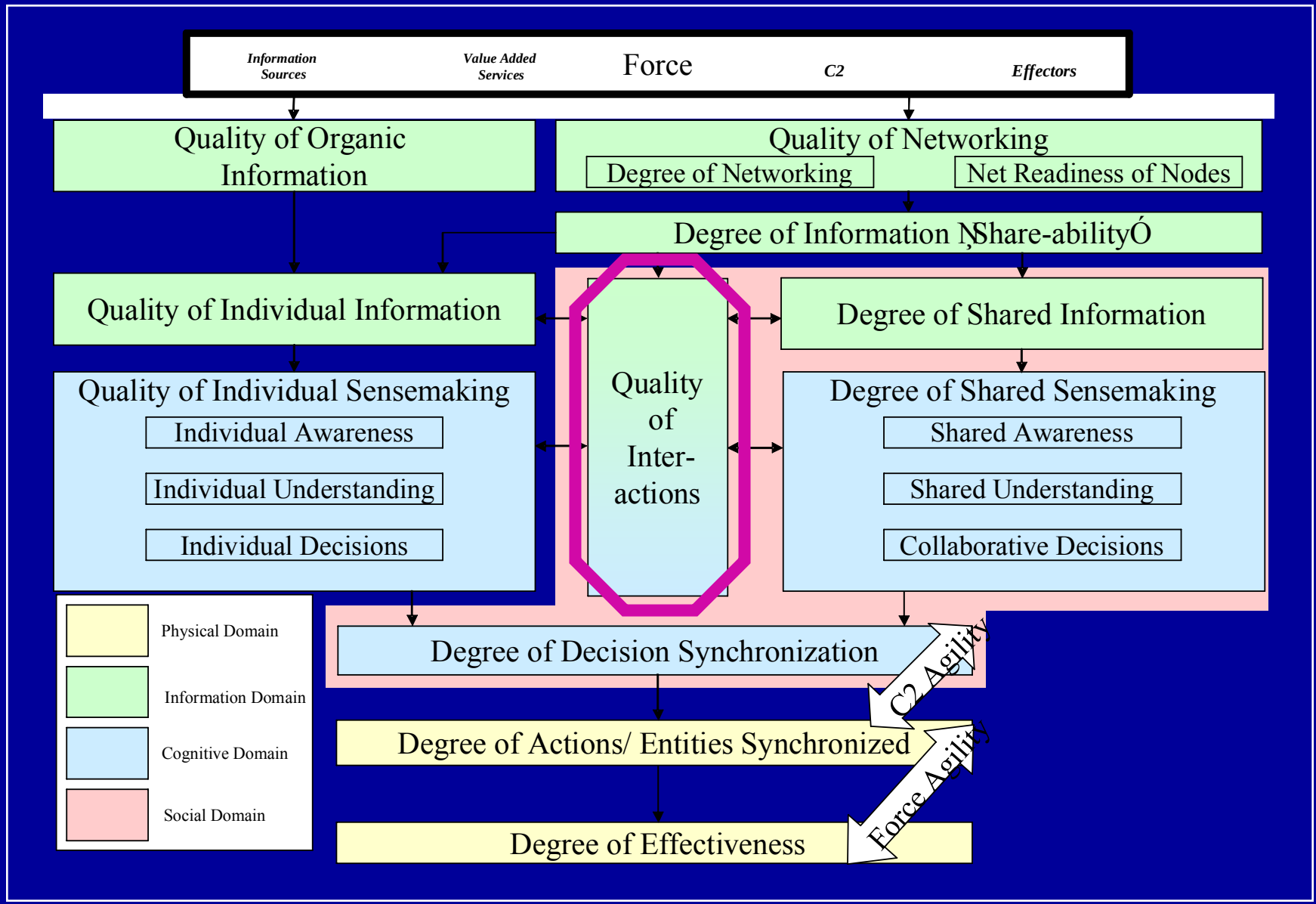
The Human Dimension Model of NCW

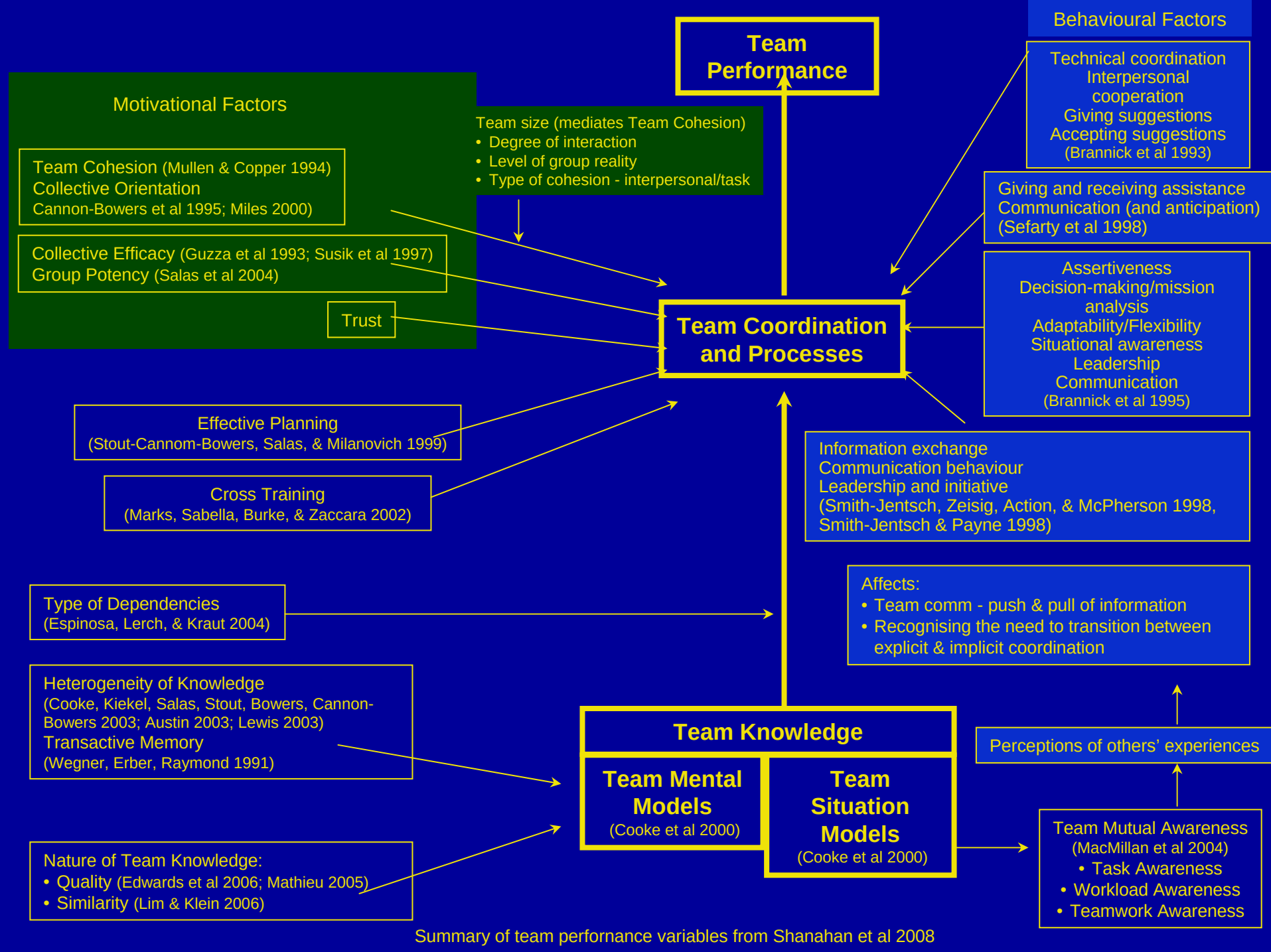
(Pascoe, Warne, and Ali, forthcoming, p.20)



The Network Centric Operations Conceptual Framework

(Garstka & Alberts, 2004, p4)



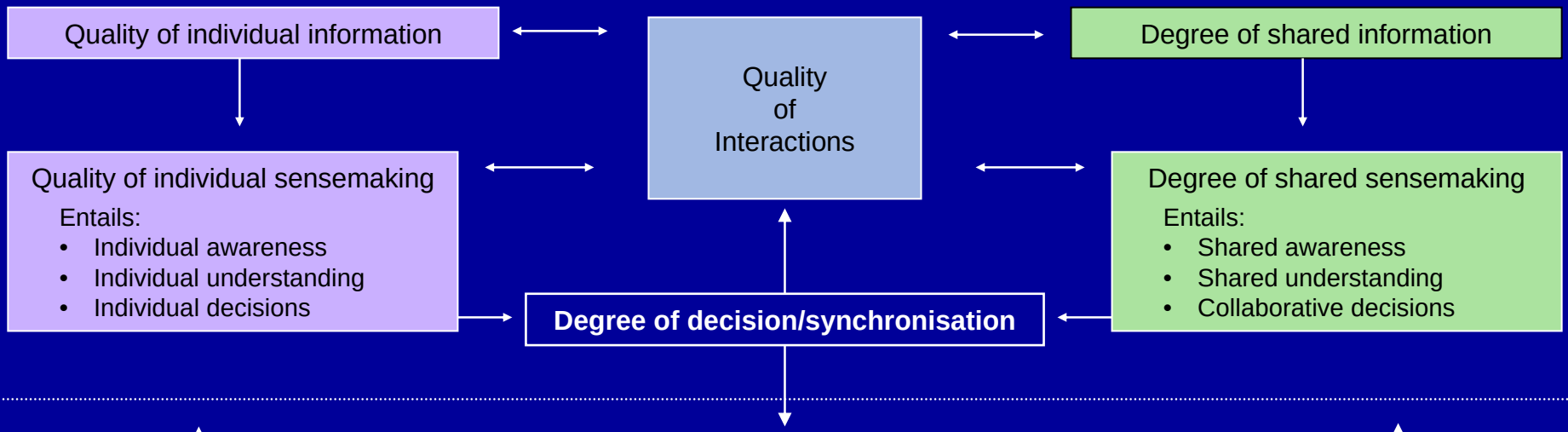


Summary of team performance variables from Shanahan et al 2008

Commander Task Effectiveness Model (Essens et al 2005)

Elements of the NCO-CF relevant to the Human Dimension

(taken from Garstka and Alberts 2004)



Team cohesion
Common identity
Morale
Collective efficacy / Knowledge of & confidence in other team members' capabilities
Mutual trust / Trust
Collective orientation / Mutual respect`
Mutual team awareness
Adapting to change
Maintenance of accurate shared vision
Goal alignment

Personal knowledge & skills / Operational experience

Personal agility & flexibility
Tolerance of ambiguity
Tolerance of uncertainty

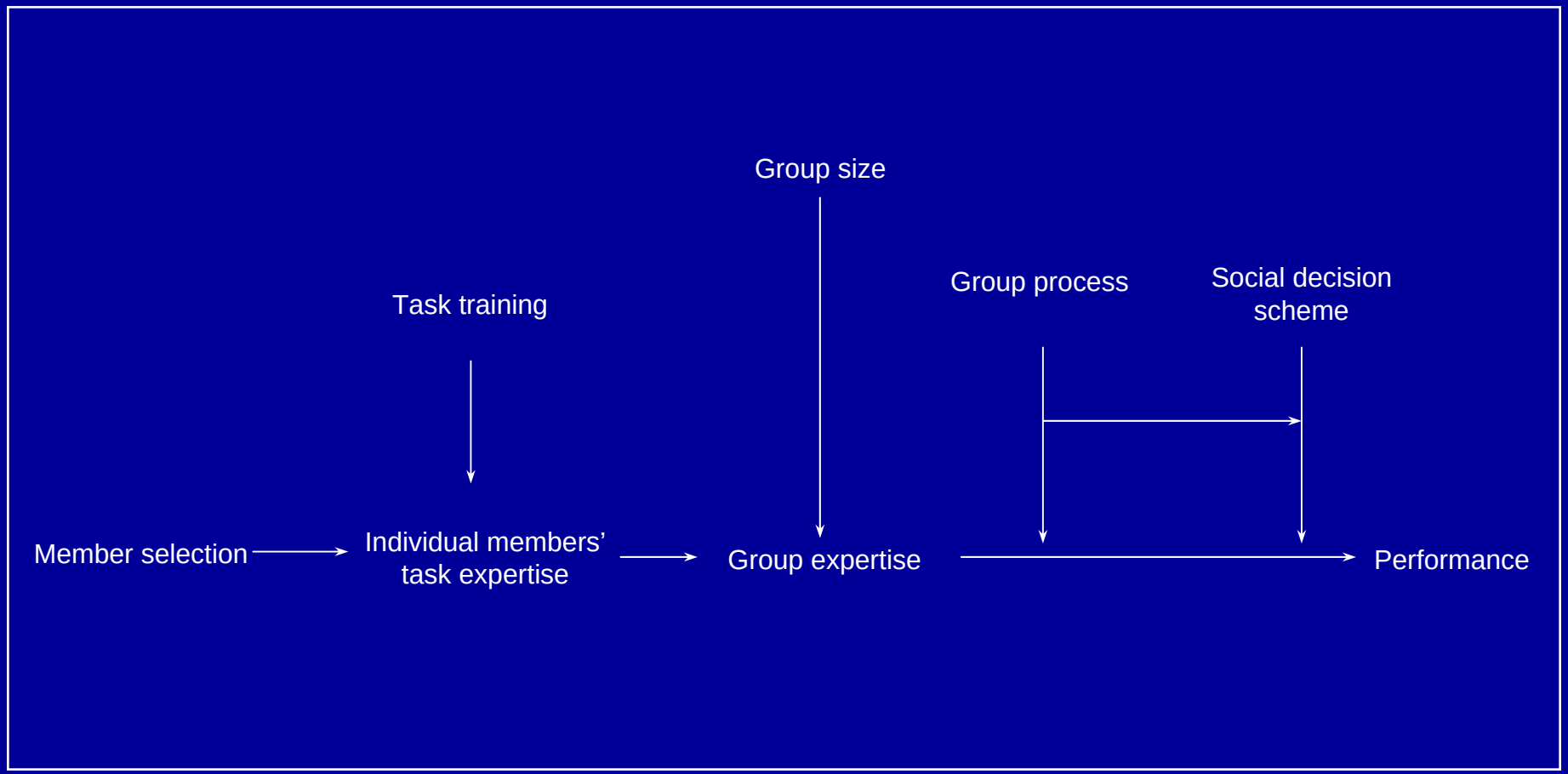
Effective interaction with other teams / Networking
Productive information processing and use
Nature of team knowledge and skills

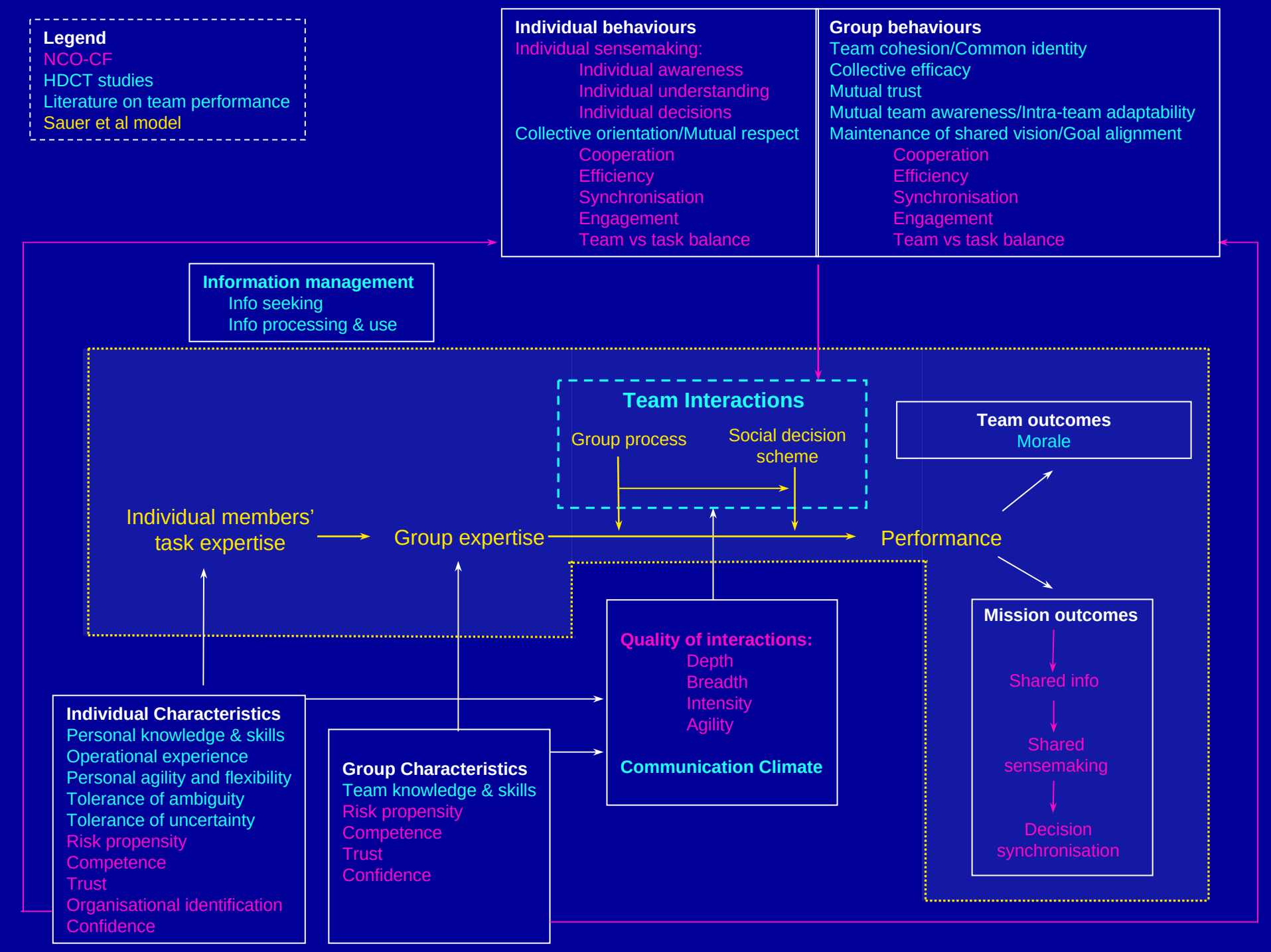
The Human Dimensions of Network Centric Warfare

(adopted from Ali et al 2005, Essens et al 2005, Shanahan et al 2008, Warne et al 2003)

Summary of behavioural theory of group performance

(Sauer, Jeffery, Lau, and Yetton, 2000, p11)




Legend
NCO-CF
HDCT studies
Literature on team performance
Sauer et al model
Individual behaviours
Individual sensemaking:
Individual awareness
Individual understanding
Individual decisions
Collective orientation/Mutual respect
Cooperation
Efficiency
Synchronisation
Engagement
Team vs task balance
Group behaviours
Team cohesion/Common identity
Collective efficacy
Mutual trust
Mutual team awareness/Intra-team adaptability
Maintenance of shared vision/Goal alignment
Cooperation
Efficiency
Synchronisation
Engagement
Team vs task balance
Information management
Info seeking
Info processing & use
Team Interactions
Group process
Social decision scheme
Team outcomes
Morale
Individual members' task expertise
Group expertise
Performance
Quality of interactions:
Depth
Breadth
Intensity
Agility
Communication Climate
Mission outcomes
Shared info
Shared sensemaking
Decision synchronisation
Individual Characteristics
Personal knowledge & skills
Operational experience
Personal agility and flexibility
Tolerance of ambiguity
Tolerance of uncertainty
Risk propensity
Competence
Trust
Organisational identification
Confidence
Group Characteristics
Team knowledge & skills
Risk propensity
Competence
Trust
Confidence