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NETWORKED ENABLED CAPABILITY AND KNOWLEDGE MANAGEMENT:

A MARRIAGE MADE IN HEAVEN?

By /par Maj/capc J A L Vosper BSc (Hons) R SIGNALS

TABLE OF CONTENTS

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ABSTRACT

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10a. Abstract.

The paper details investigation of Networked Enabled Capability (NEC), the United Kingdom's version of Network Centric Warfare (NCW), and its relationship with the field of Knowledge Management. NEC offers huge potential, but still has many issues to address. Many of these issues are not well understood. The paper argues that the core component of NEC, the network is in fact a Knowledge Management System and therefore many of NEC's issues can find solutions in existing KM theory and lessons learnt.

KM Practioners have realised that human factors are the key to the successful implementation of KM systems. Technology is an important supporting enabler, but not the key in itself. The paper explores this theme in the context of NEC, which is often thought of wrongly as a technology led concept, highlighting many human factors en route.

The paper concludes that despite some serious issues, the enormous potential of NEC means the UK MOD should continue to develop the concept. The UK MOD most however address NEC's theoretical, conceptual and developmental issues, from a strong human perspective if it is to truly succeed in delivering the capability it desires. Many of these required solutions can be adopted directly from KM best practice.

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INTRODUCTION

For five millennia war was simple. You got close enough to look your enemy in the eye and then if you had the courage, you tried to kill him. Weapons technology slowly evolved as man moved from the stone age into the bronze, iron and steel ages. Through out this slow evolution the fundamental human dynamic remained unchanged; killing another human being is a fundamentally unnatural and therefore a difficult act. War has therefore always been a highly emotive and challenging endeavor. Frequently battles involved more posturing, bravado and shouting of abuse than fighting. When battle was ultimately engaged the strongest, most skillful and often least drunk tended to survive. In the last millennia technology started to have a more significant effect, slowly at first, but with horrifyingly destructive consequences as the 20th century closed. As the 21st century starts, the industrial revolution is over and information is leading us into the 3rd wave of the Revolution in Military of Affairs (RMA). Technology appears to be on an ever faster spiral of capability evolution. This capability is ever more precise and ever more lethal. The current iteration of the spiral is arguably that of the Networked Enabled era. As technology has whisked us ever faster through the last fifty years, and made killing more remote, physically and emotionally easier, we have started to lose site of the human nature of war. Conversely, at the same time western society in particular, has become highly casualty aware. We are no longer happy to sacrifice our sons if the cause is not of the most vital national importance. Conversely, much of the third world is still living in the agrarian 1st era of the RMA, where life is cheap and little appears to have changed since the barbarism of the Dark Ages.

The Network Centric concept therefore offers a powerful western panacea: the ability to strike an enemy cleanly and efficiently, with almost virtual anonymity. Increasingly soldiers are being replaced with machines, thus potentially avoiding the blood price of war. Taken to its extreme, driven by technology, surely we could find ourselves in H.G Wells's *War of the Worlds?* Somehow we struggle to accept this vision of the future, yet does history not show us that almost all science fiction is actually a vision of future reality? For millennia man dreamed of being able to fly. In 1903, two brothers converted imagination into reality. In 1960 the ability to travel to the moon existed only in comic books, yet in 1969 man set foot on the moon and by 2020 affordable travel to the moon on commercial spacecraft is likely to be possible. Man, the ever resourceful primate, has only ever been constrained by the availability of technology to match his imagination. If man can imagine it, one day he will find a way to achieve it.

We stand close to the precipice, where technology may finally remove western man from the horror of war. Some how, perhaps due to some final taboo or incredulity over 'war without humans,' we seem unable to envisage reaching this very possible interpretation of the future. In reality, where we stand now, in the Network Centric era is very close to this vision of the future. Surveillance and armed robots were used in the caves of Afghanistan and also more recently in Iraq. In 2004 Honda demonstrated it latest ASIMO robot capable of human interaction and movement. If we fail to embrace the future, we will fail to ask the moral, ethical and practical questions essential to guiding this final push of technology. If we do not ask the questions we risk forgetting the human nature of war; that war is ultimately a battle of human wills and that it has

grave human consequences. If we let technology lead alone, we may easily take the wrong path. The more imaginative amongst us may ask are we at risk of ending-up in the popular science fiction, post-apocalyptical world, where machines have risen in ascendancy over humans? Man is inherently greedy and destructive. Man is driven to war. Man is proving to be a poor planetary caretaker. What logic would a computer see in us ruling the world? This may be a flight of fancy too far for many, but all military officers are invited to open the minds to the possibilities of every situation. This is the essence of manoeuvrism, the core of our culture.

In the Network Centric era we stand so close to the future we must explore the possibilities, understand the issues and address them. If we do not technology may well seduce us and we will forget that people are our most valuable resource. We may forget that on the battlefield the better trained and motivated soldier will usually triumph regardless of technological advantages or disadvantages. Man is as resourceful as he is imaginative. Ultimately technological advantages are always relatively short lived as they will be leveled or overcome.

The Network Centric concept in its many alternative guises, which include the United States of America's (US) Network Centric Warfare (NCW) and the United Kingdom's (UK) Network Enabled Capability (NEC), has captured the imagination of the western world. For the last six or seven years the technology driven concept has clearly seduced western governments and military leaders alike. Western armies are

promised greater military capability using less resources and the ability to resolve conflicts with higher levels of effectiveness and precision. The US Army stated in 1993:

> The migration of the current Army Command and Control System (ACCS) to the Army Battle Command System (ABCS) incorporates a common C2 operating environment at all echelons. This integration of modern INFOSYS with our tactical units continues to enhance their connectivity, decision-making, and, ultimately, lethality, survivability, and the ability to control the tempo of operations. Advanced weapons system and sensor technologies based on interoperability, digitization, and spectrum supremacy will contribute directly to improved effectiveness of the force.[1]

This tide of optimism appears, however, to have started to turn. We have perhaps started to open our minds. Metz argues the US Army is increasingly turning towards human solutions, rather than the all persuasive use of technology. This is being driven by their experiences in Iraq and also the fact that technology, such as the F22 aircraft, is becoming prohibitively expensive. The US Defence budget plateaus in 2008 with transformation incomplete, which makes its completion as originally envisaged questionable.[2] In reality NC may not prove to offer more for less. There are also many serious questions with regards NC that remain unanswered, not least because no one has actually delivered a full working NC capability. Many argue there are serious flaws in the underlying theory and the sheer complexity of implementing the concept is staggering.

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[1] United States, Department of Defense, *Field Manual No. 100-6. Information Operations.* (Washington, D.C.: 27 August 1996), Chapter 2. Available from: http://www.fas.org/irp/doddir/army/fm100-6/index.html; Internet, accessed 24 January 05.

[2] Dr Steven Metz, "Asymmetric Threats and the Adjustment of Security Transformation," Lecture, Canadian Forces College, Toronto, ON, December 13, 2004.

Despite these potential issues the UK is firmly committed to developing NEC. At the heart of the UK's NEC concept "are three elements: sensors (to gather information); a network (to fuse, communicate and exploit the information); and strike assets to deliver military effect."[3] The network provides the core component which will require the most intellectual effort in its development and the most careful consideration in its delivery. It must integrate existing sensors and weapons platforms and those that will be delivered in the future. It must also provide the right information to commanders to allow them to more effectively prosecute operations in the information age. All this must be achieved with limited resources, whilst ensuring that the UK's ability to operate within NATO, and with its key coalition partner the US, are not compromised. The 2003 Defence White paper clearly articulates the UK must develop the right capability to meet its aspirations for smaller scale scenarios as well as larger scale coalition operations with the US and other allies.[4]

The UK has not been as quick as the US to rush down the path to a predominantly technology driven NC approach. It has maintained that "NEC does not aim to put the network at the centre of capability in the same doctrinal way as NCW."[5] The Manoeuvrist approach and Mission Command are to be protected. It is this human

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[3] Ministry of Defence, *Defence White Paper : Strategic Defence Review New Chapter. July 2002* (London: HMSO, 2002).

[4] Ministry of Defence, *Defence White Paper : Delivering Security in a Changing World.. December 2003* (London: HMSO, 2003), 7.

[5] Ministry of Defence, "Networked Enabled Capability – Networked Enabled Capability vs. Network Centric Warfare," http://www.mod.uk/issues/nec/nec_vs_ncw.htm; Internet; accessed 10 November 04.

element that the UK have always held dear and the US is arguably turning towards, which perhaps presents the greatest challenge in delivering the right NEC for the UK.

The challenges of enshrining the human element are not however totally new to technologists. The now relatively mature field of Knowledge Management (KM) has wrestled with many of the same growing pains over the last twenty years, as NEC now faces. KM practitioners have realised that human elements, such as culture, organisational constructs and processes (both formal and informal) are more important to overall system success, than the supporting technology. NEC, is perhaps, not walking on totally new ground.

This paper will argue that NEC is not a fundamentally flawed concept, but it does have many issues to address. As the core component, the network, is in fact a Knowledge Management System (KMS) many of the issues can be addressed by applying KM lessons learnt from industrial KM and military NC world leaders.

In doing so, it will briefly outline the NEC concept and its importance to the UK. It will then establish an understanding of what is meant by Knowledge, KM and a KMS, before demonstrating that the NEC network is in fact a complex KMS. Generating a basic and common understanding of both NEC, KM and their intimate relationship is vital, as it becomes the base from which NEC issues and potential solutions can be discussed. It will argue, that despite the inherent complexity of the envisioned network and the existence of many broader non-KM related issues with the NEC concept, its

success would be greatly enhanced by acknowledging existing KM theory and appropriate lessons learnt from public and private sector KM world leaders. In doing so, it will address the primary issues with NC theory, the UK concept of NEC and the development approach selected by the UK. It will then recommend either theoretical, or practical lessons learnt based methods for addressing those issues that are KM related. The human element of the network and its associated issues will prove critical. It will conclude that delivering NEC is a hugely complex endeavour with many problems that can not be resolved by considering KM, but as many significant issues can be addressed by applying KM theory and lessons learnt, it would be sensible not to ignore them.

OVERVIEW OF UK NEC

Importance of the NEC concept

It is critical to first understand why NEC is so important to the UK military. It's relative importance justifies the argument that we should be doing everything possible to ensure its efficient delivery and success. This would include investigating the utility of employing KM theory and lessons learnt. The importance to the UK is clearly highlighted in the latest Defence White Paper *Delivering Security in a Changing World*. The emphasis is in fact so strong that it is one of the core messages in the Secretary of State for Defence's foreword, as well as the actual paper.

> Our focus is now on delivering flexible forces able to configure and to generate the right capability in a less predictable and more complex operational environment. This will require us to move away from simplistic platform-centric planning, to a fully "networked enabled capability" able to exploit effects-based

> planning and operations, using forces which are truly adaptable, capable of even greatest levels of precision and rapidly deployable. This implies significant changes in the way that we plan, prepare and execute operations, placing different pressures and demands on our people equipment, supporting infrastructure and processes."[6]

Though this statement clearly states the central importance of NEC, it perhaps hides the real reasons why a networked approach is so important to the UK. This importance is in fact shared by most western countries for the same reasons. The under lying reasons relate to the current Revolution in Military Affairs (RMA). Alvin and Heide Toffler argue we are now entering the ""Third Wave," the postindustrial and knowledge wave of economic and social development which follows the Agrian and Industrial waves."[7] Most authors have named this the Information Wave in the Revolution in Military Affairs (RMA). This increase in information capability has made Effects Based Operations (EBO) feasible and is making NEC a more tangible concept. Mitchel characterizes this 3rd Wave as one of "full spectrum dominance consisting of systems of systems, dominant battlespace knowledge and agile forces."[8] NCW is clearly currently in favour with western militaries. Different countries have coined different terms for their similar NC concepts.

> Besides network-centric warfare, currently used by the armed forces of the United States, Denmark, Norway and the Netherlands, other coined terms include

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[6] Ministry of Defence, *Defence White Paper : Delivering Security…,* 1.

[7] Stephane Lefebvre, Michel Fortmann, Thierry Gongora, ""The Revolution in Military Affairs": Its Implications for Doctrine and Force Development Within the U.S. Army," in *The Operational Art Developments in the Theories of War,* ed. B.J.c McKercher and Michael A. Hennessy, (Connecticut: Praeger, 1996), 175.

[8] Dr Paul Mitchel, "Utility of Force in International Politics" (lecture, Canadian Forces College, Toronto, ON, November 9, 2004).

> Australia's network-enabled warfare, the United Kingdom's network-enabled capability, the Swedish armed forces' network-based defense and the armed forces of the Republic of Singapore's knowledge-based command and control.[9]

It is not however just technological advances which are driving the current RMA, but other more socially encompassing factors. Lefebvre *et al* argue that though technology is offering huge possibilities, the push into 3rd wave is partly a solution to critical political, economic and social changes. "Facing reduced budgets, a smaller pool of recruits, much uncertainty on the international scene, the military has few alternatives but to do much more with a lot less."[10]

The reality of NEC, whether clearly publicly stated or not, is 'more for less.' The issue of cost is certainly intimated in the NEC Introduction Pamphlet, which states, "the cost of replacing or updating military capability to meet the aspirations of NEC in a single jump is prohibitive."[11] It would therefore be extremely churlish to waste resources relearning lessons that have already been learnt in the KM field. The US who have by far the greatest military RD budget have already acknowledged they must try and employ a twin track development philosophy with industry.[12] Why should this not extend to utilizing industry's lessons learnt? Ultimately NEC is highly important to the UK as it is

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[9] John J. Garstka, "Network-Centric Warfare Offers Warfighting Advantage," *Signal Magazine 2003* available from: http://www.iwar.org.uk/rma/resources/ncw/ncw-forum.htm; Internet; accessed on 3 November 2004.

[10] Lefebvre, *The Revolution in Military Affairs*…, 187.

[11] Ministry of Defence, *Network Enabled Capability – An Introduction. April 2004,* 11; available from: http://www.mod.uk/linked_files/issues/nec/NEC%20Pamphlet.pdf; Internet; accessed 27 October 2004.

[12] Lefebvre, *The Revolution in Military Affairs*…, 187.

core to its future vision for the armed forces and in theory acknowledges the government's fiscal constraints.

Definition and explanation of the NEC concept

The current UK working definition is: "Linking sensors, decision makers and weapon systems so that information can be translated into synchronised and overwhelming military effect at optimum tempo."[13] This is a useful summary of the concept, but requires elaboration to allow a clearer understanding of the network component in particular. Without this greater understanding of the network component it is not possible to make a meaningful comparison with a KMS. A few other definitions are therefore useful.

The Secretary of State for Defence highlights the nature of the network and it's primary purpose.

> [NEC] encompasses the elements required to deliver controlled and precise military effect rapidly and reliably. At its heart are three elements: sensors (to gather information); a network (to fuse, communicate and exploit information); and strike assets to deliver military effect. The key is the ability to collect, fuse and disseminate accurate, timely and relevant information with much greater rapidity (sometimes only a matter of minutes or even in "real time") to help provide a common understanding among commanders at all levels.[14]

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[13] Ministry of Defence, "Networked Enabled Capability – Working Definition," http://www.mod.uk/issues/nec/working_definition.htm; Internet; accessed 10 November 04.

[14] Ministry of Defence, *Defence White Paper : Strategic Defence Review New Chapter…, 15.*

Likewise Capability Manager (Information Superiority), Major General Rob Fulton, clarifies how it will exploit this shared awareness, and other benefits, to ultimately deliver decision superiority.

> NEC allows platforms and C2 capabilities to exploit shared awareness and collaborative planning, to communicate and understand command intent, and to enable seamless battlespace management. It will underpin decision superiority and the delivery of rapid and synchronised effects in the joint and multinational battlespace.[15]

NEC will primarily benefit the Command and Inform components of Defence Capability[16] by allowing the free exchange of information, which will enable:

> Better understanding of Command Intent; Effective Collaborative Planning; Lateral and Vertical Synchronization (Vertical synchronization implies full understanding of the command and intent and subordinates activity. Lateral synchronization is achieved by shared awareness of the operational situation); Shared Situational Awareness (SSA); Synchronised effects and Operational agility.[17]

With the exception of the last two stated benefits, these all directly relate to information sharing.

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[15] Ministry of Defence. *Network Enabled Capability – An Introduction…,* 2.

[16] Doctrinally Defence Capability is the term given to the ability of the UK Armed Forces to support Government Policy. It has seven components whose relationship provides the Defence Capability Framework. The components are: Command, Inform, Protect, Prepare, Project, Operate and Sustain.

[17] Ministry of Defence, *Network Enabled Capability – An Introduction…,* 7.

Figure 1 - Characteristics of Command and Inform[18]

NEC also offers potential benefits in terms of: "More agile forces; Better Decision Superiority; Better Effects Synchronization; Improved control of tempo; Greater optimization of resources and Increased interoperability with networked allies."[19] The popular military concept of decision superiority is an important one, as it will be shown to closely relate to the concept of knowledge superiority. Greater optimization of resources is also obviously key to the UK MOD in its resource constrained environment; as is interoperability with networked allies, in particular the US, which is a stated UK Defence policy goal.

The UK have developed a benefits chain which can be used to allow assessments for individual procurement aspirations. The chain implies a logical connection between one outcome and the next. It is against the ultimate perceived outcome, that investment can be justified. The basic tenet being applied is that better networks will ultimately lead

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[18] *Ibid…,* 7.

[19] *Ibid…*, 8.

to better effects. Though this concept appears to be inherently plausible, it does in fact have underlying issues. These issues will be discussed later in the paper when issues are collectively considered.

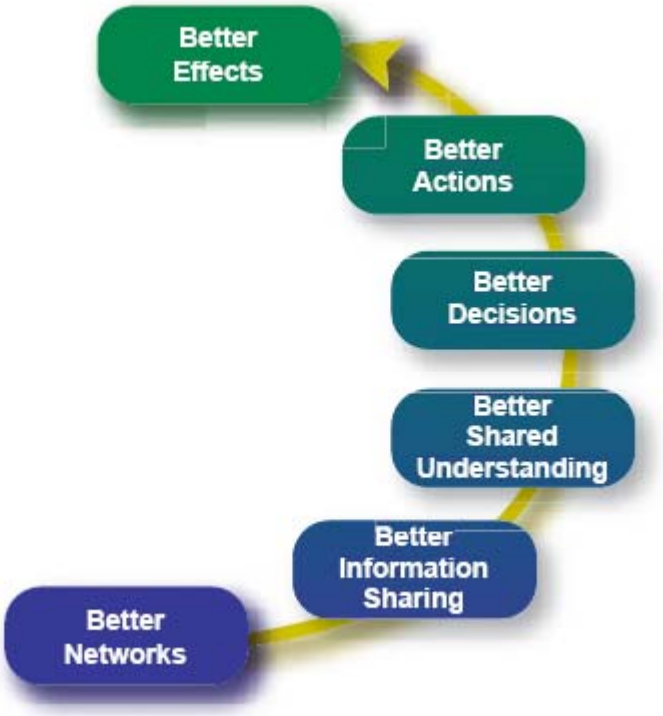

Figure 2 - NEC Benefits Chain[20]

NEC is being developed under seven themes. These will focus development and set the character of the final solution. The first six relate to the NEC vision of future capability, the last is a general theme relating to procurement. Although it is not included as a theme per say, it is recognized that an Effects Based approach will underpin all

[20] *Ibid…,* 9.

future operations. Effects may be military or non-military and will utilize all aspects of power projection i.e. diplomatic, military, information and economic.[21]

Full Information Availability	Enabling a user to search, manipulate and exchange information of different classifications captured by, or available in, all sources internal and external to the battlespace.
Shared Awareness	Providing a shared understanding and interpretation of a situation, the intensions of friendly forces, and the potential courses of action amongst all elements in the battlespace.
Flexible Working	Enabling assets to rapidly reconfigure to meet changing mission needs, allowing them to work together with minimum disruption and confusion.
Agile Mission Groups	Enabling the dynamic creation and configuration of Mission Groups that share awareness and that co-ordinate and employ a wide range of systems for a specific mission.
Synchronised Effects	Achieving overwhelming effects within and between Mission Groups by co-ordinating the most appropriate assets available in the battlespace through dynamic distributed planning and execution.
Effects Based Planning	Taking an approach to planning that focuses on the use of military and non-military effects required against an enemy, and is integrated with other planning processes in the battlespace.
Resilient Information Infrastructure	Ensuring information resources can be managed and that secure and assured access is provided with the flexibility to meet the needs of Agile Mission Groups.
Fully Networked Support	Allowing the ready use of non-frontline government bodies, industry, academia and public service capabilities to support operations.
Inclusive Flexible Acquisition	Coordinating process across MOD, OGDs and industry that promotes the rapid insertion of new technologies, facilitates coherence between acquisition programmes and provides an incremental approach to delivering 'net-ready platforms'

Table 1 – NEC Themes[22]

[21] Ibid…, 10.

[22] Ministry of Defence, *Networked Enabled Capability – Core NEC Themes.*

Focusing on the network element which underpins the whole concept, it is clear that the UK vision is that it will be a network of networks. These networks will consist of various communications systems matched to the required operational environments, which must all be integrated to ensure end to end communication capability. The network will however, need to consist of much more than just communications networks. The ability to communicate is obviously critical, but a common information management and network services model will be needed to physically enable the Network of Networks. This may include "information service provision, email, creation of work groups, file transfer and so on."[23] What is not clear in this description is how the human element of the network is included. The description is heavily technology focused. Though the human element is espoused at the highest conceptual level it begs the questions whether it has been duly considered by the UK? A preponderance of human themes will arise when issues are considered later in the paper.

[23] Ministry of Defence, *Network Enabled Capability – An Introduction…,* 16-17.

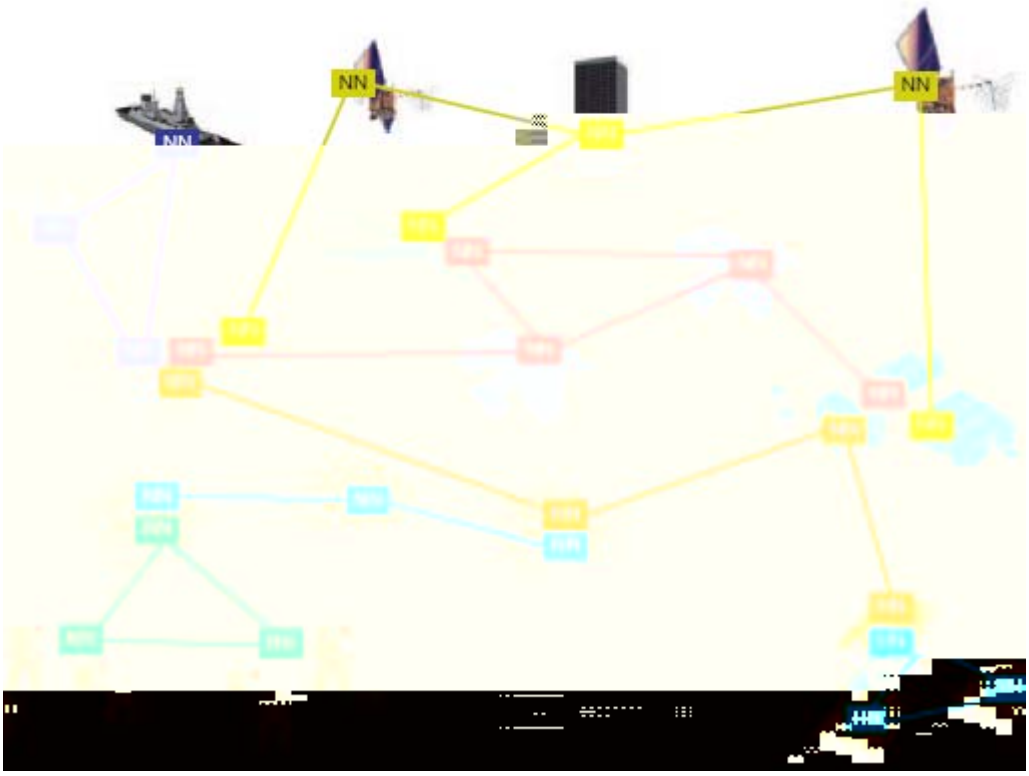

Figure 3 – The Network of Networks[24]

Relationship and differences to NCW

It is important to understand where there are parallels with NCW and also where the two concepts differ. This allows appropriate evidence from the more mature and widely discussed NCW concept to be used when considering NEC. NEC shares the same key tenets as NCW. Both aim to provide their national forces a robust network which should improve information sharing. Both are predicated on the assumption that information sharing and collaboration will improve SSA, which will improve synchronisation and thereby mission effectiveness.

[24] *Ibid.,* 16.

There are however some fundamental differences between the UK and US approaches, in terms of doctrine, resources applied and how the concepts are being developed. "NEC does seek to place the network at the centre of capability in the same doctrinal way as NCW."[25] The UK have clearly stated that Mission Command and the Manoeuvrist Approach will remain constants in the conduct of future operations.[26] The aim of NEC is not to allow the commander to directly command all assets under his command ie empower centralized command. It will enable the work of others by supporting a flexible decentralized form of command. NEC takes an evolutionary approach to delivering the required capability. It is based upon pragmatic steps leading towards a coherent framework.[27] The US approach is much more revolutionary. The resource intensive Force XXI concept is allowing development of a coherent framework at a Divisional level, prior to any attempt to roll out large increments of the concept to the army at large.

KNOWLEDGE MANAGEMENT AND KNOWLEDGE MANAGEMENT SYSTEMS

Current theory and definitions

Data, Information, Knowledge

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[25] Ministry of Defence, *Networked Enabled Capability – Networked Enabled Capability vs. Network Centric Warfare.*

[26] Ministry of Defence, *Network Enabled Capability – An Introduction…,* 5.

[27] Ministry of Defence, *Networked Enabled Capability – Networked Enabled Capability vs. Network Centric Warfare.*

There is now little academic debate on the differences between data and information. Data is fact without context. Information is meaningful fact because it is in context to the user of that information. Essentially some form of cognitive action must be applied to the information to truly move it up the hierarchy from data to knowledge. There is a however a finer line between Information and Knowledge. The dividing line is perhaps considered too rigidly by many authors and their divergent views of the more ethereal concept of knowledge are often unhelpful. This has done much to close military minds to the utility of knowledge management and endeared a focus more narrowly on information management. Perhaps the only important difference, especially in the military context, is the fact that information is more perishable. For example, some information will 'time expire' and will then detract from the commander's situational awareness.[28] The US Army view is:

> A given piece of data is largely meaningless by itself. Only when data is processed, that is, placed into a situational context, does it gain meaning and become, by definition, information. Knowledge is derived from information. Knowledge is information that has been tested and accepted as factual.[29]

Understanding what knowledge really is, is important, as it provides the user more value than data or information. Davenport and Prusak provide one of the most comprehensive definitions of Knowledge:

> Knowledge is a fluid mix of framed experience, values, contextual information and expert insight that provides a framework for evaluating and incorporating

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[28] United States, Department of Defense, *Field Manual No. 100-6. Information Operations…,* Chapter 2.

[29] *Ibid*., Chapter 2.

> new experiences and information. It originates and is applied in the minds of knowers. In organizations, it often becomes embedded not only in documents or repositories but also in organisational routines, processes, practices, and norms.[30]

Appelhans *et al* focus on the actionable nature of knowledge. "Knowledge is the ability to turn information and data into effective action."[31] O'Dell and Jackson-Grayson support this view, that "knowledge is information in action."[32] Tiwana also supports this key concept in linking information to knowledge. "Put simply: knowledge is simply actionable information."[33]

Distilling these views knowledge is really just 'useful' information. This usefulness is often because it has value, is proven, is actionable or is capable of reuse. The two terms, information and knowledge, are often used interchangeably by many authors, in particular in the military. The subtle difference is often not understood. In fact knowledge appears to almost be a socially unacceptable word in UK military circles. This is perhaps surprising considering how knowledge centric the military is. Experience is highly revered and knowledge is captured and used all the time in a huge number of well understood ways and mediums; such as lessons identified reports, post exercise reports, operating procedures and doctrine to name but a few. Ultimately the difference

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[30] Thomas H. Davenport and L. Prusak, *Working Knowledge - How organizations manage what they know* (Boston: Harvard Business School Press, 1998), 5.

[31] W.A. Applehans, Globe and G. Laugero. *Managing Knowledge: A Practical Web-Based Approach*. (Addison Wesley, 1999), 18.

[32] Carla O'Dell, & C. Jackson-Grayson. *If Only We Knew What We Know - The Transfer of Internal Knowledge and Best Practice.* (New York: The Free Press, 1998), 5.

[33] Tiwana, A. Knowledge Management Toolkit : Practical Techniques for Building a Knowledge Management System. (Upper Saddle River, NJ: Prentice Hall, 2000), 57.

is not really very important. The most important 'useful' information and knowledge need to be managed and utilised in precisely the same way because they offer the military the same benefits.

The consideration that knowledge is valuable and can be used to create sustainable competitive advantage in an organisation is an important business focused concept. This matches closely to the military concepts of gaining decision superiority. It is perhaps helpful to think of the relationships between data, information and knowledge in the form of Appelhans *et al's* Knowledge Pyramid. There is a mass of data at the base, a wealth of information sitting upon it, but only a small amount of the really valuable commodity, knowledge at the pinnacle. The challenge is often understanding what information is really of value i.e. is knowledge.

The US Military's cognitive hierarchy takes the concept a step further. It explicitly states how progression between the levels occurs and applies a fourth level "understanding" at the top of the pyramid. The commander when applying his judgement to the knowledge provided is able to generate understanding. Judgement is a human skill based on expertise, experience and intuition. "Understanding equates to situational awareness, through which we can see patterns emerging from events in the battlespace and anticipate the consequences both of our actions and those of the enemy. True understanding should be the basis for our decisions." Commanders must however accept that perfect situational awareness is unlikely in combat due to the constraints of time and uncertainty. A lack of complete information should not preclude making a

decision.[34] General George S. Patton Jr succinctly puts this in the military context: "A good plan violently executed now is better than a perfect plan next week."[35] It is this highest level of the pyramid, understanding, that therefore truly enables decision superiority.

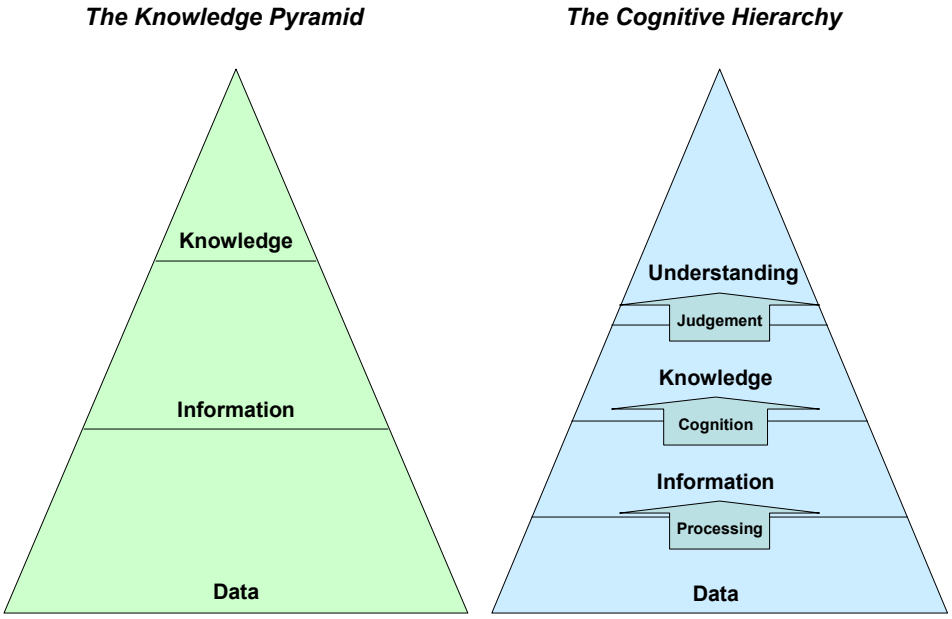

Figure 4 – The Knowledge Pyramid[36] and The Cognitive Hierarchy[37]
Knowledge Management

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[34] United States, Department of Defense, *Naval Doctrine Publication 6 - Naval Command and Control* (Washington, D.C.: 19 May 1995), Chapter 2, Available from: http://www.nwdc.navy.mil/Library/Documents/NDPs/ndp6/ndp60001.htm; Internet; accessed 24 January 05.

[35] General George S. Patton, J., US Army quoted in United States, Department of Defense, *Naval Doctrine Publication 6 - Naval Command and Control* (Washington, D.C.: 19 May 1995), Chapter 2, Available from: http://www.nwdc.navy.mil/Library/Documents/NDPs/ndp6/ndp60001.htm; Internet; accessed 24 January 05.

[36] Applehans, *Managing Knowledge...*, 20.

[37] United States, Department of Defense, *Naval Doctrine Publication 6…,* Chapter 2.

Knowledge Management (KM)

O'Dell provides perhaps the most useful definition in the military context. "KM is the conscious strategy of getting the right knowledge to the right people at the right time and helping people share and put information into action in ways that strive to improve organisational performance."[38] Appelhans *et al* also focus on the 'right knowledge'. "[KM]…involves understanding who needs what content to be successful in their jobs."[39]

David Skryme provides a 'one minute explanation' of Knowledge Management. It has a totally civilian focus, but is designed to be inherently user friendly. It is included to add further explanation. It reiterates the key concept of getting the right knowledge to the right person at the right time. It also raises the important issue of making it easily accessible and available all the time (which allows innovative action) and the inherently human nature of the exchange of some types of knowledge.

> Most organizations don't know what they know - their left hands (or brains) don't know what their right hands are doing. As a result mistakes are repeated, good ideas are not used and money is frittered away as people struggle to find the information and knowledge they need. Knowledge management is about getting the right knowledge to the right people at the right time, when they need it, not when you think of giving it to them. One aspect is about identifying the best knowledge in documents and databases and making it easily accessible from an individual's personal computer. A more important part is about creating the environment for people to mix and have conversations to share knowledge...[40]

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[38] O'Dell, *If Only We Knew What We Know…*,6.

[39] Applehans, *Managing Knowledge*, 10.

Wig's definition is also valid as it implies achieving this delivery is a deliberate and ongoing activity. The returns the military require will necessitate constant effort and application of resources. "KM is the systematic, explicit and deliberate building, renewal and application of knowledge to maximise an enterprise's knowledge related effectiveness and returns from its knowledge assets."[41] Achieving the effective delivery of knowledge requires a number of supporting activities. Knowledge Management, just like learning, is a cyclic process of activities. Different authors propound variations, but Schrieber's version is easy to relate the subsidiary concepts to.

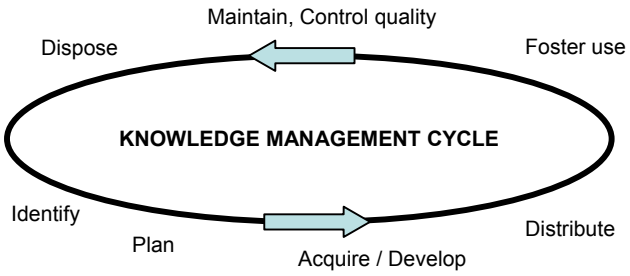

Figure 5 - Schrieber's Knowledge Management Cycle[42]

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[40] David. J. Skryme, "The One Minute Manager," I[3] UPDATE / Entovation International News [on-line], no. 61, available from: http://www.skyrme.com/updates/u61_f2.htm; Internet; accessed 27 October 2004.

[41] K. Wiig, "Knowledge Management : Where did it come from and where did it go?" *Expert Systems with Applications*, Vol 13 no. 1 (1997).

[42] Guss Schrieber, *et al, Knowledge Engineering and Management: The Common KADS Methodology* (Cambridge, Massachusetts: MIT Press, 2000), 72.

Toffler and Toffler reinforce this view of deliberate activity. Their cited activities are not a direct match to Scrieber's, but they are very close. "Any military…like any company or corporation…has to perform at least four key functions with respect to knowledge. It must acquire, process, distribute, and protect information, while selectively denying or distributing it to its adversaries and or allies."[43] The KM Cycle clearly has application in the military context.

Joint Service Publication (JSP) 602 defines KM as "the management of an environment which encourages knowledge to be created, shared, learnt, enhanced and organised for the benefit of the organisation and its customers."[44] Understanding how knowledge can be transferred and combined is important, as it is usually the combination of different types of information (e.g. HUMINT, SIGINT, ELINT, IMINT) that provides the best intelligence product; and therefore the best situational awareness. The processes of socialization and externalization are vitally important as they are the only way HUMINT can by captured and then turned into explicit knowledge, which can then be 'combined' with other electronic sources.

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[43] Alvin and Heidi Toffler, *War and Anti-War: Survival at the Dawn of the 21st Century* quoted in United States, Department of Defense, *Field Manual No. 100-6. Information Operations.* (Washington, D.C.: 27 August 1996), Chapter 2. Available from: http://www.fas.org/irp/doddir/army/fm100-6/index.html; Internet, accessed 24 January 05.

[44] MOD(UK) Information Coherence Directions, "JSP 602 Instruction: Knowledge Management v1.0," http://www.dtais.mod.uk/jsp600/default.htm; Internet; accessed 10 November 2004.

Nonaka explores the transfer or conversion of knowledge in detail. He specifies two types, explicit and tacit, and four means of conversion within the context of a spiral. Joint Services Publication (JSP) 602 utilises Nonaka's concepts and defines explicit knowledge as "Precisely and clearly expressed facts or experiences known by a person or organisation." It defines tacit knowledge as "knowledge comprising know-how, mental models, beliefs and perspectives largely based on experience. (Highly personalised knowledge that is hard to formalise and communicate)."[45]

Socialisation allows the sharing of experiences and building of new mental models. Externalisation allows this tacit knowledge to be articulated into explicit knowledge. Combination allows multiple sources of explicit information from within the organisation to be combined into powerful knowledge networks. This combination will empower decision making, and may generate new processes, or in the commercial arena, new products. This knowledge is then internalized again as people learn from doing. This prompts more thought, new experiences and starts the next iteration of the spiral.

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[45] *Ibid.*

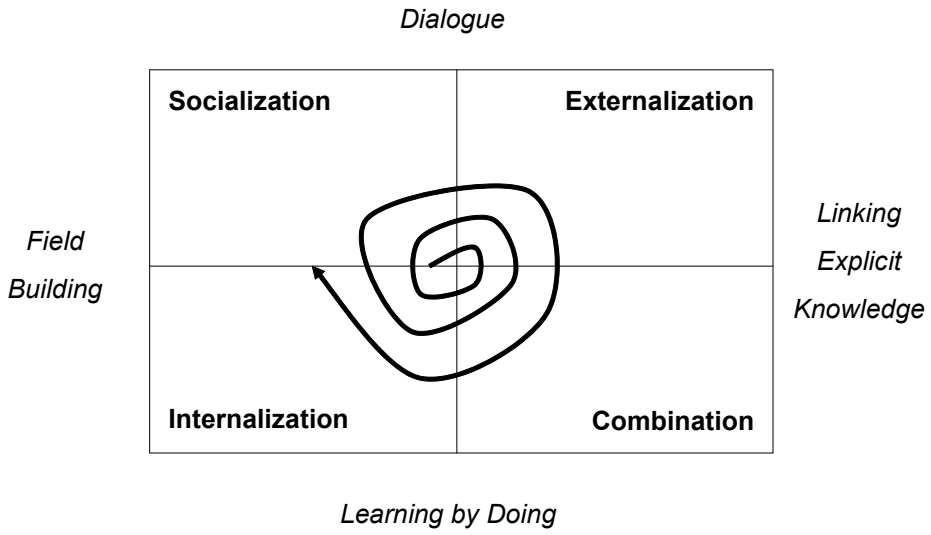

Figure 6 – Nonaka's Knowledge Spiral[46]

Information Management (IM) and Information Exploitation (IE) appear to be more commonly used terms in UK military circles than KM. JSP 602 gives KM a distinctly commercial and civilianized flavour. This misses the point as KM is probably more important to, and widely used by, the military in the Battlespace, rather than in the Business Space. This is perhaps most apparent when considering Information Operations (IO). In IO the military commander is effectively conducting the KM Cycle utilising IO's three interrelated components of Operations, Relevant Information and Intelligence (RII); and Information Systems. These must operate within a battlespace defined by the Military Information Environment (MIE) which in turn is part of the overall Global

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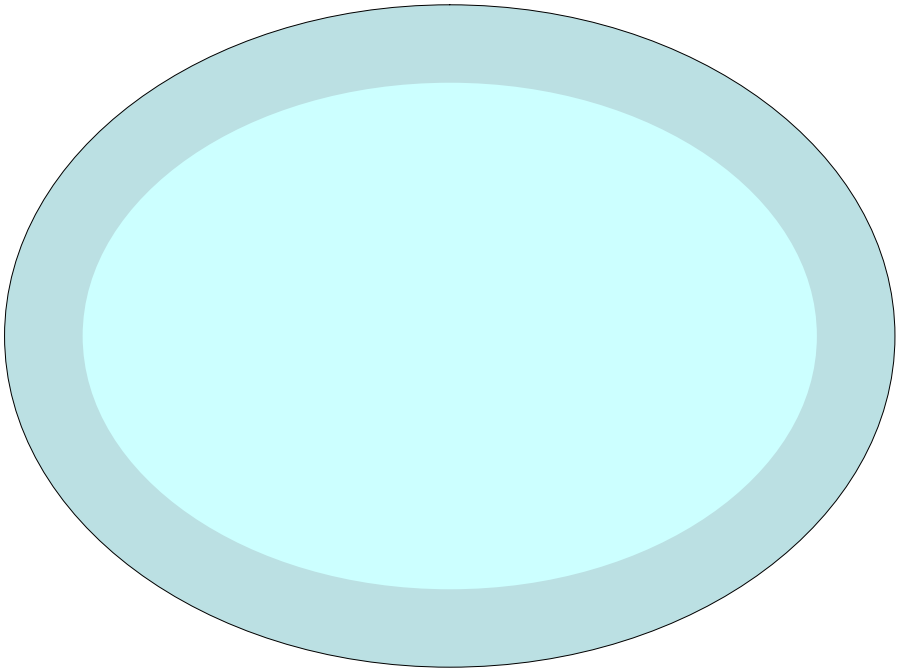
[46] Ikujiro Nonaka, *The Knowledge Creating Company.* (New York: Oxford University Press, 1995), 71.

Information Environment (GIE). There is no longer a clear line between business and battlespace, in fact separate consideration in the 21st century could be considered naïve and dangerous.



difference, as previously discussed, is minimal. For these reasons the two terms will largely be used interchangeably in the main part of paper depending on the preference of the referenced author.

In summary, KM is about delivering the right knowledge, to the right people, at the right time to improve personal and organisational performance. It is equally applicable to both the business and battlespace. It is key to NEC which will inherently cross traditional business and battlespace boundaries, in terms of both communication and intelligence. It is the life blood of NEC, without it sensor information can not be translated into effective decisions and therefore effects delivered by the shooter elements of NEC will be sub-optimal. It is a highly human centric set of activities.

Knowledge Management Systems (KMS)

Most authors are agreed the three key components of KMS are: People & Culture, Technology and Processes. Many permutations of this concept exist and the Processes element is often replaced with component names such as Infrastructure or Content.[48] Likewise, Culture is sometimes not explicitly stated with People. Technology is however pretty much universally considered as an enabler. This component view is a very useful way of thinking about KM in general and in particular the components of a KMS. Interestingly the three components of IO, introduced in Figure 7 directly map to

[48] Earl uses Infrastructure and Appelhans *et al* use Content.

Appelhans *et al's* version of the three components of a KMS (ie Operations to People, RII to Content and Technology to Information Systems).

Technology's place in the triumvirate, as an enabler only, is a very important issue that will be returned to throughout the paper. This broad view that technology is less important, as it only enables the other two components, is not often shared by the proponents of NC and the defence industry. This is because it is usually much easier to sell a tangible object, than intangible concepts; and perhaps more importantly it is considerably more profitable to sell tangible objects. This has popularized NC as a technology lead panacea, which is false and dangerous. It will be shown that the greatest challenges for NEC actually lie in the other two components which are inherently more human focused.

Establishing the NEC Network is a KMS

The relationship between the NEC network and a KMS should already be apparent, but it is worth establishing an unequivocal parallel as it is underpins the paper's argument, that the NEC network is a KMS and therefore lessons for one, are potentially applicable to the other. The UK Defence Minister's description of the NEC Network[49] will be used as a vehicle for comparison against the KM Cycle, Nonanka's Knowledge Conversion Model and the selected KM definition.

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[49] A combination of the previously cited Secretary of State's and Capability Manager (Information Superiority's NEC network descriptions.

The comparison is shown graphically at Figure 8 and it is immediately clear that the NEC Network is a KMS. It clearly corresponds with each model it is compared against. The only element of the KM Cycle that is missing from the NEC description is that of disposal, but the disposal activity is implicit when the network no longer requires the information or no longer has the capacity to store it. All elements of Nonanka's model appear and there is a direct mapping to the selected summarized definition of KM: "The right knowledge, to the right people at the right time."

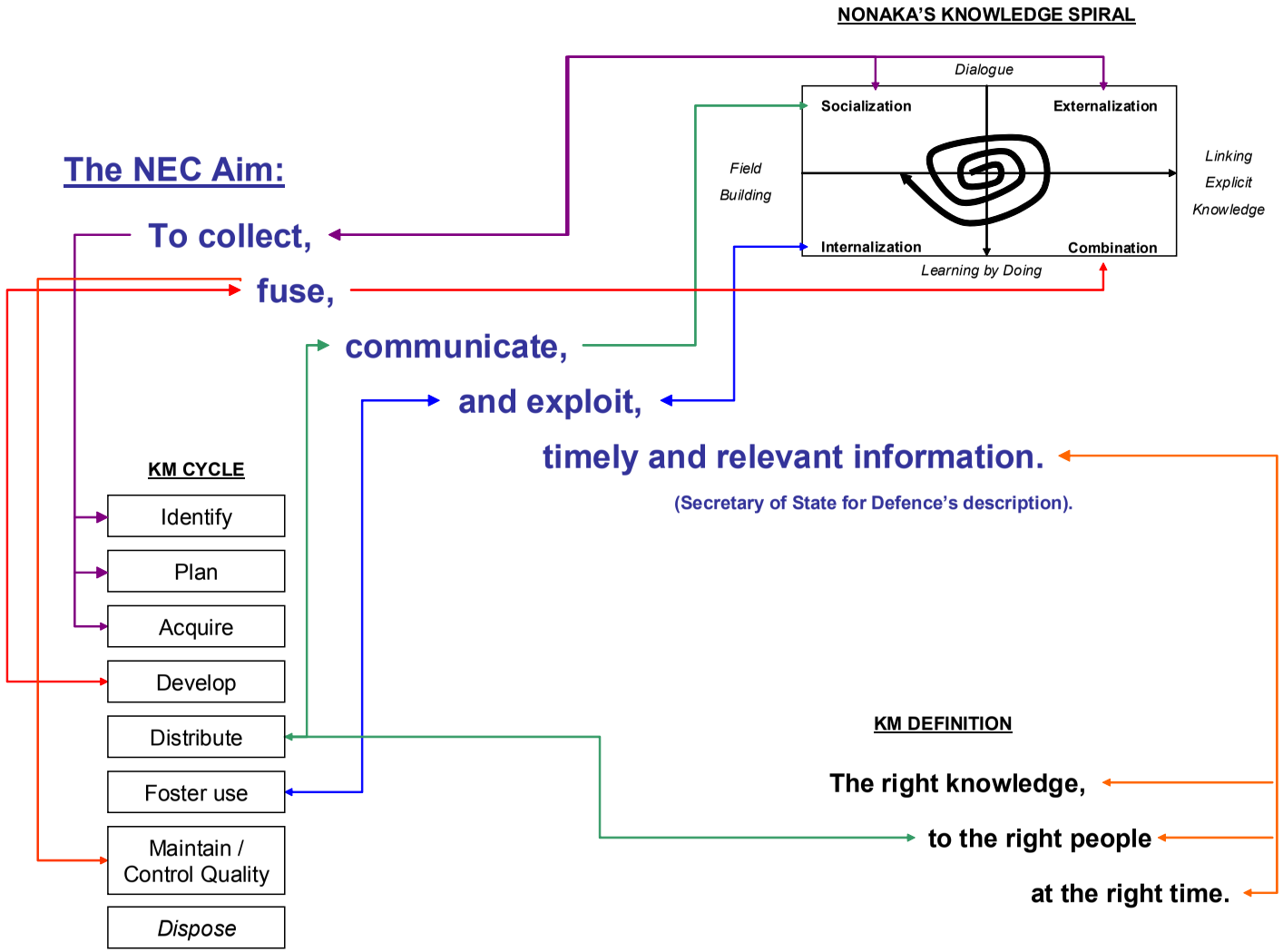

Figure 8 – Comparison of NEC Network and a Generic KMS.[50]

[50] Author derived.

ISSUES, CONSIDERATIONS AND POTENTIAL RESOLUTIONS

The most important area for intellectual thought is to understand the potential issues with NEC. Without a good understanding it is impossible to then go on to consider how they can be addressed. Some of the identified issues effect all NC variants, but others are peculiar to the UK and its vision of NEC. They have been grouped into three levels: Theoretical, Conceptual and Developmental. The highest category, the Theoretical issues affect all NC variants, and must be explored, if only briefly, to highlight how they can affect the overall direction of NEC. The lower two focus specifically on the UK NEC concept and the issues for the UK in physically implementing it. The lower two levels have the greatest significance with respect to KM, as KM can provide practical solutions to many of the problems. This is not to say that the issues raised in the two lower levels could not be experienced by nations other than the UK. In fact many will be common to all NC implementers, but that the focus of this paper is unashamedly UK NEC. The issues are summarised in Figure 9 and will now be explored in detail.

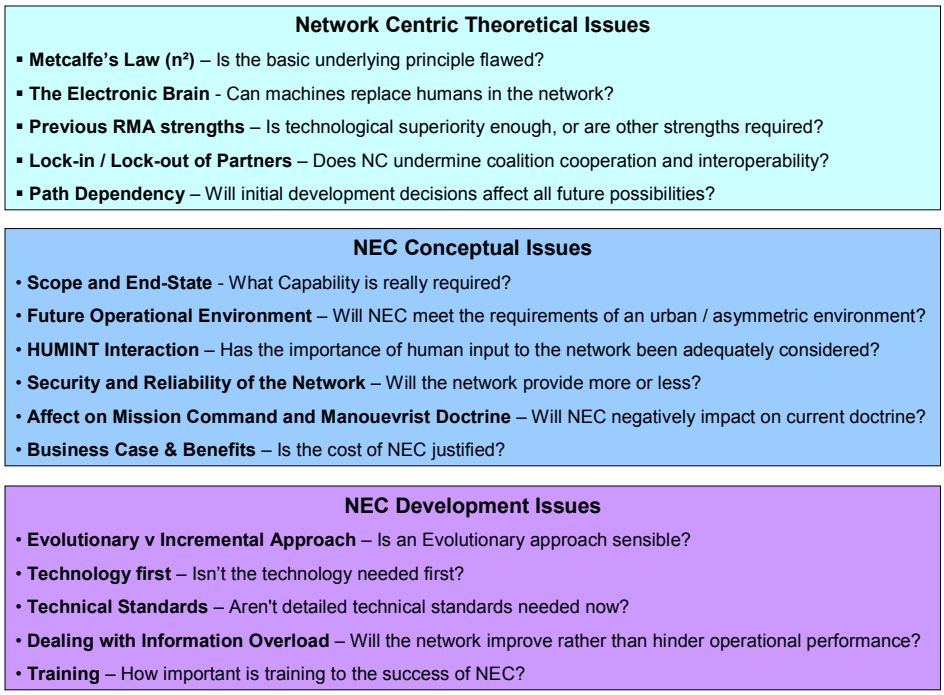

Figure 9 – NEC Issues[51]

Network Centric Theoretical Issues

There are certainly some theoretical issues with the NC concept. The key question is do they collectively undermine it completely, or can they be accommodated? It will be argued that they can be overcome and that the benefits of developing an NC approach still outweigh the disadvantages, as long as the right type of NC is developed. There are perhaps greater implications for the US, who are heavily committed to a technology led path, than there are for the UK and other smaller currently less committed nations.

[51] Author derived.

Metcalfe's Law

Giffin and Reid argue NCW was based erroneously on New Economy Theory. More importantly the boom and bust of the 1990's confirmed that New Economy Theory was in fact flawed in its own right. The theory is built on three main pillars: Moore's Law, Metcalfe's Law and the Internet. The greatest issue is with Metcalfe's Law which "…asserts that the value of a network increases in proportion to the square of the number of users of the network." The law generates excitement over the potential of NCW and is often used to loosely justify it's business case. The problem with this assertion is that value has a very specific meaning in economics, but has been misinterpreted by military advocates of NCW. In economic terms it relates to the products and/or services required to participate on the network. The law promises the opportunity of potentially gaining a monopoly and huge returns by hitting critical mass before your competitors.[52] A good example is Bill Gates's use of DOS over other operating systems, but other examples are the rise of CDs over tape or DVDs over video.

Giffin and Reid quote the misinterpretation of two of the most prominent pioneering NCW authors Admiral (Retd) Cebrowski and John J.Gartska:

> Network-centric computing is governed by Metcalf's Law, which asserts that the **"**power**"** of a network is proportional to the square of the number of nodes in the network. The "power" or "payoff" of the network-centric computing comes from information-intensive interactions between very large numbers of heterogeneous computational nodes on the network."[53]

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[52] Ralph.E. Giffin and Darryn. J. Reid, "A Woven Web of Guesses, Canto One: Network Centric Warfare and the Myth of the New Economy," 3 – 6, Available from: http://www.dodccrp.org/events/2003/8th_ICCRTS/pdf/108.pdf; Internet; accessed 6 December 2004.

[53] Cebrowski and Gartska, *Network-Centric Warfare : Its Origins and Future*, 35, quoted in Ralph.E. Giffin

The value of products in a network has now erroneously been translated into power derived by transactions or communication between products on the network, not the products themselves. These are clearly not the same thing. Giffin acknowledges that not all authors have completely missed this subtlety, "Alberts *et al* go on to admit that the association between Metcalfe's Law and the increased combat power is not straight forward, and that additional analysis and study is required in order to realize the full potential of network effects."[54] The danger is that the proponents of NEC have missed this key point.

Giffin also goes on to argue that there is consensus amongst contemporary economists that the law does not hold true at large values of n (in the case of NC n is the number of users and systems on the network). The curve actually plateaus or even reduces. Practical examples of this, such as information overload, can already be seen in "nascent networks." This means there is an optimal size to the network beyond which further benefits are not possible.[55]

This immediately indicates that NEC must have a clearly defined scope. The UK proponents must understand at what point further networking is actually a disadvantage rather than an advantage. Identifying this point is likely to be difficult and is probably only practical through modeling or prototyping networks. These arguments do not imply that NC can not

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and Darryn. J. Reid, "A Woven Web of Guesses, Canto One: Network Centric Warfare and the Myth of the New Economy," 8, Available from: http://www.dodccrp.org/events/2003/8th_ICCRTS/pdf/108.pdf; Internet; accessed 6 December 2004.

[54] Alberts et al, *Network Centric Warfare: Developing and Leveraging Information Superiority*, 102 quoted Ralph.E. Giffin and Darryn. J. Reid, "A Woven Web of Guesses, Canto One: Network Centric Warfare and the Myth of the New Economy," 9, Available from: http://www.dodccrp.org/events/2003/8th_ICCRTS/pdf/108.pdf; Internet; accessed 6 December 2004.

[55] Giffin, *A Woven Web of Guesses, Canto One*…, 14 – 16.

derive significant benefits, but that benefits will not grow exponentially ad infinitum as the size of network increases. As Giffin and Reid state we must set limits by making choices on the nature of the Network, the required interconnectivity and the Information it must contain. This may seem counter to the NC thesis, but it is necessary to ensure the most effective resource utilization for the tangible benefits achieved.[56]

The Electronic Brain

NC offers the potential for highly centralized or decentralized command. Which ever model is adopted decisions must be made at one or many levels. Depending on how far the concept is pushed these decisions makers could increasingly become machines. It is not hard to imagine the current science fiction of robots physically fighting wars, becoming reality. They would be required to make life or death 'to shoot or not to shoot' decisions based on preprogrammed Rules of Engagement (ROE) and real-time information from its targeting sensors. Conversely, some robots may purely be 'shooters' reacting to the order of a decision robot, which has been informed by a large array of sensing robots. This vision is not a huge leap of faith from existing technology. The advance in sensor and computer technologies means weapons can already act semi-autonomously. Artificial Intelligence has not delivered the hype of the mechanical brain that many foresaw. This does not however mean that it won't in the future, or that some other form of technology won't leap frog past it to provide a solution. We are really not very far from 'thinking' technology. How different is true thought from the processing of an aircraft's defensive aids suite, which automatically reacts to a sensed threat in a

[56] Giffin, *A Woven Web of Guesses, Canto One*…, 17.

predefined manner or an armed UAV which had been programmed to automatically engage an array of targets if they are found?

The key questions are perhaps, can machines ever totally replace humans as the 'brain' within the network? And would we want them to? Both questions are again fundamental in deciding the scope of how far the NEC concept is pushed. Lt Col Edmund Blash USAR argues NC's most fundamental flaw is probably its view that machine analysis and intelligence is superior and can replace soldiers. He states, "no viable proof exists that software algorithms, information fusing or Boolean decision analysis will be any more successful than the current soldier in the loop."[57]

Fundamental to this discussion are the two central theories of decision making, the analytical and intuitive approaches. In the analytical approach a number of options are generated, compared and evaluated against set criteria to try and find the best solution. Simulation can be employed to test each solution and make recommendations for improvement. The process is thorough, but tends to be time consuming especially if not heavily automated. Conversely intuition relies on the abilities of the commander more heavily to replace analysis, with his experience and judgment. The best commanders are able to grasp a situation in its entirety and suggest workable solutions almost instantaneously. This is often referred to as "coup de'oeil."[58] It can also be considered as the commander's ability to "orientate" whilst in the decision-

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[57] Edmund. C. Blash, "Network Centric Warfare Requires a Closer Look." *Signal Magazine 2003,* 6, available from: http://www.iwar.org.uk/rma/resources/ncw/ncw-forum.htm; Internet; accessed 3 November 2004.

[58] Baron Antoine Henri de Jomini, *The Art Of War* (London: Greyhill Books, 1992), 375.

execution cycle (OODA or Boyd Loop). From orientation the commander generates his understanding of the situation of the battlespace, his situational awareness. From this position he will then base his decisions.[59]

Neither solution is perfect. If the information and time are available for deliberate planning the analytical approach is usually more thorough, as large quantities of relevant information can be gathered to inform decisions and the plan. If time is short, or information scarce and the battle fluid the intuitive approach my prove more effective.[60] As Blash puts it, "Network-centric warfare will require a new type of combat leader, one who can master technology and information then make rapid and correct decisions."[61] NC should allow commanders to still be intuitive, but based on a stronger situational awareness. Computers are better suited to supporting analytical approaches, but ultimately planning and conducting operations is an art rather than a science. Machines are unlikely to ever be able to provide the genuine creativity required to produce the optimal manoeuvrist plan unless the highest thought processes can be emulated.

Applicable to both approaches is the ability to orientate. NEC aims to increase tempo by applying the decision-execution cycle as fast as possible. If the network is therefore to be truly effective it must enable a human commander to do so in a faster and more effective manner. If NC is however taken to its technological extreme, it must have the ability to orientate, be

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[59] United States, Department of Defense, *Naval Doctrine Publication 6…,* Chapter 2.

[60] *Ibid*…, Chapter 2.

[61] Blash, *Network Centric Warfare Requires a Closer Look…,* 3.

intuitive and decide by itself. Technology may in time provide workable solutions, but there are also moral and ethical considerations in accepting them and taking the human out of the loop. "The use of military force always involves moral considerations; the decision to go to war is a moral decision; and the judgments on the employment of means are always more than merely military judgments."[62] When the means selected and employed by a robot is illegal, who is guilty of the war crime committed?

The UK has stated NEC is not NCW. "NEC does not aim to put the network at the centre of capability in the same doctrinal way as NCW." But what does this really mean in terms of technical development, machine intelligence and the future of command? Ultimately how far does the UK wish to take the NC vision? If the human commander, rather than the network, is to remain central there are perhaps two major options: network empowered intuitive decision making or network assisted analytical decision making. Or should the network seek to support both approaches as both generically have advantages and disadvantages? Ultimately a decision needs to be made to set the theoretical scope of the initiative.

Previous RMA strengths

Superiority in information technology is unlikely in itself to deliver success on the battlefield. Blash argues that the "successful use of information age technology is predicated on maintaining the strengths of previous ages of development : agricultural, maritime, industrial, aeronautical and electrical." His point is made describing the US, but is applicable to all nations

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[62] Colonel Malham M. Wakin, "Ethics of Leadership," *Military Leadership*, 1981, 8.

exploring NC methods of warfare. Blash argues that if the US were to show a weakness in one area it could easily be exploited and would impact on another infrastructure area. He cites Vietnam as an example to support his view, where he argues an over reliance on technological superiority and logistics cost the US heavily when fighting an agrarian state.[63]

Western societies are becoming increasingly involved in conflicts with states who are still in the Agrarian or Industrial stages of the RMA. There are important implications for fighting against them. It is not just a case of maintaining the physical strength from previous stages, but also the associated mental strength required as a society. This mental strength is often lost as the hardships of daily life, living in these less developed environments, are no longer encountered. Western nations have become particularly reticent to lose lives during war. Conversely life is still very cheap in many agrarian societies, particularly in Third World Nations. The noted historian Sir Michael Howard clearly articulates this issue:

> Western societies have learned how to kill on an enormous scale, but they may still fight at a disadvantage against agrarian armies who have not forgotten how to die and know well enough how to kill. The Vietnam war and the recent experience in Somalia indicate that if those agrarian age armies are well-led, and if their leaders develop superior strategies, they can still prevail.[64]

This issue has a serious implication on the ultimate form NEC should take. The British Military must not become over-reliant on technology or arrogant that superior technology will automatically give them an advantage over their adversary. The UK appear to have taken a less

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[63] Blash, *Network Centric Warfare Requires a Closer Look…,* 2.

[64] Sir Michael Howard, "Can Technology Change Warfare?" 5-6, available from: http://www.au.af.mil/au/awc/awcgate/ssi/2hist.pdf; Internet; accessed 24 January 2005.

technologically focused view on NC than the US and hence are in less danger of technological over-reliance. Culturally also, Britain is probably less at risk. Britain's empirical past and associated long history of counter-insurgency warfare has ingrained in its military culture many of the lessons of fighting supposedly inferior forces. Maintaining the strengths of previous RMA eras and not becoming over reliant on technology are still important issues and should not be taken for granted in developing NEC.

Lock-in / Lock Out of Partners

There is a real danger networks do not lock out the enemy, they lock out friends and allies.[65] Operating with allies or coalition partners is growing in importance as practically all Western armies find they do not have sufficient resources or the political will to conduct significant operations on their own. Networks should support this by allowing seamless sharing of resources. Matthew Cole of QinetiQ states that:

> …UK NEC fits well with other allied and coalition nations – the primary one obviously being the USA. If you look at the activities of the other nations, there is a strong theme of maximizing the effect delivered from both their own and allied assets. In practical terms, what this means is that a country should be able to call down military effect in any given situation from assets that may not only be theirs, but those of an allied or coalition partner. The result is a much greater overall level of coherence in terms of fighting force, as well as the ability to deliver the effect at an optimum tempo."[66]

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[65] Giffin, *A Woven Web of Guesses, Canto One*…, 11.

[66] Paul Hirons, "NEC – the future of Defence?" *Defence Director,* (September/October 2004), 7.

Cebrowski and Garsta coined the terms "lock-in" and "lock-out," but they were used in a positive network context in terms of "locking in victory or locking out the enemy."[67] Giffin and Reid argue that networks instead of delivering this desired effect can actually prevent it. They argue networks lock out other friendly networks and lock in their users. The predominant network will undoubtedly be the US owned and designed network. For Western nations to obtain significant benefit from the US military, whilst conducting multi-national operations, they will need to be 'on' the US network. They must therefore have a compatible network and possibly even doctrine and training, i.e. they are locked in and have lost policy choice on what their element of the network should look like and how it should operate. As inevitably the junior partner, they must accept US network standards. The network is therefore by default effectively US owned and controlled. How much choice will the UK be left with? The UK can either be locked out like many other allies or locked in with no future policy choice. The UK is therefore left with a real dilemma. Interoperability is one of the benefits upon which NEC is predicated. The 2003 Defence White Paper stated "that in the most demanding operations we [the UK] will be operating alongside US and other allies." [68] Operating with the US is central to UK Defence Policy and can not be jeopardised.

Dr Steven Metz argues the US have acknowledged as a priority that the US need to develop their ability to work with both networked and non-networked allies.[69] This does not

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[67] Cebrowski and Gartska, *Network-Centric Warfare : Its Origins and Future*, quoted in Ralph.E. Giffin and Darryn. J. Reid, "A Woven Web of Guesses, Canto One: Network Centric Warfare and the Myth of the New Economy," 10, available from: http://www.dodccrp.org/events/2003/8th_ICCRTS/pdf/108.pdf; Internet; accessed 6 December 2004.

[68] Ministry of Defence, *Defence White Paper : Delivering Security in a Changing World…*, 7.

[69] Metz, *Asymmetric Threats…*

however mean they will need to compromise the terms of how this occurs. Giffin and Reid argue junior partners must obtain, at the outset, a strong guarantee of influence over the development and future use of the network and that they should monitor progress very carefully.[70] The Iraq War highlighted the technological, doctrinal and cultural disparities between the US and even it's closest ally the UK. The operation was effectively designed to keep forces physically separated to avoid the issues of interoperability. The UK benefited very little from networked 'real-time effect' delivered by US assets when they would have perhaps liked them most. This separation was not just due to technological, doctrinal and training differences, but also political limitations on the use of UK forces.

Lt Gen McKeirnan offers some valuable advice on integration from his experiences from Operation IRAQI FREEDOM. He cites the political imperative of integrating other nations forces in US led coalitions, juxtaposed against the practical difficulties in doing so. This is primarily due to the difficulties in keeping-up with the US technologically and the political limitations placed upon their use. His solution is integration at the human level through high quality liaison officers and a thorough understanding of the political and capability limitations of attached coalition forces. The focus on building relationships and understanding is knowledge transfer in the human or people element of the KMS.[71]

Again this issue clearly has significant impact on the shape of NEC. The UK must make careful decisions over the design of NEC to ensure we are not locked-in or locked-out. These are

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[70] Giffin, *A Woven Web of Guesses, Canto One*…, 21.

[71] LTG McKiernan, "Command of Land Operations," Lecture, Canadian Forces College, Toronto, ON, January 10, 2004.

not just technological decisions, but perhaps more importantly people and liaison, policy and process decisions.

Path Dependency

NC enthusiasts are driving an aggressive agenda. They argue that developing the technology first means obtaining a capability advantage over your adversaries. This is a similar concept to critical mass in the commercial context, which has been previously discussed. This advantage is however dependant on retaining this technological superiority. This aggressive approach overlooks an important lesson learnt from the New Economy model. Networks have proved super sensitive to their initial conditions. This is described as path dependency. If you head down the wrong path the switching costs later are high if you need to change path. Path dependency does not rule out moving fast, but it implies accepting risk if you choose to do so. We have to be clear it is worth accepting this risk, as there are other well proven ways of increasing military capability. It could well be that investing more in the training and education of the Armed Forces, could deliver a greater benefit than NEC, at less cost and at less risk.

The UK must decide whether or not to follow the US path. It has already been mentioned that the US path is now far from certain. The US Air Force and Navy may well push on to the technical limits of the NCW concept, but the Army are walking back towards more human centric ideas.[72] This may not be a good time to follow the Americans. There also is an obvious corollary to the previous discussion on lock-in / lock-out. If the UK does not follow the US, which it has clearly implied it is not going to, then it must be careful its own chosen path is the

[72] Metz, *Asymmetric Threats*...

right one for the UK Armed Forces. That path, other than for some rather arbitrary stages initial, transitional and mature, currently seems unclear.[73] The UK can not afford in resource or capability terms to get it wrong. It should not adopt a high risk, potentially high cost strategy, which could involve a major change in direction during development.

NEC Conceptual Issues

Scope and End State

An important recurring theme appears from the consideration of NC Theory. NC is not a totally flawed concept, but it has a number of major issues which should guide the scope and style of a country's NC capability. The UK must acknowledge these considerations in setting the scope and end state for NEC.

In simple project management, or operational planning terms, how can you implement a change from A to B if you don't know where or what B is? None of the reviewed UK documentation gives a really clear picture of the UK NEC end state. The UK do not have the resources to amble blindly through NEC, hoping they get to where they want to be. It must have a clear vision of where it wishes to end up. If it is not possible to design a plan to get there now, it must at least break the development down into manageable elements which can be planned. This is a primary concept of both programme and project planning. The current documentation

[73] Ministry of Defence, *Network Enabled Capability – An Introduction…,* 11.

appears to describe a very loosely bound vision of the future[74] against which current equipment procurement decisions are almost impossible.

Conversely Knowledge Discovery can often not be meticulously planned. The act of discovery often creates new alternative and unplanned possibilities.

> For many organizations KM is a journey - you pass interesting places, you learn more as you travel, you rejuvenate yourself, but there are the inevitable detours and dead ends. As for your ultimate destination - will you ever arrive? After all, when you arrive at one place, there is still more to be discovered.[75]

There is clearly a careful line to be trodden not to stifle innovation, but it is not acceptable to have an unclear end-state. The end state must as a minimum be defined in theoretical, if not practical terms. It must then be broken down to shorter manageable steps, which can be quantified through prototyping, before any attempt at force wide integration. Any other course of action is likely to end in disaster. It is for this reason that one of Davenport and Prusak's principles for knowledge management is to always develop a prototype first to prove each incremental step of a knowledge development.[76]

Future Operational Environment

The environment NEC is now required to operate in is different to the environment for which NC was first envisaged. The chances of major conventional wars are decreasing whilst

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[74] *Ibid.,* 11.

[75] David. J. Skryme, "Making Sense of KM," I^3 UPDATE / Entovation International News [on-line], no. 72, available from: http://www.skyrme.com/updates/u72_f2.htm; Internet; accessed 27 October 2004.

[76] Davenport, *Working Knowledge…*, 24.

the growth of asymmetrical and urban warfare are widely acknowledged. Many authors including Libicki,[77] Metz[78] and Mitchel[79] all support this planning assumption. The rise in asymmetric warfare is also specifically acknowledged in the UK's vision of the future battlespace.[80] The NEC Guide specifically states "NEC will directly contribute to and affect the way in which we achieve our priorities of winning the war on terrorism and conducting joint warfighting."[81] How it will assist the former is perhaps unclear as the majority of authors argue that Information based warfare "works best against industrialized warfare and much less well against pre-industrialized warfare."[82] NEC must be equally capable of engaging 1st and 2nd RMA wave opponents at the same time as 3rd wave opponents. This could be required in a very limited time and space envelope as popularised in the three block war concept.[83]

RAND research by Gombert *et al* offers an important and some what counter view to the notion that NC is only suitable for large scale conventional conflict. It primarily focuses on the

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[77] Martin Libicki, *The Mesh and the Net*, 85 quoted in Stephane Lefebvre, Michel Fortmann, Thierry Gongora, ""The Revolution in Military Affairs": Its Implications for Doctrine and Force Development Within the U.S. Army," in *The Operational Art Developments in the Theories of War,* ed. B.J.c McKercher and Michael A. Hennessy, (Connecticut: Praeger, 1996), 175.

[78] Metz, *Asymmetric Threats*...

[79] Mitchel, *Utility of Force*...

[80] Ministry of Defence, *Network Enabled Capability – An Introduction…,* 5.

[81] *Ibid.*

[82] Martin Libicki, *The Mesh and the Net*, 85 quoted in Stephane Lefebvre, Michel Fortmann, Thierry Gongora, ""The Revolution in Military Affairs": Its Implications for Doctrine and Force Development Within the U.S. Army," in *The Operational Art Developments in the Theories of War,* ed. B.J.c McKercher and Michael A. Hennessy, (Connecticut: Praeger, 1996), 175.

[83] Gen. Charles C. Krulak, "The Strategic Corporal: Leadership in the Three Block War," *Marines Magazine* (January 1999); Available from: http://www.au.af.mil/au/awc/awcgate/usmc/strategic_corporal.htm; Internet; accessed 28 January 2005.

US, but specifically expounds the relevance of the study to the UK and other NC developing nations. It argues a strong case for the utility of NC in "non-permissive contingencies short of major expeditionary war." This is a very important area of consideration for NEC, as recent history supports their view that western forces are increasingly likely to be engaged in these types of scenarios.[84] They argue NC was originally envisaged to empower small and nimble units, against larger heavier and slower massed formations, through greater situational awareness and access to firepower. In operations short of major war this empowerment of small forces is also particularly significant.[85] This cross scenario relevance does however drive a number of development considerations when considering operations short of major war:

> Operational challenges may be different than those encountered in war, so the capabilities required may also be different. Although the U.S. military is unlikely to build major capabilities that have no utility in large wars, force-planning and investment priorities could be affected if warfighting capabilities are also beneficial for operations lower on the spectrum.
>
> Designing versatile capabilities requires careful attention. Capabilities designed with only intense warfare in mind could prove clumsy or inflexible in other contingencies. Ensuring that forces will be robust across a wide band of plausible circumstances and uses demands analysis of those circumstances and uses.
>
> Concepts of operation could differ between war and other segments of the spectrum. As the concepts for using networked forces are being developed, they must not be limited only to the problems and tasks associated with war.
>
> Examination of networking beyond war is necessary if there is to be a broader theory to guide transformation, development, and restructuring for whatever the long-term future holds.[86]

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[84] David. C. Gombert, *et al,* "Stretching the Network – Using Transformed Forces in Demanding Contingencies Other Than War," 2, available from: http://www.rand.org/publications/OP/OP109/; Internet; accessed 6 January 2005.

[85] *Ibid*., 4.

[86] *Ibid*., 6-7.

It is immediately clear that their study has serious implications for the Knowledge Network, when an assessment is made of how knowledge intensive each NC supported activity is. Almost all the cited tasks are clearly knowledge intensive.

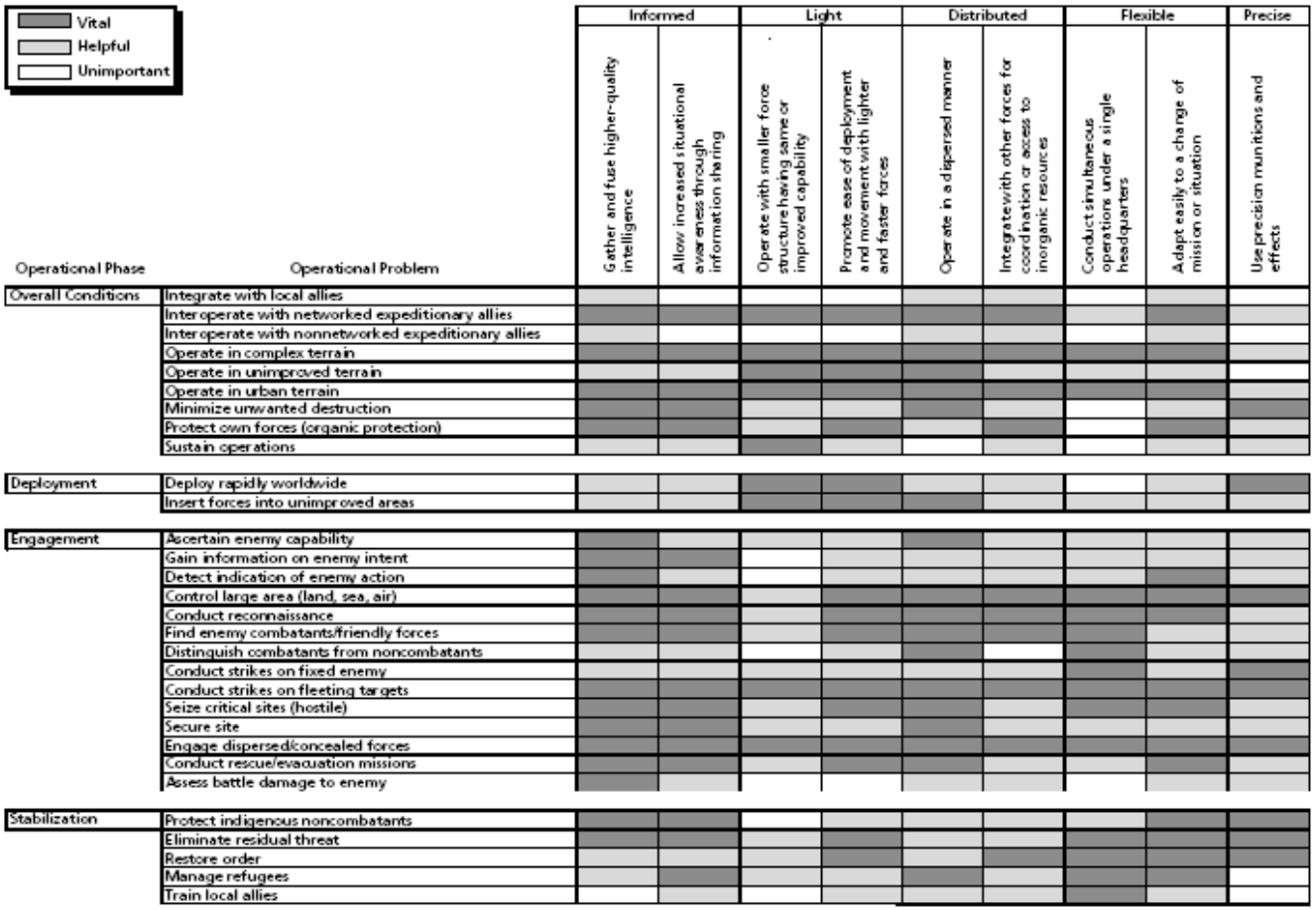

Figure 10 – Effects of Networked Forces on Operational Problems[87]

[87] The capabilities of Networked Forces are described as "Better Informed, Lighter, Easier to distribute, More flexible, More precise." David. C. Gombert, *et al,* "Stretching the Network – Using Transformed Forces in Demanding Contingencies Other Than War," 617, available from: http://www.rand.org/publications/OP/OP109/; Internet; accessed 6 January 2005.

There are no simple answers to this problem. Knowledge learning and development in one area often has spin offs into others. If however the developers of NEC understand the potential alternative uses and areas of benefit from NEC there is a better chance of developing the equipments (technology), processes and culture to support them.

To achieve this understanding RANDs insight of alternative NC activities could be more directly applied in the design and engineering of the currently envisaged information management component of the network. Applying CommonKADs Knowledge engineering approach would allow non-technical staff to quickly focus on knowledge bottle-necks in military planning and operational processes and gain a clear understanding of the tacit aspects of knowledge. Schrieber *et al* provide detailed guidance in the CommonKADS methodology on how to design and develop a knowledge management system to support identified activities. The methodology utilizes six models. The Organization model supports analysis of an organization. Its goal is to discover problems, opportunities and possible impacts of Knowledge Based Systems development. The Task model describes tasks that are performed or will be performed in the organisational environment. The Agent model describes capabilities, norms, preferences and permissions of agents (agents conduct tasks and may be people or information systems). The Knowledge model provides an implementation independent description of knowledge involved in a task. The Communication model models the communicative transactions between agents. Lastly, the Design model describes the structure of the system that needs to be constructed.

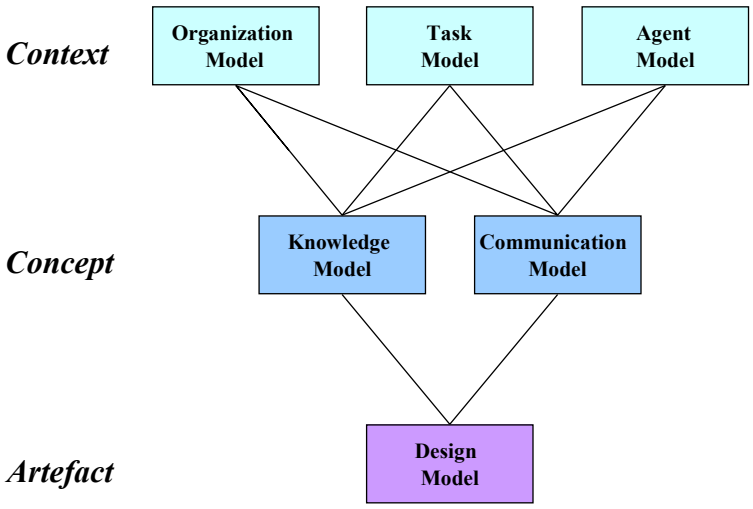

Figure 11 – Common KADS Model Set [88]

HUMINT Interaction

HUMINT will be become increasingly important in the complex asymmetric and urban environment. It will provide the vital intelligence input in environments, or against opponents, where it is difficult to take full advantage of technological advantages. Little thought appears to have been given on how to incorporate this human sensor element into the Network. The effective use of HUMINT requires efficient and timely conversion of tacit knowledge into actionable explicit knowledge. This will often take the form of time sensitive intelligence being translated into target information. The NEC network must be flexible enough to allow inputs from HUMINT as well as electronic sensors. Again this lays an important requirement on the knowledge management component of the network, as correlating HUMINT against other

[88] Schrieber, *Knowledge Engineering and Management*…, 18.

sources such as SIGINT and ELINT will be vital. This will place a heavy burden on the system in terms of the quantity of information and range of inputs it must be able to cope with.

McKeirnan argues that the lack of HUMINT available to him prior to the invasion of Iraq in Operation IRAQI FREEDOM had a significant effect on his ability to assess the situation. It had particular significance in his ability to confirm whether WMD existed or not, the intent of paramilitaries, the state of Iraqi infrastructure and societal reactions to the invasion.[89]

The most important part, and the most difficult to get right, in almost any KMS is the people and culture, or 'human,' element. Technology is usually actually the easiest. The CommonKADS agent modeling techniques described previously would help produce a clear understanding of how both human and computer agents need to be incorporated in the ultimate design of the NEC network, to include for example the intelligence collection cycle. This concept has already been well proven in the Northern Ireland theatre of operations, through the all source cell intelligence concept. This essentially human organisational construct allows for the effective fusion and filtering of intelligence within the Province.

Security and Reliability of the Network

Many proponents of NEC argue that increased survivability will be achieved through the wide spread distribution of the linked weapon and sensor platforms on the network. Conversely though, if the network is brought down, all the platforms could potentially be compromised.

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[89] McKiernan, *Command of Land Operations*…

Without the ability to communicate, or share situational awareness, platforms become isolated and vulnerable. This places huge significance on the reliability and security of the network.

> While the proliferation of information and information technology can be a great advantage, it is also a potentially significant risk that must be accounted for in every operation. Protection of soldiers and equipment, although not new, has increased in importance in today's information-rich environment. Friendly information and INFOSYS must be protected throughout the battlespace.[90]

Blash argues commercial history is littered with examples of major information, processing or communication based computer system failures. Likewise, examples of security breaches, such as hacking, are just as common.[91] The significance of such a failure on the NEC network is of course, of an altogether different magnitude. Computer Network Attack (CNA) is a reality of Information Operations in the 21st Century. The network like any other INFOSYS must be protected at the "electronic, physical and human level" within the Command and Control Warfare (C2W) C2-protect construct. These measures will be unable to completely mitigate the risk of attack, as there will never be enough resources to adequately protect everything. Risk must therefore be carefully managed, ensuring that at least essential information is identified and protected.[92] The security, reliability and risk management of NEC must therefore be of the highest order to not only protect the platforms on the system, but also the knowledge it contains.

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[90] United States, Department of Defense, *Field Manual No. 100-6. Information Operations…,* Chapter 2.

[91] Blash, *Network Centric Warfare Requires a Closer Look*…, 3.

[92] United States, Department of Defense, *Field Manual No. 100-6. Information Operations…*, Chapter 2.

This is not a new concept, but stresses the importance of human procedural protection as well as technical and physical protection. All three concepts have been widely employed within UK Electronic Warfare doctrine for many years. The implementation of this doctrine has however primarily been the responsibility of a limited group of Royal Corps of Signals experts, who understand the CNA risks, rather than the wider group of military users that will use the network in the future. If there as any lesson to be drawn from EW experience it is that only sound training will ensure the correct procedures are applied. This is again a human, rather than technological issue that NEC must accommodate.

That is not to say that technology does not also play a vital part. An effectively engineered technology component can considerably reduce the risk of attack. Again, applying sound IT development and Knowledge Engineering principles can help to ensure technological protection of the network and its knowledge. Applehans *et al* provide a useful technical architecture model which allows easy consideration of security and reliability at each level.

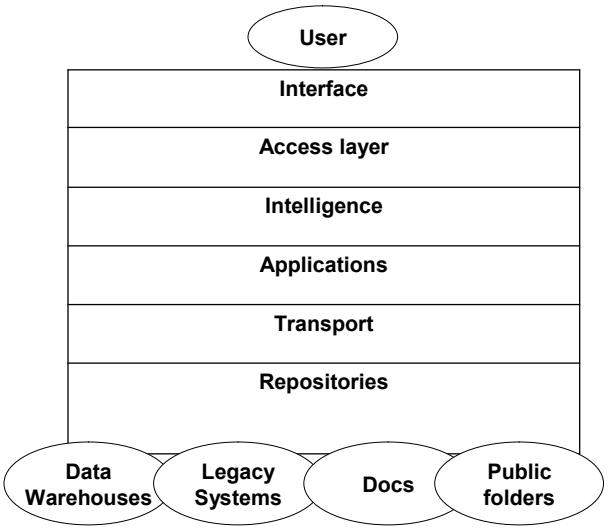

Figure 12 – Layers of Technical Architecture [93]

Affect on Mission Command and Manoeuvrist Doctrine

NC can very easily support centralization and positive control.[94] This is potentially very dangerous in eroding one of the stated core aims of NEC, which is to support decentralized decision making and mission command. Gompert *et al* argue that recent operations in Afghanistan and Iraq show that "networking is reinforcing a tendency towards centralized C2 within the U.S. military and is thus not delivering the benefits of decentralized decision making."[95] The temptation for senior commanders and politicians to want to exercise direct control to the front line, when related to politically charged time-sensitive targets, such as a

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[93] Applehans, *Managing Knowledge…*, 87.

[94] Giffin, *A Woven Web of Guesses, Canto One*…, 19.

[95] Gombert, *Stretching the Network* …, 23.

hijacked airliner, or a transiting terrorist vehicle, is perhaps understandable. Once technology allows the senior commander to actually press the button, the question has to be asked who is likely to end-up pressing it? There is undoubtedly an unhealthy potential for over command.

NC has the potential to enable "command-by-direction" at the operational level, something that since the 1800s has arguably only been possible at the lowest tactical levels. This is perhaps one vision of NCW in the US context. It is certainly one Czerwinski applies to the Force XXI concept.[96] This use would however arguably be an abuse of the true NCW concept which aims to allow rapid decentralised decision making and action in time constrained and uncertain situations.

Detailed control does offer some advantages, in particular in terms of safety control and when restrictive Rules of Engagement (ROE) mean the operation requires close monitoring, reporting and control. It is not however well suited to rapidly changing situations or when the vertical control flow is interrupted. Orders must be able to flow down and information back-up for the concept to work.[97] Czerwinski argues that the complexity of the technical support required for this style of command in the 21st century negates its feasibility and a mission command approach is the only option.[98]

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[96] Thomas, J.Czerwinski, "Command and Control at the Crossroads," Parameters 26, no. 3 (Autumn 1996), 121-32 quoted in Dr Allen English, "Contemporary Issues in Command and Control," *Intelligence, Surveillance and Reconnaissance: Air Symposium 2001* (Toronto: Canadian Forces College Air Symposium Paper, 2001), 99.

[97] United States, Department of Defense, *Naval Doctrine Publication 6…,* Chapter 2.

[98] Czerwinski, *Command and Control at the Crossroads*…, 121-32.

Rousseau takes a different viewpoint and argues centralized control will always fail because even if perfect "battlefield visibility" can be achieved, the war environment is so inherently complex, it can not be captured in a single "physical picture." This single picture can in fact be dangerous as it may infer accuracy and finality and draw the commander into concentrating on the "space configuration" rather than the more difficult "temporal" one. He again argues that mission command and "decentralization is not merely one choice of command and control; it is the basic nature of war."[99]

The UK Military and the US Marine Corps plan to use NC to enable more effective "command-by-influence" or mission command.[100] This has a flexible and decentralized command and control construct. Decisions are moved to the lower levels with the aim of increasing tempo. Unity of effort is obtained through "spontaneous cooperation of all elements of the force" rather than "conformity imposed from above." As it is governed by an understanding of the commander's intent and mission it is less vulnerable to disruption than centralized control. It should also be better in rapidly changing situations.[101]

NEC could, if taken to the opposite theoretical extreme of maximized decentralization, allow a force to command itself guided only by the commander's intent and information from the Common Operating Picture.[102] This potentially radically advances the current doctrine of

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[99] Col Christian Rousseau, "Complexity and the Limits of Modern Battlespace Visualization," *Canadian Military Journal*, Vol 4, No 2 (Summer), 37-44.

[100] Czerwinski, *Command and Control at the Crossroads*…, 121-32.

[101] United States, Department of Defense, *Naval Doctrine Publication 6…,* Chapter 2.

Mission Command. Are commanders ready for such highly empowered subordinates and for such a fluid battlespace? What are the training requirements to support it, when so much will be expected of all participants? There is clearly a spectrum of Command and Control that NC can support.

There is also perhaps a third possibility for NC enabled command. Czerwinski also mentions Frederick the Great's "command by plan" which was invented to overcome the weaknesses of command by direction. This style of command could logically be resurrected by NC. Czerwinski implies it is now only of limited use at the Strategic and Operational level due to its inability to cope with unforeseen change. If however we look to the future there is no reason why a human commander could not provide a plan to his army of robots to efficiently prosecute. This would undoubtedly be based on attritional tactics, where machines can resort to the oldest tactic for success in warfighting the total destruction of the enemy. Many authors argue history suggests that attritional warfare is much more successful in achieving long term success. It has only really been ruled out as the preferred tactic, in deference to Manoeuvre warfare, by western nations in the last two hundred years, because they are no longer prepared to accept the friendly casualties it inevitably creates. When the only friendly casualties are a few robots will attitudes change? Surely this is more likely as we face more radical asymmetric opponents, who can not be reasoned with, and can sometimes only be stopped by physical elimination.

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[102] Giffin and Darryn. J. Reid, "A Woven Web of Guesses, Canto Two: Network Centric Warfare and the Myth of Inductivism," 6, Available from: http://www.dodccrp.org/events/2003/8th_ICCRTS/pdf/109.pdf; Internet; accessed 6 December 2004.

If we take Pigeau and McCann's view on command and control[103] a step further and decide that in the 21st century the key components of command are planning (which includes decision making during planning) and decision making during the execution of the operation; and that the key components of control are the synchronization of effects and the coordination of forces and then apply them to Czerwinski's three command styles, we can see some interesting opportunities for the exploitation of NC. It also perhaps provides two opposing alternatives for the original NCW vision. Each has its merits and problems and these will also vary depending on how far down each path NC is pushed. Czerwinski and Rosseau dismiss command by direction, but arguably it has clear benefits in some cultures and for armies who can only conduct limited training. If Czerwinski's technological concerns can be overcome it may still yet become a better solution than mission command. After all it only stopped being the preferred method of command two hundred years ago because the battlefield became too complex for one commander to control. If technology can effectively turn back the clock it may well return to being the favoured method of command.

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[103] Dr Ross Pigeau and Carol McCann. "Re-conceptualizing Command and Control." *Canadian Military Journa*l, Vol 3, No 1 (Spring 2002), 56.

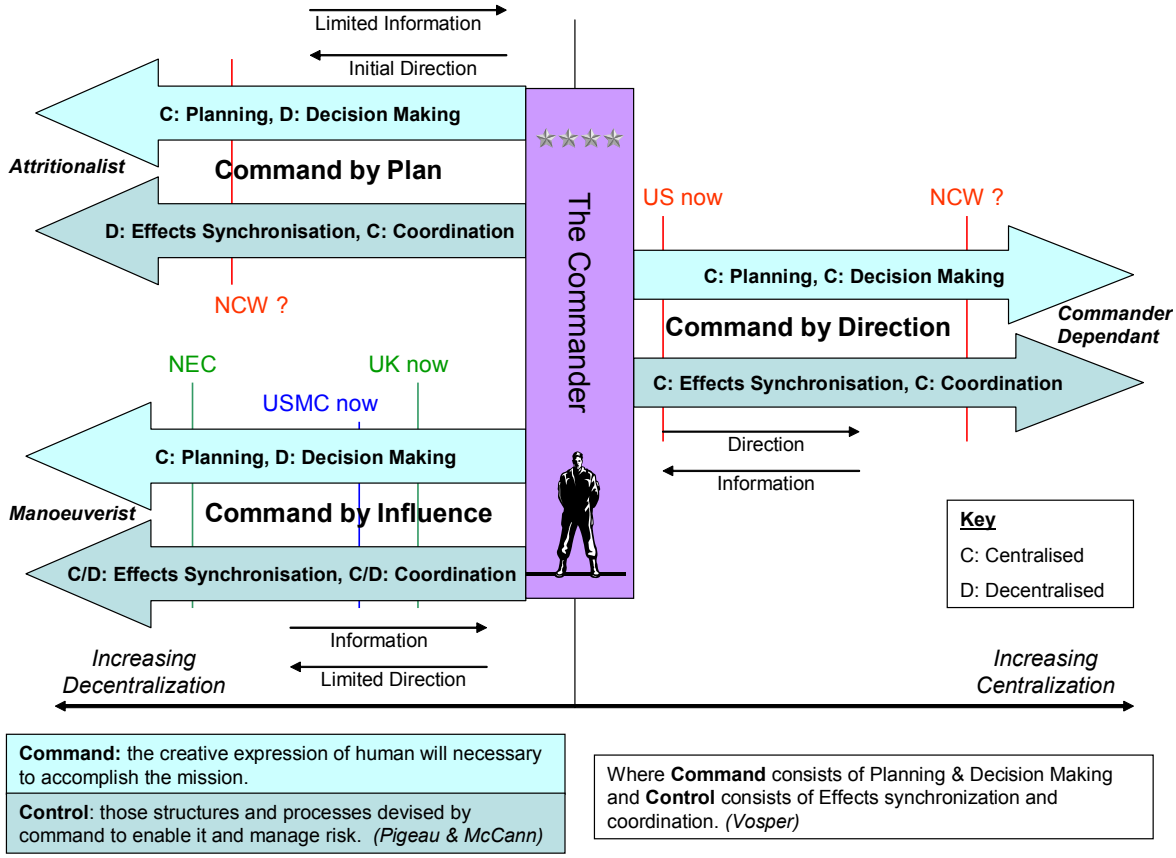

Figure 13 – The Command and Control Spectrum [104]

NEC has stated it does not wish to put the network at the centre of capability in the same doctrinal way as NCW, but how will mission command and manouevrist doctrine be physically protected and where exactly on the spectrum between centralized and decentralized command and control do the UK want to end up? All these proposed options will have the commander in some way central to them. The UK must be clear about what direction it is taking the NEC concept and must decide how far it wishes to take it in that direction. This will fundamentally affect its form and scope. As has been shown there are clearly a number of divergent possibilities. Once a clear decision has been made UK doctrine must then protect mission

[104] Author derived.

command and the manoeuvrist approach, and clarify how it will change with the introduction of NEC. The technology component of the network must not be allowed to lead the people and processes element, in the same way as NCW appears to be leading the Americans down the path to more centralised control.

Business Case & Benefits

The UK MOD currently have no overall business case for NEC. This is all the more important as the US NCW experience demonstrates that the cost of transformation is potentially spiraling out of control. A lack of a proper business case also flies in the face of its own SMART procurement guidance. The UK MOD have taken the position that it is difficult to provide a quantifiable benefits assessment for the whole NEC proposition, as the system will be developed in an evolutionary manner and it effects so many projects already in the Equipment Programme. The UK have therefore adopted a Benefits Chain approach which can be used to allow assessments for individual procurement aspirations. As described earlier this relies on the basic tenet that better networks will ultimately lead to better effects.[105] It has already been demonstrated this is a misguided interpretation of Metcalf's law. There is also a danger that benefits will primarily be delivered to the senior command and staff minority. They will be the early beneficiaries of enhancements in situational awareness.[106]

Gartner argue, with reference to the commercial arena, that this lack of shared benefits will not encourage take up of the new systems by the majority. This has proven a common cause

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[105] Ministry of Defence, *Network Enabled Capability – An Introduction…,* 9.

[106] Giffin, *A Woven Web of Guesses, Canto One*…, 18.

of IT project failure over the last twenty years. Gartner recommends focusing benefits for KM initiatives in three areas: Business Goals, Workplace Goals and User Goals. By providing perceived benefit to everyone the implementation has a far higher chance of success.[107]

These groupings relate closely to John Adair's "Task, Team and Individual needs," with which, military personnel will be much more familiar with, from the military leadership context. Adair's simple "Action-Centred Leadership" concept provides a model for the leadership and the management of any team, group or organisation. He argues:

> Good managers and leaders should have full command of the three main areas of the Action Centred Leadership model, and should be able to use each of the elements [task, team and individual] according to the situation. Being able to do all of these things, and keep the right balance, gets results, builds morale, improves quality, develops teams and productivity, and is the mark of a successful manager and leader.[108]

Adair is effectively arguing that they must all be fulfilled if an organisation is to prosper and perform well. Likewise, if a KM initiative supports all three areas it will therefore increase the chance of its successful adoption.

Without a business case and a clear plan for implementation it will be impossible to prioritise defence expenditure on NEC. NEC expenditure will effectively be hidden across numerous projects in the Equipment Programme. Overall visibility will be highly limited. If a programme level business case was developed it would be possible to start to prioritise

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[107] K. Harris, *The Business Case for Knowledge Management*, Gartner Symposium Florida October 2003 Report, Gartner, 2003.

[108] Businessballs.com, "Action Centred Leadership," http://www.businessballs.com/action.htm; Internet; accessed 10 Jan 05.

expenditure against the elements of NEC which are expected to deliver the most benefits to deployed forces. Benefits can then be considered in detail for each value chain proposition as it is developed. This would of course be much easier if NEC is delivered in clearly prioritized increments, rather than as currently planned a loosely controlled evolution.

NEC Development Issues

Evolutionary v Incremental Approach

Perhaps the greatest current NEC issue is its evolutionary development approach. An evolutionary development approach to delivering NEC without a clearly specified end state and no overall business case is highly risky and unlikely to be resource efficient. The UK have loosely labeled development in three stages "Initial, Transitional and Mature," but no real indication is given on the capabilities expected at the end of each stage.[109]

The IT industry has ably demonstrated the generic problems with big-bang and evolutionary development approaches. Controlled increments have proved far more successful in resource effective delivery. The UK's selected approach may be a cultural backlash to super projects that are perceived to never 'deliver' or the difficulties of establishing an NEC programme when it effects so much of the existing Equipment Programme.

Demchak argues the UK have a poor record of change management and equipment procurement. He also argues it has a poor record of being able to support complex high

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[109] Ministry of Defence, *Network Enabled Capability – An Introduction…,* 11.

technology systems. He argues this is as much a reflection of UK society, which does not have a German style 'engineering culture,'[110] as specific failings in the UK's procurement processes. The introduction of SMART procurement appears to be improving the system,[111] but if SMART procurement guidelines are to be effectively ignored it can not perceivably help.

Delivering NEC is a huge undertaking and its magnitude and complexity should never be overlooked. It will be nearly impossible for the current coordinating structures (e.g. the 1 Star NEC Group) to deliver NEC effectively and efficiently without a clear pan-equipment programme plan. The basis of project control is the 'plan, execute, monitor' control loop. Without a clear plan it is almost impossible to monitor progress and therefore apply effective control.

The required plan should be developed by identifying clear increments. The plan should aim at the synergy of highest payoff systems first, whilst implementing common data standards to eventually allow the alignment of all systems in the long term. The concept of targeting quick wins first, whilst laying the conditions for effective future development, is well inculcated in modern IT and KMS development. This apparently simple lesson has however, been learnt the hard way and at considerable expense to industry, the UK military should not relearn this lesson.

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[110] Chris. C. Demchak, "Coping, Copying, and Concentrating: Organizational Learning and Modernization in Militaries (Case Studies of Israel, Germany, and Britain)," *Journal of Public Administration Research and Theory*: J-PART, Vol.5, No3 (July 1995), 358-361.

[111] Colin Graham, "Arming the Forces," *Defence Director,* (January 2005), 5-8.

EBO have already demonstrated the benefits of vertical slices of the network. The development of such slices could provide NEC's quick wins. Garstka cites many examples from as early as the mid nineties.

> One of the best examples of how networking and digitization can be leveraged to create an information advantage took place in a training exercise in the mid-1990s when Royal Air Force (RAF) Tornado aircraft from U.K. 29 Squadron with tactical datalinks defeated U.S. Air Force F15Cs with voice-only communications in a series of air-to-air engagements that took place during a red flag exercise in the airspace over the Nellis Air Force Base range. Historically, the most favorable outcome that the absolute best RAF pilots could manage when flying against F-15Cs was a draw. However, when the RAF introduced a datalink in the form of Link-16, U.K. 29 Squadron pilots, flying with new innovative tactics, were able to increase their kill ratio over the F-15Cs equipped with voice-only communications to approximately 4-1.[112]

Damchek argues this concept of delivering increments, one at a time, has been core to the Israelis highly effective approach to equipment development and integration. The Israelis have been far better at implementing change than the UK. They have also managed it without negatively affecting capability, a key requirement, given their on going security situation. Each technological increment is supported by a heavy emphasis on training to ensure the people and process element is brought up to speed and the introduction of the new capability is truly successful.[113]

KM initiatives are not exempt good Programme and Project Management. Skryme cites having a "disciplined structured approach to major development projects" as a key criteria for success. This requires staff with "core skills in change management and many of the specific

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[112] Garstka, *Network-Centric Warfare Offers Warfighting Advantage…,* 5.

[113] Demchak, *Coping, Copying, and Concentrating*…, 351.

techniques of information and knowledge management (especially those with a strong human element)."[114]

Technology first

Blash argues that normally in most evolutionary advances, in both the military and commercial arenas, the technological and scientific innovations come first. The technology to fulfill NC or NEC is not yet fully available. He is however quite right to argue that the potential of NC is promising, so it is worth spending some resources in investigating the concept to prove that it is viable. Ultimately, without continual experimentation, technological advances and maintaining a technological advantage relative to the enemy is simply not possible.

Two of the prime technologies that NC is currently envisaged to be based on are Microsoft data and internet technologies. These are currently immature and security issues are aired regularly in the IT media. For these reasons Blash argues that funding should be only made available for "advanced and actual prototype systems" if the concept is first proved viable.[115]

Again, this points to an incremental development approach which involves prototyping. The UK can not afford a broad conceptual test-bed *a la* the US Force XXI, because it is simply unrealistic in cost terms. This therefore again, logically drives the UK towards prototyping and developing NEC in slices starting with high value slices of the network, in conjunction with the

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[114] Skryme, *Making Sense of KM.*

[115] Blash, *Network Centric Warfare Requires a Closer Look*…, 1.

required weapon and sensor capabilities. This follows Davenport and Prusack's basic KM principle that all KM developments should start with a prototype.[116]

Technical Standards

The key to interoperability between the multiple components of NC is a set of common data standards. All higher level information and explicit knowledge will be transportable if the basic data building blocks are aligned. NEC currently has no comprehensive set of data standards. The UK MOD is in fact finding it hard enough to integrate in-camp IT systems in the Defence Information Infrastructure (DII) Programme. The complexity of integrating current weapons platforms, IT systems and sensors, let alone those under development, that will be required under NEC is of an order of magnitude higher. The US dilemma is even greater due to the even greater number of systems and initiatives to be integrated. They did however start to address the issue as early as 1993:

> The AES and other initiatives like C4I for the Warrior are reinforcing the important contributions INFOSYS make to information-based warfare. Of particular importance is the evolution of the Army's comprehensive information architecture with its three supporting initiatives focused on *operational, system,* and *technical architectures.* When completed, this initiative will create a common operating environment (COE) of standardized, interactive systems and templates for the collection, storage, and manipulation of all Army data bases…The technical architecture will establish a set of rules governing the arrangement, interaction, and interdependence of all the parts and elements that together constitute our INFOSYS. It specifies the permissible standards for designing C4I capabilities and is critical to the creation and maintenance of interactive systems.[117]

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[116] Davenport, *Working Knowledge*…, 24.

[117] United States, Department of Defense, *Field Manual No. 100-6. Information Operations*…, Chapter 2.

If data standards are not set early there is huge danger of difficult and highly expensive reengineering being required later. Data standards are the 'foundation of the NEC house.' You do not want to have to change the foundations once any part of the house has been built. The US have applied comprehensive data standards to ensure all currently ongoing and future equipment developments are NCW compliant.[118] The UK would be well advised to follow suit.

Dealing with Information Overload

"Drowning in data, yet starved of information." [119] This short quote from Stanat's *The Intelligent Organization* epitomizes the growing dilemma most large IT rich organisations face today. In many organisations the same dilemma arguably exists a level up, drowning in information, yet starved of knowledge. Either scenario can result in 'information overload.'

> One of the dilemmas facing today's manager is that on the one hand they seem to be suffering from information overload, yet on other hand, they often they complain about shortage of information needed to make vital decisions…Symptoms of overload are a growth of incoming information, including electronic mail, an explosion in the volume of information sources (there are over 10,000 business newsletter titles and a similar number of CD-ROM titles). Symptoms of scarcity are the lack of vital information for decision making, unexpected competitor moves and the inability to find the relevant 'needle in the haystack'. [120]

In the military context it has to be asked at what point does more information only exasperate the fog of war rather than bring clarity? At overload people and/or IT systems are

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[118] United States, Department of Defense, *Net-Centric Checklist May 12, 2004 Version 2.1.3.* Available from: http://www.defenselink.mil/nii/org/cio/doc/NetCentric_Checklist_v2-1-3_May12.doc; Internet; accessed 24 January 05.

[119] Knowledge Connections, "Information Resources Management," http://www.skyrme.com/insights/8irm.htm; Internet; accessed 27 October 2004.

[120] *Ibid.*

incapable of dealing with the sheer volume of information or knowledge. This situation has already become a prevalent issue in the US military and transformation is not yet complete. This is not just a fault of the availability of information, but also the natural tendency in humans to want to be able to see the complete picture before making a decision.

> Today, commanders operate in an environment increasingly marked by the rapid flow of information and decisions among strategic, operational, and tactical levels. These factors are complicated by an explosive expansion in the opportunities for access and the manipulation of operationally relevant information by the wide array of individuals, organizations, and systems found in the GIE.[121]

For example, English cites that during Operation Allied Force, the air war over Kosovo and Serbia in 1999, the NATO forces had clear information superiority with tremendous amounts of data. This data could not however, be interpreted in a timely fashion and transformed in to the knowledge the commander required for his campaign planning or its execution.[122]

Similarly McKeirnan's experiences from Operation IRAQI FREEDOM also provide a powerful example. He argues that US C4ISR technology gave him "Information Superiority,"

The right technology and processes then needed to be in place, to track the progress of decisions he had made, in order to provide him "Execution Superiority."[123]

Like Fulton he uses the term "decision superiority" in the military context, but again he is describing knowledge superiority. Rather worryingly, this situation is only likely to get worse. Theoretically NEC has no limits to the amount of information the network will demand as more nodes are added. This will cause information overload, an unsustainable demand for bandwidth and an ever increasing need for specialist staff and resources to conduct information and knowledge management.[124]

McKeirnan's experiences highlight a clear warning for NEC. It must be careful to focus on the people and process element of the network to ensure they have capabilities to translate information into actionable knowledge for the commander. As previously discussed 'the electronic brain' may never be able to achieve this.

Commercially this discipline is being described as Information Resource Management (IRM). Information and knowledge are treated as a tangible resource and actively managed. The human element of this activity is acknowledged as key by Skryme.

> Good information management involves 'data mining', 'information refining' and 'knowledge editing'. You can use technology such as intelligent agents, to help, but ultimately subject matter experts are needed to repackage relevant material in a user friendly format.[125]

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[123] McKiernan, *Command of Land Operations*…, 10.

[124] Giffin, *A Woven Web of Guesses, Canto One*…, 16-18.

Skryme also argues that Knowledge centres often play an important part in introducing effective IRM into an organisation and providing a cost effective solution.[126] Knowledge centres consist of well trained and resourced staff and systems to effectively manage and deliver knowledge as a centralized function. The implication for NEC is that it must implement the human resources and processes to conduct this activity. Additional manpower and training is likely to be required in headquarters staffs at every level of command, as they simply do not currently have the skills, or manpower, to conduct the task effectively.

The commander must also be shielded from too much information of an inappropriate level. With so much information available there is a danger of commanders getting embroiled in too much detail. For example, it is inadvisable for the Divisional Commander to be directing the actions of his point section. The temptation can be to micro-manage. This not a new problem, and good leadership can still prevent it, but the temptation is likely to be greater when technology makes it so easy.

KM acknowledges this dilemma and almost all knowledge management methods focus heavily on matching the required knowledge to an individual or team dependent on the task they perform. They then focus on making the delivery as efficient as possible through the most appropriate means. They enforce sensible knowledge delivery processes (how much knowledge of what type) through optimised interfaces or communication means.

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[125] David Skyrme Associates, "Insights No.8 - Information Resource Management," http://www.skyrme.com/insights/8irm.htm; Internet; accessed 24 January 2005.

[126] *Ibid.*

A popular alternative to Common KADS is provided by Applehans *et al.* The methodology storyboards processes identifying content centres and allowing requirements for lower level knowledge satellites to be identified. These satellites can then be given ownership to ensure effective management. Centres of gravity around which information orbits can then also be identified. This information can then be used as the basis of any web design (intranet, extranet, internet). As NEC will be based on web technologies, this specifically web based approach may prove highly effective.

The US Army have adopted a schema for content mapping based on subject and usage categories of Relevant Information (RI). The subject categories are "METT-TC: mission, enemy, terrain and weather, troops and support available, time available and civil considerations."[127] The usage categories are: "COP-related information, Execution information, Exceptional Information and Essential elements of friendly information."[128] This IM framework provides the structure through which the KM Cycle can identify, plan, acquire, etc, the required knowledge and ultimately put the commander's decisions into action. These are contents centers in the context of Appelhans *et al's* methodology and shows how easily this KM approach could be applied.

US Operational Systems already employ tailoring where the commander and staff can adjust their "display for resolution and content appropriate to their echelon of command and the

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[127] United States, Department of Defense, *Field Manual No. 6-0…*, Appendix B, para B-10.

[128] *Ibid,* Appendix B, para B-55.

mission." This means their systems provide them with the right near real-time RI on the current situation from the Common Operating Picture (COP).[129]

The UK Measurement of Power (MFP) System (for Operational Readiness Reporting and Management) and the infrastructure focused MFP 2 for Regional Forces are both good examples of in barracks Knowledge Management systems which achieve this. The careful consideration of what information the commander would need, during the system's design phase, has ensured an easy to use interface which ensures only the 'right' level and type of information is delivered to the commander to base his decisions upon. NEC must apply the same logic to it's development. The 'need to know' principle has been applied in the past for the sake of security. It may now have more relevance in preventing information overload.

The other side of information overload is the failure of technology. The size of the network is potentially limitless. The communication capability is however always finite and governed by physical bandwidth limitations. Dealing with this constraint requires realism on physical expansion of the network and the nature of information transfer permitted. Just because a system can transmit video for example, does not mean it is always appropriate for it to do so as it is highly bandwidth intensive and may negatively effect more important knowledge transfer. This is as much a matter of user education, in terms of appropriate electronic working practices, as technical controls.

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[129] *Ibid*, Appendix B, para B-57.

Training

The quality of training will prove vital to the success of NEC. NEC will be far more complex and technology focused than anything that currently exists militarily. It will require high computer literacy from almost all military personnel and a sound understanding of the processes to be employed. This will undoubtedly deliver a heavy burden in terms of training. Demchak's study of organisational learning within the German, British and Israeli militaries clearly highlights the issue. "Increased complexity in modern machines imposes a knowledge burden on the organisation attempting to use them."[130]

It is common knowledge that the UK's implementation of its new BOWMAN Digital Radio system has required much more training than originally envisaged, in particular in terms of refresher training to address skill fade from the initial training package. What is worrying is BOWMAN is one of the simpler underlying technologies for NEC.

This is not purely a UK problem. The US Rangers, a special forces unit, have recently received CDA (a handheld dismounted equivalent of the Force XXI Battle Command, Brigade-and-Below (FBCB2) system). It can transmit data files, imagery and video; as well as support online 'chat' messaging and voice over IP. It also provides blue force tracking, a whiteboard facility (between commanders) and even the ability to operate tactical fire direction software. This is much closer to the envisaged capability of NEC and the key lessons learnt from its implementation where training based. "A condensed version of training was not feasible – four

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[130] Demchak, *Coping, Copying, and Concentrating*…, 347.

to six weeks of training would be required."[131] This begs the question if it takes special forces 4 – 6 weeks to train on a system short of the full NEC capability, how long will it take less intelligent ordinary soldiers with a more complicated system? Considering the UK's current operational tempo and existing stresses on the training system, it is unlikely such an additional training burden would be acceptable.

One of the key challenges is therefore of course to make new technology as easy to use as possible, but as more capability is incorporated it will inevitably become more complicated to use. KM advocates argue this is why a strong focus on the human element is vital when implementing such change. Skyrme observes:

> …One of the most common ones [issues] is that of the human-technology relationship. Technologists invent new and better technical solutions, then wonder why they don't work as planned. The answer is invariably the same - they didn't give due attention to the human factors: ranging from the user interface, training and development, through to individual psychology and social behaviours.[132]

NEC must address this human focused consideration or it will fail. There is however, a much more serious implication beyond training, if systems can not be made simple enough for the existing 'intellectual quality' of soldiers to operate. More intelligent soldiers may be required at all levels to deal with NEC. This would have serious implications on recruiting. It is highly unlikely, due to current UK demographics, that the Army would be able to attract the required quantity of young men and women of the required intellect, without major changes to

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[131] Patrick Chisholm, "Info-Warfare in the Palm of the Hand," *Defence Director,* (September/October 2004).

[132] Skryme, *Making Sense of KM*…

the perceived benefits of joining the Army. Such a change is likely to have a large and unsupportable financial cost.

CONCLUSION

The NEC concept is pivotal to the UK military. It provides the vision of how the forces will deliver the required effects based capabilities to operate in the 21st century effectively, whilst meeting environmental, demographic and fiscal constraints. NEC is based on three elements: sensors, shooters and a network. The network is the core element and is a complex knowledge management system. The network's ability to collect, control and disseminate the right information and knowledge to the right people at the right time is critical to the overall success of NEC. Though technology is the most widely popularised component of the network, it has two other more important components. The network actually consists of a human element, a process element and the supporting technology element. Dealing with human and process element issues, such as doctrinal issues and training, will prove more difficult and more important than developing the supporting technology. Technology is an enabler and must not be allowed to lead the development of the other two components.

NEC is by no means a perfect concept, it has many issues. At the highest level it has theoretical issues, which it shares with all Network Centric variants, such as NCW. It also has UK specific issues, at the conceptual level and at the physical development level. Despite these issues NEC is not an untenable proposition as most can be addressed with, now mature and well proven, knowledge management and project management techniques. Industry and the US, as NC world leaders, have already addressed many of the UK's issues. NEC has the ability not

only to provide considerable benefits in the conventional warfare context it was first envisaged for; but also in asymmetric scenarios involving complex terrain, primarily through its ability to increase situational awareness. Despite its issues NEC is certainly worth pursuing.

Core amongst addressing these issues is ensuring a clear vision and end state for NEC is articulated. This will set a clear scope for the initiative. This is vitally important as the UK has limited resources to deliver the initiative and it can ill afford to walk the wrong path. Importantly, the benefits of NEC are not infinite. They do not increase exponentially with the size of the network. There will be an optimum size for the network. Delivering NEC is undeniably a hugely complex undertaking which cuts across the entire Equipment Programme. It is therefore all the more important that NEC, like any major change initiative, must have a clear overall plan and business case to ensure it is coordinated across all lines of development.

The potential for NEC as technology advances is enormous. The further the concept is pushed the greater the implications. Clear increments must therefore be set and managed to deliver usable capability, which delivers high benefit from the start. EBO has demonstrated the potential for developing slices of the network independently and NEC must ensure that through an efficient incremental approach it provides quick win benefits first. The planned evolutionary approach is unclear, high risk and should be rethought.

The consideration of human issues will be critical to establishing the scope and allowing the effective implementation of NEC. Mission Command, military ethics, HUMINT and interoperability with coalition and NATO partners are all potentially severely affected by the

introduction of NEC. Positive benefits are however possible in all these areas, if each area is carefully considered and sound practices are adopted to develop the human component of the Network.

The process component must ensure HUMINT is effectively incorporated with technical sensor information and that doctrine protects and updates the mission command philosophy. It must also ensure that information overload is avoided and personnel understand and apply the right procedural security measures to protect the network. The technology component of the network is also very important. The right technology must be delivered to ensure reliability, interoperability and security issues are addressed. The design of the technology will also prove vital in ensuring training requirements are minimised and that information access is optimised through effective human computer interfaces.

Only by addressing all three components of the network, holistically and effectively, will NEC deliver its true potential efficiently. This requires the UK to open its mind to the possibilities, their implications and make some key decisions on where it ultimately wants to take NEC. NEC is not a fundamentally flawed concept, but it does have issues to be addressed. The network component is a knowledge management system and therefore many of the issues can be addressed by applying KM lessons learnt from industrial KM and military NC world leaders.

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