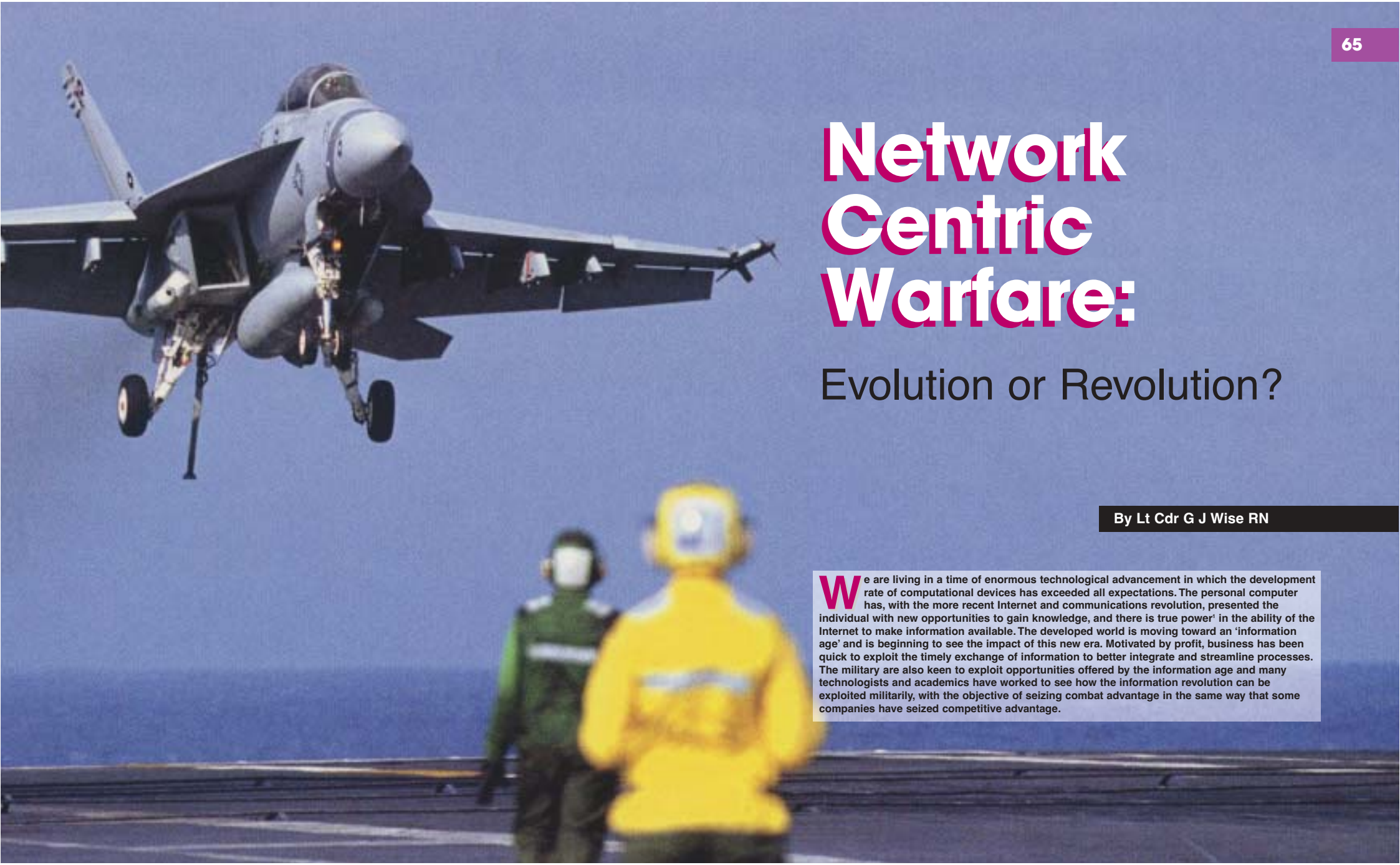

Network Centric Warfare:

Evolution or Revolution?

By Lt Cdr G J Wise RN

We are living in a time of enormous technological advancement in which the development rate of computational devices has exceeded all expectations. The personal computer has, with the more recent Internet and communications revolution, presented the individual with new opportunities to gain knowledge, and there is true power[1] in the ability of the Internet to make information available. The developed world is moving toward an 'information age' and is beginning to see the impact of this new era. Motivated by profit, business has been quick to exploit the timely exchange of information to better integrate and streamline processes. The military are also keen to exploit opportunities offered by the information age and many technologists and academics have worked to see how the information revolution can be exploited militarily, with the objective of seizing combat advantage in the same way that some companies have seized competitive advantage.

...will NCW ultimately be evolutionary or revolutionary?

The military exploitation of these new technologies may be contributing to a contemporary 'Revolution in Military Affairs' (RMA), which according to many occurs when the nature and conduct of warfare are radically altered. Whether this will be the case remains to be seen, but there is little doubt that recent conflict, with its emphasis on the use of stealth, precision guided munitions (PGM) and information,[2] indicates that new technology has brought about unprecedented levels of tactical military effect. In studying the nature and effect of new technologies, military leaders have sought coherence, and recent military operational concepts[3] are underpinned by the wider information revolution.

The US Navy has embraced this thinking and is in the vanguard. Their concept is called Network Centric Warfare (NCW), which is the subject of this paper. NCW has been described as 'an operational concept which marks a fundamental shift from platform-centric operations toward network-centric operations, deriving its power from the effective linking of dispersed knowledgeable entities'.[4] Working on the principle that information is power, NCW places 'information superiority' at its core and the US Joint Chiefs of Staff have noted that 'information superiority [is] a key enabler of the transformation of the operational capabilities of the joint force'.[5]

This is not a lightweight ambition and NCW will undoubtedly face many challenges on its journey from concept to reality. NCW is an immature discipline and its concepts are still being developed. As a result there are differing views on what it is, what benefits it can deliver and how it should be implemented. Yet NCW is already beginning to pervade UK thinking, raising the question of what NCW means for us. It is therefore timely to take a step back from the hype and present an analysis of NCW's claims and prospects.

This paper will therefore examine how the concept of NCW came about and its relationship with the wider contemporary RMA. It will then examine where NCW seems to be going to determine its military applicability and implications, unpicking the underlying concepts of 'shared awareness', 'speed of command' and 'self-synchronisation' to identify the prospects and challenges facing it. Finally, the paper will attempt to determine whether the journey will be successful in terms of revolutionising US Navy war fighting capability – will NCW ultimately be evolutionary or revolutionary?

This paper will not examine weapon technology, specifically the PGM whose tactical and strategic utility has been well proven in recent conflict. Nor will this paper plumb the depths of computer or sensor technology, as it is more important to explore the effect that the technology can create rather than the technology itself. Frequent reference will however be made to 'information', of which many different definitions exist. Throughout this paper we will take data to be unstructured observations or facts, and information to be data which are selected, summarised and presented to the recipient such that it is useful.

The paper concludes that the concepts of NCW are not far removed from current manoeuvre warfare doctrine, and the evidence thus far points more to an evolution of current capabilities than a revolution in the nature of war fighting. Underpinning NCW is 'information superiority', and while the promise of NCW advocates that the fog and friction of war can be lifted is a valuable idea, the reality is that the application of new technology is not the whole answer. Nevertheless, NCW will have a place in future war fighting, but it will need to be flexible (anathema to most military procurement) and the doctrinal, organizational and systemic implications will need to be fully explored if revolutionary change to the character of war fighting is a genuinely desirable outcome. These changes require the adoption of a culture which encourages experimentation and innovation. The reality is that resistance to change is likely to be fierce, and the most likely but benign outcome is a continuation of current war fighting methods, but made possible by 'better' information architectures.

THE REVOLUTION IN MILITARY AFFAIRS

To determine whether NCW might measure up to being revolutionary, it is necessary to consider what a 'revolution' in military affairs might constitute, assuming that such revolutions occur. Turning to contemporary thinking, one of the current RMA apostles is Admiral Bill Owens (Vice Chairman of the US Joint Chiefs of Staff from 1994-6), who believes that it 'promises to transform the application of military force far more than the stirrup, the machine gun, or even the nuclear weapon ever did'.[6] But what is this RMA of which Owens evangelises, and where has it come from?

The historian Krepenevich contends that warfare has been recurrently revolutionised through the ages, often by changes in technology,[7] and that when revolution occurs, it fundamentally alters the way in which wars are fought and won. However, the introduction of new technology on its own is not enough to revolutionise warfare, and Krepenevich argues that organisational adaptation and innovative operational concepts are also part of the transformation recipe[8]. Other schools of thought abound,[9] for example Van Creveld divides military history into four eras separated by revolution:[10] the age of tools; the age of the machine; the age of systems; and the age of automation. The Tofflers take a wider societal view, asserting that war is waged in the same manner in which wealth is created, believing us to be entering the 'information age'.[11] Others believe history demonstrates warfare is subject to periodic accelerations of a continual evolution during which revolutionary changes emerge. But whatever the particular thesis, there is little argument that military capability has been periodically revolutionised and broad consensus that we are on the cusp of the next one.

An oft-quoted example of military revolution is Blitzkrieg, used to such startling effect by Germany in the period 1939-41

An oft-quoted example of military revolution is Blitzkrieg, used to such startling effect by Germany in the period 1939-41. While the technologies of armour, aircraft and radio had been used toward the end of the first world war, for instance at Cambrai in 1917, it took new operational concepts and doctrine to effect a radical change in war fighting capability. In the late 1980's, Andrew Marshall (the first Director of Net Assessment, US DoD) recognised that the period between the two world wars, which saw considerable technical and operational innovation, provided the best model to study and used it in developing a definition of an RMA, which has become broadly

accepted as 'a major change in the nature of warfare brought about by the innovative application of new technologies which, combined with dramatic changes in military doctrine and operational and organizational concepts, fundamentally alters the character and conduct of military operations'.[12]

Having identified what we mean by an RMA, it is worth briefly examining how the contemporary RMA might develop. Krepenevich sees it as an increased ability to detect and engage, with a higher degree of precision and lethality, far more targets, over a far greater area, in a shorter period of time.[13] Owens echoes this view, with a belief that it is characterised by 3 broader functional concepts[14] – battlespace awareness, C4I, and precision force use. McKitrick et al suggest the emergence of new systemic 'warfare areas'[15] – long-range precision strike, information warfare, dominating manoeuvre and space warfare. On the other hand, O'Hanlon is more cautious, arguing that from a technology perspective it is too early to say whether rates of scientific advance will support a revolution.[16] The detail of these predictions contain four salient themes: firstly that any RMA will probably involve the integration of systems with systems; secondly that achieving an RMA will take time; thirdly, we do not know what the outcome will look like; and lastly, that increasingly available new technology will have a key role to play.

The rate of development of sensors and networks by the US has been unprecedented and is to date virtually unrivalled

Taking all this into account, it is not difficult to spot the pedigree of Joint Vision 2020 which synthesises and builds on these themes. The US Joint Chiefs of Staff proposes to achieve 'full spectrum dominance' through 'dominant manoeuvre', 'precision engagement', 'focussed logistics' and 'full dimension protection',[17] made possible by by information superiority. Seen alternatively as 'grandiose'[18] and 'less than radical',[19] there is little agreement regarding the prospects of this vision being achieved. Turning the promise of an RMA into reality is likely to be a severe challenge and it will not happen by chance.

Underlying the promise of a contemporary RMA are the advances made in the ability to gather, process and disseminate information. The assumption is that value can be derived from information and that this value increases as it moves toward 100 percent relevance, 100 percent accuracy and zero time delay. Any RMA is thus likely to involve exploitation of the wider information revolution.[20] On the face of it, the

...the superior information position, or 'information superiority' is about knowing more of the enemy and his intentions than he knows of you

assumption appears to be a fair one. The US has poured enormous resources into information gathering and dissemination assets; from satellites to unmanned air vehicles, spanning the entire electromagnetic spectrum (especially visible, and increasingly real-time); and equally, the network infrastructure (or 'infostructure') across which information is transported. The rate of development of sensors and networks by the US has been unprecedented and is to date virtually unrivalled.

The RMA proponent's belief is that US forces should be able to place themselves in a superior information position relative to opponents, and that this has intrinsic war fighting value. The thinking behind this proposition needs little rehearsal, for intelligence has long been considered the key to winning war with Sun Tzu providing the mantra to 'know the enemy and know yourself [and] in a hundred battles you will never be in peril'.[21] Thus, the superior information position, or 'information superiority'[22] is about knowing more of the enemy and his intentions than he knows of you.

Modern war, with its foreshortened engagement timelines and increasingly difficult target identification make the proposition of information superiority an extremely attractive one, and there is little dissent among RMA advocates that it is a 'good thing'. The US military has come to often confer upon itself the comfortable notion that in any battle situation, they will be able to gain information superiority over their foe.[23] However, looking in from the outside are a number of other nations eager to learn from any new capability, and they regard the US with envious eyes. For example, a peculiarly Indian perspective that 'an ounce of silicon and effective information exploitation may be worth more than a ton of uranium'[24] neatly indicates a covetousness in what they are observing. It is fallacious to believe the US will be without competition, and the US should not rely on the cost of technological advancement acting as an entry barrier to assure any form of dominance. Indeed, by conferring 'critical success factor' status on information superiority, the US has defined new vulnerabilities and targets for both attack and defence.[25]

THE STRATEGIC CONTEXT FOR NETWORK CENTRIC WARFARE

Having examined the RMA context of NCW, what of its strategic context? Here it is necessary to briefly examine the likely circumstances under which US forces may be engaged and the nature of future competitors, because whatever NCW turns out to be, it must provide military value in this projected environment. To peer thus into a foggy future is open to contention, but to proceed without such an assessment is to ignore the relationship between NCW and why the US thinks it needs it.

Conflict is often thought of as military engagement between nation states, normally fought for territory, resource, religion, ideology or in self-defence. While this type of conflict certainly exists, the current 'war' against terrorism and missions of humanitarian assistance are clear examples of lower intensities of military mission. The immediacy and number of these conflicts is likely to increase and they will become more complex.[26] It will become more difficult to identify the 'front line'; a premium will be placed on speed and precision; the need to act with international consensus will set legal constraints on action; and surprise and deception will play key roles. Underlying these themes is change to the international order, which is apparent in greater regional instability, set in an increasingly globalised yet simultaneously fragmenting world. Events are recorded in real time by a pervasive media, a public expectation for rapid, discriminate results with minimum casualties exists, and a US desire to be a 'force for good' prevails; all eminently exploitable by potential competitors. Add to this the danger of asymmetric engagement, asymmetric ideals, weapons proliferation and weapons of mass destruction, attacks against infrastructure[27] or military infostructure , and a complex picture emerges. Yet NCW must be credible in this diverse and complex environment against a range of potential competitors.

While it is true that the US does not have a current peer competitor, to presume that one will not emerge over the next two decades would be to ignore history

Attack on Pearl Harbor December 1941

One useful framework for thinking about competitors distinguishes 3 types:[28] firstly, the peer competitor who is capable of competing across the full spectrum of military activity at a global level; secondly, those developing states who will be able to compete regionally using comparatively limited capability; and thirdly, competitors who emerge from militarily ineffectual nations scarred by complex security problems but armed with niche capabilities. While it is true that the US does not have a current peer competitor, to presume that one will not emerge over the next two decades would be to ignore history.[29] It is plausible that improved access to high technology will pave the way for a nation such as India to achieve peer status, in much the same way as Japan did in the 1930's. In the same manner, regional competitors such as Iran are unlikely to stand by while the US establishes unassailable military capability. These competitors, realising the risks attached to engaging the US in head-to-head battle, may use new technologies coupled with new techniques to engage in new ways. A nation such as China may be the first to develop revolutionary ways of competing, given its alternative strategic culture and doctrine descended from Mao rather than Clausewitz.[30] The concept of achieving high leverage against US forces[31] through niche capability can be extended to non-state actors; the sort of terrorist organisation typified by Hamas or al-Q'aida who co-ordinate a network of dispersed units using commercial communications. The point here

is that the information revolution also underlies any change in the nature of conflict[32] and the interrelationship between threat and opportunity will undoubtedly create unforeseen dynamics that NCW must be adaptable enough to cope with.

Another increasing trend has been for nations to act in coalition, as all-arms groups and away from home. This emphasis on joint, combined, expeditionary warfare has set new challenges for force providers and procurers, ushering in a period of great change in force structures but against a backdrop of shrinking defence budgets. In addition, we have seen in the field of operations other than war, an increasing requirement to be able to integrate with other government departments and non-governmental organisations, typically relief agencies. This trend seems set to continue, so there is a real need to ensure that NCW can integrate with partners and permit coherent interoperability.

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WHAT IS NETWORK CENTRIC WARFARE?

So, given the background strategic context and the promise of an RMA, what is Network Centric Warfare? In short, NCW is the US Navy's concept for an RMA, made possible by the information revolution. Although the words 'network centric' are much used, there are a variety of views on what they actually mean and the aim here is to provide an interpretation based on the literature. However, before commencing there are three notes of caution. Firstly, it is fair to say that NCW is not a thing and cannot be considered as such; it is an immature operational concept in whose prospects the US Navy is placing much faith. Secondly, there is a tendency towards a literal interpretation of the term 'network'. While NCW does rely on computer and communications networks, it also has a broader outlook. Thirdly, it is also fair to say that a network-centric force does not currently exist.[33] Given these three cautions, we must recognise that an absolute characterisation of NCW is still emerging, and it is possible to develop only an interpretation of the concept, which follows.

NCW has grown out of the empirical observation that networked computing has fundamentally changed the underlying economics of business and can have dramatic effects on competitive performance. It has been observed that networking information can improve corporate understanding, thus empowering decisions at lower levels, enabling speedier reactions to occur and making businesses more agile. Equally important is the recognition that agile businesses are able not only to share information better, but gather it better, generally having an 'information grid' (improving information reach) and a 'sensing grid' built on a series of networks (improving information richness; timeliness, accuracy, content and relevance).[34] It is claimed this coupling of information reach and richness increases agility and leads to improved competitiveness. A belief has thus developed that the same thinking can be applied to conflict;[35] after all, the thinking goes, the cut-and-thrust of business can closely resemble conflict. NCW has therefore been conceived as military operations that deliver increased combat power through the networking of a force.[36] NCW is focussed at the operational and tactical levels of warfare, taking as underlying tenets that information is the key enabler and that NCW is about more than technology; it is also about human and organisational behaviour.[37]

It is claimed that NCW will enable a shift to occur from warfare based on attrition to warfare characterised by new concepts of shared awareness, speed of command and self-synchronisation, which will not aim to

destroy the enemy per se, but to neutralise the effect the enemy can create. By networking the forces' sensing capabilities and fusing the information gathered into a common picture, the force will be able to achieve a shared awareness. Using this shared awareness, the force will be able to generate a superior speed of command, and this will allow the force to create high rates of change in the environment, in essence by making decisions faster than the enemy. By focussing these changes on the enemy's vulnerabilities, it will be possible to 'lock out' their courses of action as they will, by the time the enemy has developed them, already be neutralised. Taking this idea one step further, if all units share an awareness not just of the battlespace,[38] but of the commander's intent and the objective, they should be able to organise their activities from the bottom upwards. Bottom-up organisations are perceived as dynamic and better able to rapidly exploit opportunities in a complex environment. Thus, in ideal conditions, the force will be able to self-synchronise its activities, effectively out-thinking and out-manoeuvring the enemy, and bringing about earlier foreclosure of hostilities.

NCW brings with it powerful claims for a number of prospective advantages. The movement of information is clearly less costly than the movement of things, and increasing availability of satellite communications removes the requirement to group platforms closely together, giving units the freedom to focus on their operational functions, rather than the creation and maintenance of communication links. It can raise awareness of what other participants can see, which may help to reduce Clausewitz's 'fog and friction' of war. In addition, the potential exists to move complexity away from platforms and into the infostructure, because not all platforms will require similar sensing capabilities. Sensors and weapons can be increasingly decoupled, giving greater versatility to the force as a whole, and that force can be more geographically dispersed, taking advantage of longer range weapons. Speed of command potentially improves operational tempo while force protection can be improved because units can be kept out of harm's way until they are required to cause an effect. Finally, the combination of these actions allows effects to be massed without having to mass platforms.

NETWORK CENTRIC WARFARE – ON THE ROAD TO VALHALLA?

If NCWs claims seem like the road to Valhalla, it must be remembered that the benefits discussed thus far are prospective benefits, which require NCW and the wider RMA to overcome many challenges, even if some precursor systems are increasingly in place. The question is whether NCW has the power to yield revolutionary results. A number of influencing factors have already been identified: NCW must be more than technology; the technical edge may be short-lived; it must cope with the full spectrum of conflict against all competitors; it must be adaptable; and it must be interoperable. This is a remarkable set of challenges, yet there are a number of additional implications arising from NCW's concepts of shared awareness, speed of command and self-synchronisation that must be considered. It is these implications that this paper will now examine in examining whether NCW has the potential to yield the promised RMA.

INFORMATION SUPERIORITY AND SHARED AWARENESS

NCW's dependence on information superiority sets it as a pre-condition of network-centric operations. Admiral Owens, reviewing current technology, argues without reservation that the RMA has the potential to lift Clausewitz's 'fog of war', pointing to the ability of Allied forces during the Gulf war to thwart Iraq's every move through superior surveillance. Owens suggests that to be able to sense all objects in an area 200 by 200 miles square across the entire electromagnetic spectrum is a realistic objective,[39] and points to a plethora of systems which are building capability in this direction. Other NCW apostles point to a strong

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correlation between information sharing, improved situational awareness, and improved combat power. Garstka argues that the potential of NCW has begun to emerge, citing a US Air Force experiment which found that employing tactical data Link 16 to share information between F-15C fighters improved situational awareness significantly over non-Link 16 fitted aircraft, increasing the number of 'enemy' fighters killed by a factor of 2.5.[40] It is difficult not to be impressed by the technology on offer and the way in which sensor and information networks are being progressively integrated. Yet despite this technical prowess, the underlying belief among NCWs evangelists that technology can lift the fog of war has met with much challenge.

Recent experience in Somalia and Kosovo has highlighted that well-equipped, modern forces using high technology have been unable to achieve information dominance against a resourceful, indigenous, entrenched opposition that can meet its needs with simple or easily available means. The presence of real-time airborne surveillance did not deny Somali warlords the ability to co-ordinate their actions using mobile phone, or by signalling using burning car tyres. The same assets did not overcome the fog of war on the ground during the disastrous US raid into Mogadishu of 3 October 1993.[41] In Kosovo, information superiority did not prevent NATO from mistakenly striking trains, convoys and the Chinese Embassy in Belgrade. In addition, the Serbs used deception, disinformation, camouflage and CNN to limit the effectiveness of NATO's sensors.[42] NATO had almost perfect intelligence about the intentions of President Milosevic, yet did not foresee his ethnic cleansing campaign in time to stop him.[43] This all points to systemic issues with information superiority and some commentators have even described it as an 'Alician rabbit-hole'[44] or a 'chimera'.[45] So what is the problem, and why does information superiority not appear to be the whole solution?

More data does not necessarily equal better information. Indeed, there are plenty of examples where the underlying data has been plain wrong,[46] and shared mis-information is probably more damaging than no information. Cebrowski counters with the observation that information superiority does not equal more

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volume of data, but more accuracy, relevance and timeliness. He argues that 'once the chaff has been winnowed the question of information overload subsides'.[47] However, he fails to examine the process by which this transformation from data to useful information occurs; the interpretation of that data. The most essential component is the human who brings together disparate data and creates from it a coherent assessment, a not inconsiderable task. As some have commented, the human element seems to be missing from current NCW theory.[48]

Witness the USS Vincennes incident in which an Iranian airliner was mistaken for an F-14 fighter and shot down. All of the data required to support an identification of neutral airliner was present and in the fog of the moment, the Vincennes command team made the wrong decision

Even when the requisite data is available, interpreting it remains a fine art and the more problematic relationship between information and military decision-making is not fully understood.[49] Even if the interpretation process is not overwhelmed by the increasing amounts of data available, knowing which data create useful information is one thing, but knowing which information allows a commander to make good decisions is another entirely. Witness the USS Vincennes incident in which an Iranian airliner was mistaken for an F-14 fighter and shot down. All of the data required to support an identification of neutral airliner was present and in the fog of the moment, the Vincennes command team made the wrong decision. One of the deepest challenges for NCW lies in tackling this conundrum of the relationship between better information and the nature of command.

More information does not necessarily equal better shared awareness. Shared battlespace awareness is in the mind,[50] not in the network's various databases. In order to outsmart the enemy, one has to know not only where he is, but also what his intentions are. There will be plenty of occasions when assessment of the enemy's intentions will be at best an informed guess. This guess, based on the commander's intuition, remains largely in the human purview and the prospects for automation are bleak. There has yet to be a computer that can differentiate between a feint and a main effort.[51] Although there is some limited application for simple machine-based reasoning, more complex forms of machine assistance are currently beyond the art of the possible as rule-sets have to be constrained by design. Thus it will be a long time before machines will be able to account for or predict the unexpected, and it is exactly this harm that the enemy is attempting to inflict on us. The perennial question will continue to be whether the information gathered is truly 'superior' – an enemy with inferior battlespace sensors but superior intuition may prove to have the superior battlespace awareness.

Neither information superiority nor shared awareness will remove friction from war, whether it arises from rational or irrational act. Clausewitz recognised friktion as a fundamental factor in the conduct of war, arising from danger, exertion, imperfect information, chance, resistance within one's own forces, physical and political limitations on the use of force, unpredictability caused by interaction with the enemy and disconnects between ends and means in war.[52] It is the interplay of these factors that leads us to the maxim that 'no plan survives contact with the enemy' and imperfect information is only one aspect of general friction. Indeed, there is compelling evidence that all of the frictional factors mentioned above were present in the Gulf war,[53] despite the fact that advocates often cite this war as evidence of the incipient RMA.

...technology can only detect what is observable; it cannot detect what cannot be observed

The only certainty is that uncertainty will remain an important factor in warfare. The bottom line is that technology can only detect what is observable; it cannot detect what cannot be observed. War will always be a struggle between opposing wills and the enemy will use ingenuity and guile to increase uncertainty. Attaining certainty requires access to all relevant information, but it is time-consuming to gather and process and although certainty increases with time, information can quickly become obsolete as interaction with the enemy continues. Also, there are practical limits on the amount of information that can be gathered, processed and assimilated in time to be of use and so a balance must therefore be found between the requirement for information and quick action. Thus the technology may be able to quickly transmit, store and present large amounts of information, but it is worthless without proper analysis.

It seems that even if technology will be better able to sense and inform, information superiority is not the whole answer – it is what is done with the information that is the key to success, not the information as an end to itself. A better interpretation of the requirement might be one from which superior decisions can be made. Thus a more appropriate concept may be 'decision superiority'. Joint Vision 2020 illustrates that the US has begun to acknowledge the criticisms levelled at information superiority, and has introduced a concept of decision superiority that allows for the human element of training and experience. Turning shared awareness into decision superiority requires a common framework and solid understanding of the way that friendly forces will operate. This implies a doctrine that is well rehearsed by all participants. NCW-enabled operations will therefore require regular training which, to achieve the required level of complexity and sophistication, is likely to be expensive and difficult to routinely mount outside of a synthetic environment.

SPEED OF COMMAND

Command has always required information to decide a course of action. The essential element of competitive decision-making and therefore successful command is to take action before the factors on which the decision was made are invalidated, and the challenge is to balance the risk of incomplete information with the need for speedy decisions. Speed of command is therefore about converting information into actions via decisions faster than the enemy can manage, often described as the OODA loop.[54]

Whether increasing the availability of information will affect decision making in a network-centric force remains to be seen. Some claim that it will reinforce a 'zero defect' culture, slowing command by feeling a need to wait for that last vital clue, thus stifling initiative and the ability think 'out of the box'.[55] Others claim that NCW's emphasis on speed will lead to hasty decisions.[56] But these are perennial issues that are not unique to a network-centric force. The question NCW must tackle is 'how fast?' The key is being fast enough when needed, remembering that advantage is relative not absolute. It has been noted that 'we need to understand better how we can leverage speed of command in military situations and dispel the myth that speed is either a panacea or an unmitigated good'.[57] The emphasis here should be to exploit any extra time made available by provision of better information in the 'OO' portion of the OODA loop to improve the decision or to mass additional effect. Of course, the underlying assumption remains that a superior information position exists.

...forgetting that speed is not necessarily of the essence is tantamount to acting in anger

NCW should concentrate on what to do when inside the enemy decision cycle, not pursue speed for its own sake.[58] As one commentator has noted, forgetting that speed is not necessarily of the essence is tantamount to acting in anger.[59] Another way of looking at speed of command may be that improved shared awareness allows shorter duration plans to be made in the first place. These plans, potentially of lesser consequence, could possibly be better targeted, and thus achieve disproportionate effect. However, the danger exists that network-centric forces will be capable of acting so rapidly inside the enemy's ability to act or communicate that they end up responding to their own signals, effectively spinning on their own axis. The question then becomes one of exactly whose options have been locked out.

It is important to continue considering the human element of decision making. Human decision-making capacity changes under stress and time pressure[60] and among the observable changes is a tendency to focus more on the decision and less on situational awareness. Hence we rely on a smaller, more comfortable, portion of the available information and tend to become wedded to the existing plan. Over-emphasis on speed is thus potentially damaging to our cognitive capabilities and above all, NCW must ensure that the commander is protected as far as possible from these effects.

The concept of speed of command is a good one, but is open to criticism because it tends to focus attention on the means and not the end. The end is an improved rate at which effect can be brought to the enemy. Advocates of NCW believe that speed of command is a new concept. However, using initiative to precisely mass effects against enemy vulnerabilities is a key tenet of the manoeuvrist approach.[61] It would probably be more accurate to describe speed of command as operational tempo and acknowledge that this is reinforcing current doctrine. Therefore speed of command is synonymous with increasing tempo in manouevrist warfare, hardly a revolutionary development.

SELF-SYNCHRONISATION

Synchronisation is an essential aspect of complex military operations, and achieving it arises largely as a result of training and initiative. Self-synchronisation thus describes the ability of an informed and trained force to synchronise activity from the bottom upwards. Advocates of this concept believe that such bottom up organisations are better able to cope with the fast-paced, dynamic and complex environment of military operations.[62] The organising principles are unity of effort, clearly articulated commander's intent and carefully crafted rules of engagement.[63] Traditional military operations use top-down command to achieve synchronisation of effect. However, because each element of the force has its own preferred operating rhythm, combat is managed at the operational level as a sequence of discrete steps, each separated by a distinct pause in which battlespace awareness is regained.[64] Each pause offers an opening to the enemy. Thus the aim of self-synchronisation is to deny the enemy the ability to exploit this opening by removing the pause between steps, which also has the effect of maintaining a rate of change in the environment that the enemy commander cannot cope wit;[65] in essence increasing the friction felt by the foe. This is conceptually very sound, however in practical terms, self-synchronisation must have bounds of control. It must have conditions, or doctrine, associated with its use.

Writing about the theory of manoeuvre warfare, Antal notes[66] that developing a faster decision cycle than your opponent means you must delegate decisions and allow trained, subordinate leaders maximum freedom of action guided by the commander's intent, train cohesive units capable of independent action, develop a streamlined information gathering and processing system, and instil the understanding that decisions will be made without the availability of perfect information. From the discussion this far, it would be difficult to differentiate between the conceptual objectives of NCW and current manoeuvrist doctrine. However, when considering the possibilities arising from the synergy between speed of command and self-synchronisation, a distinct and powerful difference begins to emerge.

On initial inspection, self-synchronisation seems very similar to the current doctrine of mission command, but conceptually it can be more radical than this. Mission command means that a commander assigns a task, resources and guidelines to a subordinate and then gives them as much freedom as possible in the execution.[67] In a self-synchronised force, the task is inferred from the commander's intent and resources are co-ordinated from the bottom up. With each force element acting towards the commander's intent, but not in an explicitly synchronised way, each element can operate at its own optimum speed, without being held back by the need for higher-level synchronisation. This means that while the effects that can individually be delivered may be smaller, they will occur in an asynchronous fashion that is difficult for the enemy to comprehend.[68] This is where the concept of 'lock out' arises, with multiple events changing the environment in rapid succession. The synergy of speed of command and self-synchronisation provides opportunity for a 'swarm' of events which are unified to the commander's intent but which push the enemy into a state of chaos. Some commentators have written about operations at the 'edge of chaos', taking from chaos theory and seeking application in NCW,[69] and if NCW offers anything truly radical, it is probably here.

...we may find that the US will be forced to hold back their abilities in order to operate in coalition

Self-synchronisation may not meet with universal approval, nor will it necessarily suit all circumstances. If the ability to self-synchronise is taken to its limits, then there will be inevitable implications for doctrine in terms of the command and control process, and also for training. It may be that the US can move to a self-synchronisation capability in time, but the question is whether their likely allies would wish to do so; we may find that the US will be forced to hold back their abilities in order to operate in coalition.

SOME IMPLICATIONS OF FOLLOWING AN NCW STRATEGY

Assuming that the issues tackled earlier can be successfully resolved, and something more radical than a 'refined' manoeuvre war doctrine emerges out of the benefits of self-synchronisation and speed of command, what might the implications be for US forces, their potential competitors and allies? These are the broader issues which the US must deal with which are fundamental to the efficacy of following an NCW strategy. This paper does not offer solutions, but highlights important areas of consideration for both US and other nations considering the pursuit of similar strategies.

HIERARCHY AND ORGANISATION

Improved access to information at all levels and the ability to self-synchronise and operate at higher tempos has implications for the military chain of command. Networks tend to imply flatter organisational structures, and in order for self-synchronisation to occur, these structures must be allowed to form; yet this is in conflict with current hierarchical military command culture. For organisations such as militaries that feel they must uphold hierarchies, the challenge will be to discover how to combine the strengths of both hierarchy and network. For organisations that are used to a culture of 'information being power', the greater pervasiveness of information will result in better-informed subordinates. This will effectively democratise lower levels, thus leading to 'consultation and co-ordination', building blocks of the network design,[70] rather than 'command and control'. This is a side effect of NCW that requires fundamental culture change to bring about.

The potential pitfalls of increasing tactical visibility to higher levels of command are exemplified by the ability of Predator unmanned air vehicles to feed live pictures from Afghanistan to the White House (Predator TV)

Some argue that advances in information technology make it possible for the superior commander to exercise better centralised command. Whilst this is a possibility, it is not necessarily a virtue. The subordinate in the field will always have a better understanding of the situation, especially of the human aspects of war. The potential pitfalls of increasing tactical visibility to higher levels of command are exemplified by the ability of Predator unmanned air vehicles to feed live pictures from Afghanistan to the White House (Predator TV).[71] Couple this ability with the fact that Predator can now be armed with Hellfire missiles, and a new definition of the 'long screwdriver' emerges, thus forever removing the distinction between the tactical and strategic. Without doubt this is a potentially revolutionary change with strong organisational implications that requires much thought.

So, if the US needs to redesign their organisation to fit NCW, what might it look like? One organisational form which shows some promise is the 'virtual organisation' in which the relevant actors come together in an ad hoc manner for a specific, time-limited, purpose.[72] The composition of such teams would be based on 'best man for the job' rather than any sense of traditional military hierarchy, with the intention of providing an optimal skills mix. However, the virtual organisation is not without difficulty, mainly arising from the limited ability of geographically dispersed individuals to gain shared comprehension, clear understanding of command intent and mutual trust, irrespective of the underpinning technical networks. Other types of organisational form are being researched which mix the characteristics of both hierarchy and network,[73] the 'command network'; however the implications and efficacy of such structures will depend heavily on experimentation and the jury will remain out for years to come.

It is quite probable that a shift to a network centric strategy will further encourage competitors to find new ways of competing, including attack on the infostructure, in essence 'hacking' into the network to deny service or deceive; information warfare

COMPETITORS AND ALLIES

Should the US create an NCW-enabled RMA, they are likely to create an asymmetric opponent of everyone. The form of strategic asymmetric attack that could be mounted needs little rehearsal following the events of 11 September 2001 and few would dare to engage the US in head-to-head battle or to allow a rerun of the Gulf war. It is quite probable that a shift to a network centric strategy will further encourage competitors to find new ways of competing, including attack on the infostructure, in essence 'hacking' into the network to deny service or deceive; information warfare. This exploitation of the US dependence on information superiority may yet prove to be NCW's undoing and the US will have to concentrate much effort on mitigating this threat. The ability of a network-centric force to induce chaos among the enemy at will may prove to have credence as a deterrent, but only if NCW is secured against information warfare.

The flip side of this point is interoperability. Allies need to be able to communicate with the US if they are to operate with them symmetrically, thus there must be openings into the system which are potential points of exploitation that have to be guarded. Coalitions of the willing, who are perhaps unused to operating with the US, will provide particular challenges because of security concerns. In addition, coalitions will need to share common doctrine and training, and have organisations that are able to 'recognise' each other structurally. If the political imperative of coalition operations remains, the US will have to ensure that allies do not become 'locked out' of NCW because of fundamental incompatibilities, especially if they are not

equipped with the same 'sense and share' capacity or are not privy to the same 'national' information as the US. This tends to suggest that standing coalitions such as NATO will have greater value to the US in international conflict resolution than informal coalitions. Tiered participation is also a possibility where more capable and closer allies are allowed into the 'inner sanctum' while others are sidelined and expected to do what they are told. One cannot see such a situation encouraging good international relations.

CONFLICT INTENSITY

A further set of implications arises from considering the diverse intensity of military operations that the US is likely to contribute to. A common criticism is that NCW focuses on high-end war fighting and does not lend itself to operations other than war.[74] The question here is whether the ambition of speedily 'locking out' enemy courses of action is appropriate in low intensity conflict. However, it is not necessary to use the full spectrum of capability in all circumstances, and as long as the US has operational versatility, this issue is of lesser importance.

Of more importance is what the 'network' and its information may be able to add. Here, there is scope for a network-centric force to act as the information provider, maintaining channels of communication to all interested parties, including non-governmental organisations and relief agencies. The challenge will be turning information superiority to benign use. In such operations, the value of self-synchronisation is questionable and in any case is probably not universally desirable at all levels of conflict; while the benefits to another Gulf War are fairly obvious, the benefits to humanitarian relief operations are less easily stated.

CULTURE AND CHANGE MANAGEMENT

While Cebrowski, Alberts et al are quick to point out that commerce has been able to revolutionise its processes using information technology,[75] they have not been so quick to point out that these successes have occurred in companies which already have deeply embedded cultures of innovation and change.[76] The status quo is anathema to companies who have successfully made the transition to information-enabled operations and there are more examples of change management failures in commerce than there are success stories, a point acknowledged by Alberts et al[77]. However, industry is quick to learn from mistakes and has procurement and reorganization cycles that make the military look laborious by comparison. Defence reform is not dynamic enough to keep up with changes in the environment, and large-scale modernisation will always be a complex and expensive undertaking. Thus the military will always lag the art of the feasible.

...there is nothing more difficult to take in hand, more perilous or more uncertain in its success, than to take the lead in the introduction of a new order of things

One could argue that this works to the military's advantage because it allows previously adopted change to be fully absorbed into the organisation and become inculcated; the military being a large and hierarchical organisation with a strong sense of propriety within which culture change is rarely achieved without overcoming much stiction. However, this is more likely to hold back any revolution, leading to an evolutionary approach in which opportunity is lost. As we have observed, in order to achieve whole scale revolution, we have to introduce more than new technology. The dilatory rate of change of organisational structures and culture act as a brake on the uptake of new concepts and is the greatest cause of friction[78].

Success will be measured by the willingness of the military to adapt to, and fully adopt, new methods of working, even if they threaten established hierarchies and structures. Meanwhile, the US Navy wants NCW, but questions whether it is prepared to take the risks necessary to achieve it, for as Machiavelli noted, 'there is nothing more difficult to take in hand, more perilous or more uncertain in its success, than to take the lead in the introduction of a new order of things'.

There is a danger of being sucked in by the hype surrounding NCW. To say that NCW will definitely revolutionise warfare, before much more experimentation has been conducted, would be brave in the extreme. While this outcome cannot be discounted, the concerns and evidence presented here point toward not only evolutionary implementation, but also evolutionary results. For a start, the conceptual distance between NCW and traditional maritime operations is not as large as supposed[79], and the three key concepts of shared awareness, speed of command and self-synchronisation, as we have seen, correspond closely to the principles of manoeuvre war.

It is therefore incongruous to develop future war fighting concepts on the notion that the US will, through information superiority, gain the total advantage

Shared awareness has long been an aspiration and is likely to see incremental improvements in capability as networking technologies come on line. The progress that has been made is undeniable. However, no amount of technology is going to remove Clausewitz's fog and friction and his warning that war 'has to operate in the dark, or at best in the twilight'[80] remains salutary. While technology has the power to push at the fog's edges, war will continue to be frustrated by friction, if for no other reason than because the enemy gets a vote. It is axiomatic that both sides will engage in information denial at the same time as information gathering, more still that both protagonists will take action on different information thresholds.
It is therefore incongruous to develop future war fighting concepts on the notion that the US will, through information superiority gain the total advantage. The concept of decision superiority, is no better placed, as it will be affected by the same limitations in generating shared awareness. As every car driver knows, shining a bright light at fog serves to create dazzle, not penetrate the fog.

Equally, we have seen that speed of command is in essence improved operational tempo, while self-synchronisation could closely approximate the current doctrinal tenet of mission command. Self-synchronisation could become more radical than this, but whether it is desirable is questionable. Meanwhile, achieving synergy between forces, delegation of authority to appropriate levels, local co-ordination and individual initiative are not new aspirations which are waiting for an NCW revolution; they are with us in well trained and equipped forces today. Command in war remains a universally human activity and NCW advocates would do well to remember this during future development work. Now, more than ever, NCW's evangelists need to consider carefully whether it really does offer anything fundamentally new before embarking on a programme of wholescale revolution.

All the indications are that the philosophy of NCW will become deeply embedded in US thinking. What remains to be seen is the extent to which the US Navy can, or even needs to, re-invent itself to make sufficient space for NCW to mature and deliver its potential revolution. For example, NCW may well allow changes in force structures, with a move to lighter armed, more mobile formations and platforms. If the US can induce shock and chaos using NCW, then high-end war fighting capability is preserved, while simultaneously offering greater potential versatility at lower intensities of conflict, where it is predicted that

the greatest frequency of operation will occur. However, NCW will not provide a single answer or solve all problems. The goal should be to identify those combinations of new thinking and new technologies that offer better answers to the war fighter's needs over as great a portion of the spectrum of conflict as possible.

NCW is unlikely to come about overnight or without significant investment in time and money. To achieve the vision set out in JV2020 of a force capable of 'dominant manoeuvre', made possible by implementation of NCW concepts, will require continued experimentation. Experimentation by definition requires a culture of innovation in which an acceptance exists that fundamental changes to existing concepts of organisation and structure may be required. Should this willingness exist in a US Navy that is prepared to accept the risks associated with radicalism, then there is a prospect that NCW may ultimately be revolutionary. Should the willingness not exist then the probability is that NCW will realise evolutionary improvement to current doctrine. It will, without doubt, generate improvements in the conduct of 20th century warfare, but may not become the blueprint for 21st century war. The US Navy only have a short period to begin to effect any required culture change, otherwise however large the head of steam, NCW will fail to make the climb. As Cebrowski notes, 'the keys to success are bold leadership, continual experimentation and learning and organizational adaptation'[81].

For NCW to be evolutionary may be both the best and the worst outcome. It may be the best outcome because it does not fundamentally alter the balance of capability between the US and their allies and potential competitors. It is the case that to fundamentally revolutionise the way of war is to create an asymmetric opponent of everyone, at least in the short term. These opponents will be increasingly required to compete on unequal terms, driving conflict in new directions for which NCW and the wider military is potentially not well prepared. To believe that the concepts of NCW are equally applicable across the entire spectrum of conflict is, at this stage, a premature conclusion. It may be the worst outcome because the US Navy may in the end not prove to be the vanguard. Other potential competitor nations, with access to similar industrial and technological capabilities, may develop the battle-winning advantage by another route.

Bibliography
Books

Achenbach, Joel, (1997), Reality Check, in Alberts, David and Papp, Daniel (eds), The Information Age: An Anthology on Its Impacts and Consequences, Volume 1 Part 1: The Information and Communication Revolution, (Washington D.C, National Defense University).

Alberts, David, Garstka, John and Stein, Frederick (eds), (1999), Network Centric Warfare: Developing and Leveraging Information Superiority, 2nd ed, (Washington D.C., CCRP).

Antal, John F, (1993), Thoughts about Manoeuvre Warfare in Hooker, Richard D (ed), Manoeuvre Warfare: An Anthology, (New York, Presidio Press)

Arquilla, John and Ronfelt, David (1997)1, A New Epoch – and Spectrum – of Conflict, in Arquilla, John and Ronfelt, David (eds), In Athena's Camp: Preparing for Conflict in the Information Age, (Santa Monica, RAND).

Arquilla, John and Ronfelt, David (1997)2, Cyberwar is Coming!', in Arquilla, John and Ronfelt, David (eds), In Athena's Camp: Preparing for Conflict in the Information Age, (Santa Monica, RAND).

Berkowitz, Bruce, (1997), Warfare in the Information Age, in Alberts, David and Papp, Daniel (eds), The Information Age: An Anthology on Its Impacts and Consequences, Volume 1 Part 3: Government and the Military, (Washington D.C., National Defence University)

Bowden, Mark, (1999), Black Hawk Down, (London, Bantam Press)

Campen, Dearth and Gooden (eds), (1996), Cyberwar: Security, Strategy, and Conflict in the Information Age, (Fairfax Virginia, AFCEA International Press)

Creveld, Martin van, (1989), Technology and War: From 2000BC to the Present, (New York, The Free Press).

Cooper, Jeffrey, (1994), Another View of the Revolution in Military Affairs, in Arquilla, John and Ronfelt, David (eds), In Athena's Camp: Preparing for Conflict in the Information Age, (Santa Monica, RAND).

Czerwinski, Tom (1998), (ed), Coping with the Bounds – Speculations on Nonlinearity in Military Affairs, (Washington D.C., National Defense University).

Davis, Norman (1996), An Information-Based Revolution in Military Affairs, in Arquilla, John and Ronfelt, David (eds), In Athena's Camp: Preparing for Conflict in the Information Age, (Santa Monica, RAND).

Libicki, Martin, (2000), What is Information Warfare?, in Gongora, Thierry and Riekhoff Harald von (eds), Towards a Revolution in Military Affairs? Defense and Security at the Dawn of the Twenty-First Century, (London, Greenwood Press).

Gordon, Andrew, (1996), The Rules of the Game: Jutland and British Naval Command, (London, John Murray Ltd).

Handel, Michael I, (2001), The Masters of War: Classical Strategic Thought, 3rd ed, (London, Frank Cass).

McKitrick, J; Blackwell, J; Littlepage, F; Kraus, G; Blanchfield, R; and Hill, D, (1998), The Revolution in Military Affairs, in Schneider BR & Grinter LE (eds.) Battlefield of the Future: 21st Century Warfare Issues, (Alabama: Air University Press).

O'Hanlon, Michael, (2000), Technological Change and the Future of Warfare, (Washington D.C., Brookings Institution Press).

Owens, Admiral Bill, (2000), Lifting the Fog of War, (New York, Farrar, Straus, Giroux).

Toffler, Alvin & Heidi, (1995), War and Anti-War: Survival at the Dawn of the 21st Century, (New York, Warner).

Watts, Barry, (1996), McNair Paper 52, Clausewitzian Friction and Future War, (Washington D.C., National Defense University).

Articles

Adams, Thomas, 'The Real Military Revolution', Parameters, Autumn 2000, pp. 54-65.

Barnett, Thomas, 'The Seven Deadly Sins of Network Centric Warfare', US Naval Institute Proceedings, January 1999, pp. 36-39.

Bodnar John and Dengler Rebecca, 'The Emergence of a Command Network', Naval War College Review, Autumn 1996, pp. 93-107.

Bracken, Paul, 'The Military After Next', Washington Quarterly, Autumn 1993, pp. 157-174.

Cebrowski Arthur and Garstka John, 'Network Centric Warfare: Its Origin and Future', US Naval Institute Proceedings, January 1998, pp. 28-35.

Garstka, John, 'Network Centric Warfare: An Overview of Emerging Theory', Naval War College Review, Summer 2001, pp. 27-35.

Gravell, W, 'The Offensive Punch – Network Centric Warfighting', Surface Warfare, March/April 1998, p.14.

Harig, Paul, 'The Digital General: Reflections on Leadership in the Post Information Age', Parameters, Autumn 1996, pp. 133-140.

Hayes, Bradd, Modisett Lawrence, Daniel, Donald & Kamradt, Hank, 'Transforming the Navy', United States War College Center for Naval War Studies, Decision Strategies Department, Report 00-3, 2000.

Henry, Ryan and Peartree, Edward, 'Military Theory and Information Warfare', Parameters, Autumn 1998, pp. 121-135.

Kamradt, H, 'Netcentricity – Seminal Doctrine or Just Puff?' The Naval Review, Vol 89 No 1, January 2001, pp. 8-11.

Kamradt, Professor Henry and MacDonald, Cdr Douglas (1998), The Implications of Network-centric Warfare for United States and Multinational Military Operations, An Occasional Paper of the Center for Naval Warfare Studies, United State Naval War College.

Krepinevich, Andrew, 'Cavalry to Computer: The Pattern of Military Revolutions' National Interest, Fall 1994, pp. 30-42.

Lescher, William, 'Network Centric: Is it Worth the Risk?', US Naval Institute Proceedings, July 1999, pp. 58-61.

Metz, Steven, 'The Next Twist of the RMA', Parameters, Autumn 2000, pp. 40-53.

Scarborough, Sheila, 'Why NCW Will Fail', US Naval Institute Proceedings, May 2001, pp. 31-33.

Smith, Edward, 'Network Centric Warfare: What's the Point?', Naval War College Review, Winter 2001, pp. 59-75.

Thomas, Timothy, 'Kosovo and the Current Myth of Information Superiority', Parameters, Spring 2000, pp. 13-29.

Tucker David, 'The RMA and the Interagency; Knowledge and Speed vs. Ignorance and Sloth?', Parameters, Autumn 2000, pp. 66-76.

Zimm, Alan, 'Human Centric Warfare', US Naval Institute Proceedings, May 1999, pp.28-31.

Defence Publications

British Defence Doctrine, JWP 0-01.

Internet

http://www.dod.ccrp.gov accessed 21 Nov 2001, Admiral Arthur Cebrowski, 'Network Centric Warfare: An Emerging Response to the Information Age'.

http://www.dtic.mil/execsec/adr98/chap13.html accessed 14 Nov 2001, 'The Revolution in Military Affairs and Joint Vision 2010'.

http://www.cfcsc.dnd.ca/irc/amsc/amsc1/038.html accessed 14 Nov 2001, 'The Revolution in Military Affairs: All That Glitters Is Not Gold'.

http://www.idsa-india.org/an-apr-01.html accessed 14 Nov 2001, Kapil Kak, 'Revolution in Military Affairs – An Appraisal.

http://www.dodccrp.org accessed 21 Nov 2001, Kishore Sengupta & Carl Jones, 'Creating Structures for Network Centric Warfare: Perspectives from Organization Theory'.

http://www.dtic.mil/jv2010 accessed 14 Jan 2002, 'Joint Vision 2010'.

http://www.dtic.mil/jv2020 accessed 14 Jan 2002, 'Joint Vision 2020'.

Notes:

1 Metcalfe's Law states that the 'power' of any network is proportional to the square of the number of nodes in that network.
2 More holistically, Command, Control, Communications, Computers, Information, Surveillance and Reconnaissance (C4ISR).
3 The US Joint Vision 2020 is an example; see www.dtic.mil/jv2020.
4 Alberts et al (1999), p.2.
5 www.dtic.mil/jv2020, Joint Vision 2020.
6 Owens (2000), p.17.
7 Krepenevich (1994), p.30. Although open to debate, Krepenevich identifies ten military revolutions: Infantry; Artillery; Sail & Shot; Fortress; Napoleonic; Land Warfare; Naval; Mechanization & Aviation; Information; and Nuclear.
8 Krepenevich (1994), p.31.
9 For a summary of RMA perspectives, see O'Hanlon (2000), pp.11-18, or Cooper, J (1994) pp.116-123.
10 van Creveld (1989).
11 Toffler, Alvin & Heidi (1995).
12 Taken from McKitrick et al (1998).
13 Krepenevich (1994). p.41.
14 Owens (2000), pp.15-16 and pp.98-102.
15 McKitrick et al (1998).
16 O'Hanlon (2000), pp.106-142.
17 As defined by JV2020: Dominant Manoeuvre – the ability to gain positional advantage with decisive speed and overwhelming operational tempo; Focussed Logistics – the ability to provide the right people, supplies and equipment in the right place, at the right time, and in the right quantity; Full Dimensional Protection – the ability to protect personnel and assets required to decisively execute tasks.
18 For example, O'Hanlon (2000), p.18.
19 For example, Metz, Steven, 'The Next Twist of the RMA', Parameters, Autumn 2000, pp. 40-53.
20 See for example Arquilla, John and Ronfelt, David (1997)2. In their view, the struggle for information dominance holds the key to victory.
21 Taken from Handel, (2001), p.238.
22 'The capability to collect, process, and disseminate an uninterrupted flow of information while exploiting or denying an adversary's ability to do the same'. Defined in US Doctrine publication JP1-02, and reflected in UK Doctrine publication JWP-010.
23 Thomas (2000), p.14.
24 www.idsa-india.org/an-apr-01.html accessed 14 Nov 2001; Kapil Kak, 'Revolution in Military Affairs – An Appraisal.
25 Henry & Peartree (1998), p.127.
26 Admiral J Blackham, presentation to Royal Aeronautical Society, 13 September 2001.
27 A concise round up of the info-war threat can be found at Berkowitz, (1997).
28 Bracken (1993), pp.163-169.
29 McKitrick et al (1998).
30 Arquilla & Ronfeldt (1997)2, pp.41-48.
31 McKitrick et al (1998).
32 Arquilla & Ronfeldt (1997)1, p.4.
33 Garstka, John, 'Network Centric Warfare: An Overview of Emerging Theory', Naval War College Review, Summer 2001, p.28.
34 ibid, p.29.
35 See Alberts et al (1999), Cebrowski & Garstka (1998), Garstka (2001).
36 Cebrowski & Garstka (1998), p.30.
37 www.dod.ccrp.gov accessed 21 Nov 2001, Admiral Arthur Cebrowski, 'Network Centric Warfare: An Emerging Response to the Information Age'.
38 'Battlespace awareness' is a comprehensive and comprehensible near-real time view of the battle environment, describing the war fighter's knowledge of the position, motion and status of own, enemy and neutral forces, the intent of enemy forces, and the environment. Alberts et al (1999), pp.133-140.
39 Owens (2000), pp.119-138.
40 Garstka, John, 'Network Centric Warfare: An Overview of Emerging Theory', Naval War College Review, Summer 2001, pp.31.
41 See Bowden (1999) for an excellent account of the fog of war in Somalia.
42 Thomas, Timothy, 'Kosovo and the Current Myth of Information Superiority', Parameters, Spring 2000, p.15.
43 Ibid.
44 Gordon (1996), p.591.
45 Handel (2001), p.xxiii.
46 For example, see Achenbach (1997), pp.181-194
47 www.dod.ccrp.gov , Cebrowski, Op.Cit.
48 Zimm, Alan, 'Human Centric Warfare', US Naval Institute Proceedings, May 1999, pp.28-31.
49 Zimm, Op.Cit. p.29.
50 From an interview with Lt Cdr Keith Cunnane Royal Navy, 3 December 2001, Strategic Deployment Battlespace Integration researcher, QinetiQ.
51 Zimm, Op.Cit. p 30.
52 This is a contemporary taxonomy, taken from Watts (1996), pp.27-35.
53 Watts (1996), pp. 37-57.
54 Observe, Orient, Decide, Act; After Col J R Boyd, USAF.
55 For example, see Harig, Paul, 'The Digital General: Reflections on Leadership in the Post Information Age', Parameters, Autumn 1996, p.138.
56 For example, see Barnett, Thomas, 'The Seven Deadly Sins of Network Centric Warfare', US Naval Institute Proceedings, January 1999, p.37.
57 Alberts et al (1999), p.13.
58 Barnett, Op.Cit. p.38.
59 Ibid.
60 Zimm, Op.Cit. p.30.
61 Manoeuvre warfare seeks to shatter the enemy's will and cohesion by applying strength against weakness through the combined application of manoeuvre, tempo and surprise. From UKOPSDOC, JWP 0-10.
62 Kamradt (2001), p.8.
63 Alberts et al (1999), pp.175-180.
64 Smith, Edward, 'Network Centric Warfare: What's the Point?', Naval War College Review, Winter 2001, p. 60.
65 Gravell (1998), p.14.
66 Antal (1993), pp.70.
67 UKOPSDOC, JWP 0-10, p.2-10.
68 Perhaps this is a modern interpretation of General Giap's guerrilla warfare tactics, employed so effectively against the US in Vietnam.
69 For example, Smith, Op.Cit, or the anthology provided by Czerwinski (1998).
70 Aquilla & Ronfeldt (1997)2, p.45.
71 Michael Evans, 'Spy-plane TV offers instant missile targets', The Times, 23 January 2002, p.15.
72 http://www.dodccrp.org accessed 21 Nov 2001, Kishore Sengupta & Carl Jones, 'Creating Structures for Network Centric Warfare: Perspectives from Organization Theory'.
73 For example, see Bodnar John and Dengler Rebecca, 'The Emergence of a Command Network', Naval War College Review, Autumn 1996, pp. 93-107; Sengupta & Jones; or Davis (1996), pp.92-94..
74 Barnett, Op.Cit. p.37.
75 Albert et al, pp.25-51; also Cebrowski Arthur and Garstka John, 'Network Centric Warfare: Its Origin and Future', US Naval Institute Proceedings, January 1998, pp. 28-35.
76 Lescher (1999), p.59.
77 Alberts et al (1999), p.25.
78 For an interesting treatment of this issue, see Scarborough, Sheila, 'Why NCW Will Fail', US Naval Institute Proceedings, May 2001, pp. 31-33.
79 Kamradt (2001), p.9.
80 Taken from Handel (2001), p.244.
81 www.dod.ccrp.gov, Cebrowski, Op.Cit.