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Battle Management for an Information Age Military: organizational culture and "the military mind"

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synopsis

This talk is part of a larger project which seeks to understand how military organizations have responded to the end of the Cold War and, in particular, why the U.S. military finds it so difficult to focus on the kinds of conflict in the Third World which seem most likely. I examine these issues through a series of instances, the one for this paper being the organization of command and control.

Command and control systems are central to the conduct of military operations. While there is a technical basis to command and control systems, they are in a very real sense, *social* systems. They are forms of organizational behavior. This is familiar territory for sociologists, even if this particular subject matter is not.

This paper is in three parts: (1) I argue that new information technology offers opportunities for radical innovation in both centralized and decentralized forms of command and control, and I introduce the debates between system-of-system and self-synchronization approaches; (2) I explain why different components of the military opt for one or other of these approaches as a result of organizational history and identity; and (3) I embed this cross-sectional analysis in a dynamic historical analysis of warfare trends, arguing that the US military is preparing to fight future wars in the wrong way.

Although the trend is for warfare to be located increasingly in the Third World, the U.S. military devotes most of its energy to preparing for hi-tech war. The roots of this orientation (and distaste for operations in the Third World) lie in the organizational identities created during the Second World War and reinforced during the Cold War.

Neither the system of systems nor the self-synchronization approach is well-suited to the kinds of military operations that are most likely in the future, in large part because they are oriented to “regular,” “conventional” war, rather than to “irregular” and “unconventional” operations. As a result, the U.S. military runs the risk of preparing for the wrong war.

The Promise

The Gulf War of 1991 revealed a quantum jump in the way in which American military forces conduct operations. The linkage of computers, satellites and radio seemed to offer the promise of a new way of waging war. Most manifest in the advent of "smart bombs," the Department of Defense rapidly came to believe that a "revolution in military affairs" (RMA) had begun. Quite what this will mean is a matter of intense debate within the military. Some thinkers argue that the RMA requires a new theory of war. In this paper I discuss one central aspect of this new theory of warfare, what used to be called "command and control," and is now referred to as C4ISR (Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance) or as C4ISTAR (with "Target Acquisition" providing the expanded acronym.)

The new technologies raise the possibility that military commanders will be able to "see" everything in the battlespace and communicate this information in near-real time to all subordinate units. The ability to synchronize the operations of vast numbers of soldiers, vehicles and weapons in ways hitherto only dreamed of, now seems within reach. To see why these changes in the methods of command and control might be such a revolutionary proposition, we need to consider how military forces have been organized and managed in the recent past.

The Collapse of Control in Modern War

Given the stress, confusion and complexity of battle, the span of control of any commander is necessarily rather limited. As a result, military organizations are hierarchical, with several layers of subordinate commanders. Orders flow down, and information flows up. Horizontal flows of information (much less mutual coordination) are rare.

A divisional commander leading his[1] troops into battle as recently as the 1980s faced a task of considerable complexity. He had to coordinate the movements and actions of large numbers of quite disparate elements: infantry, armor, artillery, engineering troops, and a whole host of technical and support troops. He and his subordinates would need to call on forces from the Navy and Air Force for support, creating a need for coordination across, as well as within, organizations. These soldiers had to operate under conditions of great stress and confusion, with enemy forces attempting to disrupt their activities and destroy them.[2] The commander would have only a very imperfect idea of what was happening on the battlefield: the location and intent of enemy units, and even of his own units, would be shrouded in the fog of war. The inevitable problems of lapses in communications, the limited vision of subordinate units, and the stress of battle would

[1] There were no female divisional commanders at this time.

[2] The difference between combat and competition is important for an appreciation of the differences between military organizations and business organizations.

pour sand into the gears of the military machine. The potential for things going wrong was high. It is hardly surprising that the military coined the acronym SNAFU.[3]

Since the beginning of modern warfare[4] the command and control of military forces has been a major problem and concern. In some ways, the advent of modern war had raised the difficulties of command and control to new heights. Consider Wellington at Waterloo in 1815: mounted on horseback, he rode up and down his line (a distance of a mile or so) giving orders to his subordinates. He could see (and communicate with) his own forces. There might be some delay as his orders were transmitted by orderlies galloping from one part of the field to another; and there might be a certain amount of "noise" in the communications system, but by and large Wellington could "touch" his forces and tell them what to do. Moreover, Wellington could also see (rather less well, given the smoke covering much of the battlefield) the adversary forces.

In this ability to see the battlefield, Wellington had an advantage over his opponent: Napoleon could not see part of the British force, arrayed in line just over the crest of the ridgeline. While not the most important aspect of the battle, Napoleon's inability to see what was happening on the other side of the hill was an example of a larger information deficit, his unawareness of the approaching Prussian army under Blucher.

Nevertheless, if commanders could not see what the enemy was doing on the other side of the hill, they could see (and communicate) reasonably well on the battlefield itself. The command and control of military forces was a relatively straightforward matter.

This capacity was to be dramatically degraded as modern war expanded the size of the battlefield and vastly increased the lethality of the combat zone. Take, for example, the battle of the Somme.

The Somme, 1916

At 7:30 a.m. on Saturday, July 1st, 1916 some 66 thousand British troops climbed out of their trenches along a 16-mile stretch of the front line and advanced towards the German trenches some four hundred yards away.[5] Within 30 minutes half of the attacking force were casualties, mainly as a result of machine-gun fire from the German positions. By the end of the day some 120,000 troops had been committed. Half would become casualties. The battle dragged on for another three months, being officially terminated on November 14th. By then British casualties were in excess of 400,000 and the front line had been moved forward six miles.

[3] Of course, what counted were not the mistakes made by the commander, but whether the adversary made more (or worse) mistakes.

[4] There are debates among military historians about the periodization of warfare. I am persuaded by Stephen Biddle and ? that the origins of the modern military system are best located in the final years of the First World War, 1916-1918.

[5] The distance between the British and German lines varied considerably. 400 yards is a rough average.

When the infantry climbed out of their trenches and walked into no-man's land they were, for all intents and purposes, stepping into the unknown. They were leaving behind a vast and familiar organization, with its communications trenches, telephone lines, supply dumps, and command hierarchies. They were stepping out, not only into the unknown, but into a deafening silence in so far as communications were concerned.

By 1916 both armies had constructed defensive systems of some depth. The front line of trenches was protected by formidable belts of barbed wire; infantry could shelter from an artillery barrage in dug-outs cut into the earth, trenches were built in a zig-zag manner to minimize the impact of artillery and to make it harder for an attacker to shoot along the trench. Machine-guns were distributed throughout the length of the front line, and were also placed in specially protected strong points. Behind the front line were two other lines of trenches, forcing the attacker to take not one, but three defensive positions. The second and third lines of trenches sheltered reserve units which could be thrown into a counterattack to eject any attack from whatever gains they had made in the front line trenches.

This was the obstacle facing the British Army as it planned its attack on the German lines. The infantry attack was preceded by an artillery barrage. For a week some 50,000 gunners had worked around the clock to fire 1.5 million rounds at the German positions. The infantry had been assured that the preparatory artillery barrage would have cut the barbed wire in front of the German trenches. They had been assured that this thunderous weight of shell would have killed or shocked the German defenders into a near-catatonic state. Their officers assured them that they would simply have to walk across to the German lines and take possession. These were reasonable expectations, but they were not known facts. As it transpired, the assumptions were wrong. The British high command could not see over the hill.

And it is here that command and control enters the story. The attack required the coordination of infantry and artillery. A central task of the artillery was to prevent or disrupt German attempts at resistance and counterattack. As the attacking infantry walked across no-man's land, they had to reach the German trenches before the defenders could rush out of their dug-outs and bring their machine-guns to bear. It was crucial to prevent German machine-gunners from winning the race to the parapet. It was also very important to bring artillery fire to bear on German reserves which might be moving up to the front line trenches in an effort to evict the, by now exhausted, British soldiers. There were further coordination tasks: losses in British attacking units had to be made good, supplies had to be moved forward, and fresh units had to be fed into the battle in order to maintain a forward momentum.

The problem of coordination turned out to be insoluble (at least for the British) with the technology and social organization of the time. British commanders did not know how far their troops had advanced, nor did they know what casualties had been sustained. They did not know where German troops were successfully resisting, or where they were counterattacking. Once the infantry left their trenches, the British high command was blind and deaf. It had lost command of the battle.

The British had foreseen and planned for these difficulties. The attempted solution, which turned out to be no solution at all, was to script the advance with timetables and objectives. The artillery barrage would pound the German trenches until the time at which it was calculated the British troops would arrive; the artillery barrage would then move on to the next German position, and would stay there until the British troops arrived – at the duly appointed time – at this second objective. The process would then be repeated for a third phase. It is apparent that such a system would only work if, as we say, all went like clockwork. Any glitch, any resistance, any friction as Clausewitz would have put it, would defeat the schedule and preclude any effective coordination of the battle. [6]

There were only two ways to move beyond the impasse. One was to provide the attacking infantry with their own organic, movable artillery. This was to be done with the tank. The other solution, the one that concerns this paper, was to provide effective communications between the attacking infantry and divisional commanders located several miles behind the front lines. The British were cognizant of the need for communications, and experimented with carrier pigeons, signaling to aircraft, stringing telephone wires forward along with the attacking troops, etc. None of these proved satisfactory. The only feasible method of communication was the runner. It would take perhaps two hours for a runner to return across no-man's land to the forward nodes in the telephone system, if he made it at all. It would then take a further period of time for the telephone message to work its way up the many levels of command to headquarters and then down to the appropriate artillery unit ordering them to adjust their fire. If a message had to be conveyed to the forward troops another runner would have to undertake the perilous and time-consuming journey back across no-man's land. During the battle of the Somme, it sometimes took over seven hours for reliable information to find its way to headquarters.[7] Only with the advent of more or less reliable radio communications in the Second World War would a partial (and short range) solution to the problem of slow communications be available.

Foremost among the command and control problems was the need to prevent friendly forces from colliding with each other, resulting in confusion and fratricide. This was accomplished by the physical demarcation of the battlefield. As divisions, brigades, companies etc., advanced forward their areas of operation were marked off from each other by a series of boundaries drawn on the map. At the forward edge of battle, cross-cutting lines were drawn to demarcate areas where the artillery attached to the attacking

[6] It is something of a puzzle that the British high command should have adopted these tactics. The answer is to be sought in the class composition of the Army. By 1916, the British Army was an army of conscripts. The officers, drawn from the upper levels of Edwardian society, believed that such an army, composed of poorly trained amateur soldiers drawn from the lower classes, could not demand much in the way of individual initiative from the soldiers. They could, under the command of middle class officers educated in the public schools, be expected to do as they were told. Given these assumptions about the rank-and-file, the rigid timetables made sense.

[7] Robin Prior and Trevor Wilson, Command on the Western Front, 1992, p.183

forces would target its fires. Beyond this line, air forces would operate without any need to co-ordinate with ground troops; behind this line, careful liaison would be required. These techniques for **deconfliction** and physical segmentation were subsequently also applied to air operations.

The increasing size and complexity of the battlefield meant that increasingly larger staffs were needed to collect and process information and to coordinate increasingly specialized and diverse organizations and weapons systems. The trend for all armies seemed to be towards ever-greater complexity and ever-larger (and more cumbersome) staffs.

But the story of command and control is more complicated, less linear, and sociologically more interesting. During 1916 and 1917 the British and French on the Western Front attacked, and the Germans remained on the defensive. In 1918 the Germans launched a series of offensives in the West. Their solution did not involve tanks or radios. It relied instead on the exploitation of initiative.

Known as *aufstragtaktik* or "infiltration tactics," the idea was that specially trained elite units, storm troops, would bypass enemy centers of resistance and keep moving forward. Follow-on waves of regular troops would then eliminate the pockets of resistance that had been by-passed. In this way the forward momentum of the attack would be sustained and the attacking troops would eventually break through the zone of defense into open land beyond. The tactic worked. In the March 1918 offensive, the German infantry advanced forty miles on a fifty-mile front, a feat unparalleled in the history of the Western Front. They managed this without tanks or any other special weapons. To a large extent, the German success must be explained by their adoption of a command and control system which was the very opposite of the British.[8]

Despite the initial success of *aufstragtaktik*, as German forces pushed through the British front lines, they lost communication with their rear areas, their commanders, and their supporting units. They became directionless, disorganized, and rapidly began to run out of supplies. The British, in contrast, were able to retreat in a more or less orderly (if overly hurried) fashion, and fall back on their rear area support and communications systems. The German advance sputtered out. *Aufstragtaktik* turned out to be a tactical, but not an operational or strategic, solution to the problems of command and control.

The British system, highly directive, allowing little autonomy to subordinate formations, and the German system, giving great autonomy to the stormtroop units, represent extreme points on a continuum of command and control philosophies. It is time to examine this in a little more detail.

[8] The German reliance on decentralized command and control stemmed in part from the different way in which their army was organized. Non-commissioned and junior officers were given much more authority than was the case with the British. Moreover, General Staff officers were used to short-circuit the chain of command to push initiatives. A General Staff colonel might find himself elbowing aside a nominally more senior general in order to impose the vision of high command on operations.

Types of Command and Control Systems

The theoretical ideal in a military organization is for a single commander to issue his orders and have all the subordinate units behave exactly as he wishes. The phrase "like clockwork" conjures up the image of the perfectly synchronized machine. If a military machine could be designed like this, with perfectly centralized command, and if it worked in combat, it would be the most desirable type of organization. Why would one want a lieutenant to make important decisions that could alter the course of the battle instead of having the top commander control events?

As Martin van Creveld has argued, the central issue in designing a command and control system is the distribution of uncertainty. Centralized command reduces uncertainty at the top, but increases it at the bottom; the reverse is true for decentralized command and control systems. As he says,

> "… the history of command in war consists essentially of an endless quest for certainty… The history of command can thus be understood in terms of a race between the demand for information and the ability of command systems to meet it."[9]

Van Creveld goes on to argue that this poses an organizational choice:

> "Confronted with a task, and having less information available than is needed to perform that task, an organization may react in either of two ways. One is to increase its information-processing capacity, the other is to design the organization, and indeed the task itself, in such a way as to enable it to operate on the basis of less information."[10]

This leads to the now-standard distinction between two types of command and control. On the one hand, in **directive** or detailed command, the commander issues precise instructions to his subordinates. The subordinate is given little discretion, and is expected to report back for new instructions if he is unable to carry out the instructions. On the other hand, in **mission** command or **commander's intent** (*aufstragtaktik*), the commander makes known to his subordinates what he intends to accomplish and then gives the subordinate considerable flexibility in deciding how he will carry out the mission.

Mission command entails a certain amount of loose coupling, and directive command a great deal of tight coupling, to use Charles Perrow's terminology.[11]

For the purposes of this paper, I will reduce all variations in command and control to a single dimension: centralized—decentralized.

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[9] Martin van Creveld, Command in War, 1985, pp. 264-5
[10] ibid. p. 269
[11] Charles Perrow, Normal Accidents, 1984

New technology

It is now technically possible (due to the linkage of computers, VDUs, telephones, radio and satellites) to send vast quantities of data almost instantaneously, with great reliability, to vast numbers of people (and machines) anywhere in the world. These data can be presented in the form of animated visualizations. This is the IT revolution. What the implications of this technological advance might be for the functioning of social systems is one of the important questions of the day. It has generated a literature concerned with the "information age," "the global age," "network society," and so forth.

Reflecting on the nature of these changes, American military thinkers saw information as the key to the new way of war. New kinds of sensors could now "see" the enemy. Vastly enhanced communications powered by computers and satellites meant that this information could be used in all sorts of novel ways. (An unmanned aerial vehicle could sense a target, send the information via satellite to a headquarters, and a precision-guided munition could be sent to the target controlled by the GPS. This action, and many others, could be visualized on a computer screen at headquarters thanks to massive computing power and a huge capacity to transmit masses of data at high speed.) The power of computers meant that radically new possibilities in organizing and controlling military forces were opening up.

What this means in practical terms is that the speed with which messages can be sent vertically (both up and down) has increased greatly; more importantly, information can be shared *horizontally* to a much greater degree than was previously the case. In principle, every decision-maker on the battlefield, from the grunt to the four-star general, can share a common operating picture and can have access to the total amount of data available in the system as a whole. For example, the most modern American tanks have a VDU in each tank, enabling each tank commander to share the same picture of where both friendly and enemy forces are.[12]

It is the ability to "see" everything of relevance in the battlespace that, in principle, opens up the possibility of a revolutionary new way of conducting military operations.

But how exactly would the new technologies be used to change command and control methods? My own view on this is that the technology is neutral with regard to whether or not a directive or mission system of command and control – or indeed, some new system of command and control – can be adopted.

[12] I do not wish to claim that this technological revolution was unprecedented. One can reasonably argue that by the middle of the Second World War radio communications had revolutionized command and control. It is also possible to argue that the telegraph in the mid-nineteenth century had a major impact on command and control. What distinguishes current technology is partly the sheer scale of data transmission, partly the increased range of types of data (digital as well as voice) that can be transmitted, and partly the increased automaticity of communications systems.

Two extreme views have been promulgated. I refer to them as the "system of systems" and the "self-synchronization" approaches. The debates in the military have been rather muddied. Both approaches are often subsumed by military thinkers under the heading of "network centric warfare." I believe that they are quite distinct approaches, and that they have vastly different implications for how military forces are organized and controlled.

In my view, these two new approaches are up-dated variants of the old tension between centralized and decentralized command and control systems. I now briefly describe these two new views of C4ISTAR and place them in their intellectual context. I then take up the question of why some military organizations opted for one, rather than another, of the new approaches.

Both the system-of-systems concept and the self-synchronization theory had much in common. Although they each represented extreme and opposing solutions to the inherent dilemmas of command and control, they each sought to derive their theories from a common observation: namely, that the proliferation of the new technology meant that an opportunity existed to bring all the components of the military together into some sort of system whose whole would be greater than the sum of the parts.

In its most prosaic form, network centric warfare was an attempt to move Department of Defense thinking away from an emphasis on weapons platforms to an emphasis on networks and systems. Individual soldiers, sailors and airmen still thought of combat largely in terms of specific weapons platforms. How should a tank or a plane be maneuvered? How should a ship engage the enemy? At this level, the advocates of network centric warfare made a straightforward, and not entirely novel point: the modern military operated as a set of systems of some sort. What counted was not the individual tank, but a combined arms force of tanks, infantry, artillery, aircraft, ships, satellites, etc. The American military was composed of lots of such systems, and it was incumbent on military personnel to think in terms of systems or networks rather than in terms of stand-alone platforms. Exactly what kind of system, and how systems differed from networks, were questions that were seldom directly addressed. This masked a radical divergence of approaches to command and control.

By the late 1990s, Network Centric Warfare appeared to be the Department of Defense proposed solution to the question of how the military should be transformed for the information age. As Department of Defense reports themselves recognize, the term does not have an unambiguous or uncontested meaning for everyone in Department of Defense. The Network Centric Warfare Report puts a positive gloss on the situation by suggesting that

> "Although NCW currently means different things to different people, these differences, more often than not, involve different forms of Network Centric Operations… rather than disagreements about the basic concepts. When one goes behind the labels, one finds more agreement than is sometimes apparent. Given that the theory of NCW is only a couple of years old, the level of awareness

within Department of Defense and the Defense community is remarkably high, the theory is developing nicely, and applications abound."[13]

Lifting the Fog of War? A system of systems, tight coupling

In July 1996 the Joint Chiefs of Staff released a pamphlet entitled Joint Vision 2010. This was the first authoritative statement – at the highest level – of the emerging vision of war. It sought to specify the central ways in which the RMA would alter military operations. Key features were the ability to strike the enemy precisely and to maneuver rapidly. Information technology was seen as the great enabler of these heightened capabilities.

The IT revolution holds out the prospect of such a quantum leap in information that the "fog of war" can be eliminated. According to Admiral Bill Owens, a key outcome of the information revolution is the ability of a commander to "see" everything of relevance in a box 200 kilometers on each side.[14] The very title of one of his books, Lifting the Fog of War, (2000) suggests what he thinks the key implication of IT advances will be. As he says,

> "By 2010… the US military will be able to "see" virtually everything of military significance… More important, the US military commander will understand what he sees."[15]

Owens does not spell out in detail what he thinks the implications for command and control will be, but his remarks are clearly consonant with a centralized, directive approach.

> "The general or admiral will be able to immediately relay his orders (and the information that supports them) to his subordinate commanders… In turn, subordinate commanders will be able to alert their units, brief the combat leaders, and prepare for battle in a fraction of the time required even today."[16]

This reading may be a little forced, but if the commander can see everything, why would he not exercise as much detailed control as he could?

Add to this the ability to use all sorts of robots and unmanned vehicles, weapons and sensors. The commander might then be in a position to direct all sorts of relatively automated subsystems to sense and engage enemy units. In this vision of war, soldiers on the ground are largely relegated to the role of sensors. (This is one aspect of what Special Forces did in Afghanistan: they directed airpower to targets.) Owens' point was that all the components of a military organization – the people, the weapons, the sensors, the communications systems, and so on – could come together to form a system of systems.

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[13] Network Centric Warfare Report p. 12-2
[14] As I will discuss below, a central issue here is how relevance is defined.
[15] Admiral Bill Owens, Lifting the Fog of War, 2000, p. 119
[16] ibid, p. 15

This was to derive its power from its tight coupling, and would be wielded by an all-seeing, all-knowing commander.

The notion of dispelling the fog of war has its skeptics. A common point made is that it is not simply objects that are hidden; the intentions of the adversary are also often unknown. For this reason, the fog of war is unlikely ever to be entirely dispelled. To the extent that American military analysts think they can remove the fog of war through technical improvements in C4ISR, they are in danger of entertaining a dangerous illusion. Martin van Creveld, for example, remarks:

> "… dependence on technology inevitably creates vulnerabilities that an intelligent enemy will not be slow to exploit."[17] And he continues, "To believe that wars of the future… will be less opaque and therefore more subject to rational calculations than their predecessors is, accordingly, sheer delusion."[18]

While there are many skeptics in the military, there are also many fervent supporters of a system of systems approach. The urge to control the uncontrollable is inherent in all military thinking, and elevated to a fundamental principal in those spheres whose habitus disposes them to think along deterministic lines. More on this shortly.

Self-synchronization and organic metaphors

If the key word for Owens was "system," the key word for the other school of thought was "network." The notion that the military was a network of component parts offered a rather different slant on how it would operate and how, in particular, command and control would function. Greater connectivity via networks would be used to devolve decision-making down to lower levels.[19]

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[17] van Crefeld, op cit, p. 231

[18] ibid, 266

[19] The implications of networks for organizational form are also, I think, somewhat unclear. It is generally believed that networks enable hierarchies to be flattened, with the intermediate managerial levels removed. But even if this is true, decision-making can be moved either up or down. For example, is it possible to remove some of the levels in the chain of command? Perhaps we could get rid of majors and lieutenant-colonels, and brigadier-generals and major-generals, leaving just Colonels and Generals? Perhaps we could operate with the brigade at the basic building block, and get rid of divisions? Or perhaps the US military is evolving towards a fully joint task force type of organization. At this point military officers will say that these things are impossible and unthinkable. Perhaps they are right; but there is nothing sacrosanct about current forms of military organization, (Of course, as a matter of sociological reality, organizational forms and the associated career hierarchy are **entirely** sacrosanct. Military officers are invested in a career which has a pronounced hierarchical structure, and to suggest that it be radically altered is to attempt to undo an entire professional socialization. This is why jointness is so difficult and problematic) and some sort of change is surely possible and perhaps desirable. It is noteworthy that there is little serious discussion among military analysts on this topic.

The proponents of moving command and control downwards believed that war was an intrinsically stochastic process, rather than a deterministic one. In the 1990s, they turned to the emerging science of chaos and complexity to buttress their arguments. General Gordon Sullivan, Chief of Staff of the Army in the immediate post-Cold War period was one enthusiast, recommending to his top generals a raft of business books, including the semi-mystical Leadership and the New Science: Learning about Organization from an Orderly Universe, by Margaret Wheatley (1992.). Doctrine writers in the Marine Corps in the 1980s were others. These metaphors were finally enshrined under the label of network-centric warfare.

Complexity theory (**see appendix 2**) seemed to offer an escape from the tensions inherent in choices about command and control. If control was devolved downwards, there was a loss of control at the top and the risk that order would disappear and that organizational goals would not be achieved. Complexity theory argued that this was, at least in some instances, a false dilemma. The bottom-line deduction from complexity theory was that, in the right circumstances, lower level units could act autonomously in such a way that out of a large number of independent actions order would emerge. The term for this is self-synchronization. Systems capable of self-synchronization are termed complex adaptive systems. They adapt to changes in the environment via a series of responses on the part of individual units. These are uncoordinated in any directive manner. Together, they move the system to a new level of complexity.

In January 1998, Admiral Arthur Cebrowski and John Garstka published an article in the U.S. Naval Institute Proceedings entitled, "Network-Centric Warfare: its Origin and Future." The notion – or at least the verbiage – of network centric warfare was rapidly taken up by the Department of Defense.

Cebrowski and Gartska drew heavily on the business literature to argue that the information age was generating profound changes in the American economy:

> "Here at the end of a millennium we are driven to a new era in warfare. Society has changed. The underlying economics and technologies have changed. American business has changed. We should surprised and shocked if America's military did not…
> We are in the midst of a revolution in military affairs (RMA) unlike any seen since the Napoleonic Age… Network-centric warfare and all of its associated revolutions in military affairs grow out of and draw their power from the fundamental changes in American society. These changes have been dominated by the co-evolution of economics, information technology, and business processes and organizations, and they are linked by three themes:
>
> The shift in focus from the platform to the network
> The shift from viewing actors as independent to viewing them as part of a continuously adapting ecosystem
> The importance of making strategic choices to adapt or even survive in such changing ecosystems"[20]

[20] US Naval Institute Proceedings, January 1998, p. 29

Developing these themes from evolutionary ecology, they went on to argue that military organizations would co-evolve at the strategic level, and that their component parts would self-synchronize in action.

A sense of the magnitude of the change envisaged may be gleaned from this remark in an official Department of Defense report on Network Centric Warfare:

> "Network Centric Warfare is no less than the embodiment of Department of Defense transformation. It is a monumental task that will likely span a quarter century or more. It will involve ways of operating that have yet to be conceived. It will employ technologies yet to be invented. It will increase warfighting capabilities more than all the advances that have been made in the history of warfare to date."[21]

This is a large claim.

The theory of Network Centric Warfare is an attempt to explain why the RMA will create a new form of command and control based on self-synchronization. The crucial means is the development of a "common operating picture" at all levels of the organization, thereby creating the option of decentralizing command and control. Physically, this is conceptualized as a computer display terminal in every vehicle. The map on the computer screen shows the position of all friendly units. This is provided by automatic GPS updating (the "blue force tracker.) Such information as comes in to the system (at any level) from a wide range of sensors (from humans to unmanned aerial vehicles to nanorobots) is integrated, interpreted and immediately displayed on all terminals. Everyone knows everything.

[There has been a leap in the argument, of course, which the observant reader will have noted. Inputting data on enemy forces involves judgment and interpretation. It transforms data into knowledge. This is a complicated and risky business, and exactly how data will be transformed into knowledge is one of the key unresolved questions of network centric warfare.]

Thinking of the military as a set of networks – a network of networks – implied that there need be no central directing brain controlling a host of automata. Instead, the component parts of this loosely-coupled system would operate with considerable autonomy.

Consider close air support of ground troops. There are a number of ways to do this. Directive control plans movements in advance and allocates air strikes according to a central plan. Another solution is to provide the ground forces with their own organic air support. This is the Marine Corps method. An air controller located with the ground troops then talks to the pilot by radio, telling him where to attack. To bring in close air support in this way, the ground forces must first deconflict the area by ordering artillery to cease firing for the period when the aircraft will be in the neighborhood.

[21] Department of Defense, Network Centric Warfare, Report to Congress, 27 July 2001, p.12-1.

What Cebrowski saw was that if the pilot could access the ground picture digitally, he would have the same information as the soldiers on the ground. There would be no need for the time-consuming and error-prone voice commands over the radio link. Furthermore, since the pilot was also digitally linked to the artillery (and vice-versa), the artillery need cease firing only for the brief moment when the aircraft came in for the attack, or the pilot could use a temporary lull in the artillery bombardment to make his attack. With everything happening digitally in near-real time, the potential for snafus would drop exponentially and operations could assume a higher tempo. The points in the network could synchronize with each other without going back up the chain of command to higher headquarters. This was, at least in one sense, what was meant by "self-synchronization." The new information technology would facilitate a radical decentralization of command and control with enormous payoffs in terms of military effectiveness.

Self-synchronization implies one of two things: (1) subunits understand larger system goals (commander's intent) sufficiently well that these larger goals are achieved; or (2) even in the absence of an understanding of larger system goals, subunits coordinate their actions in such ways as to achieve larger system goals. The first of these is an updated and enlarged notion of mission command and control; the second suggests a radically new form of command and control, what I am calling self-synchronization.

There are a lot of questions here. How does the transition from data to understanding occur? Will the shift to a smart pull system of information transfer be matched by an increased smartness of the end users? How will the common operating picture be formed? Who will decide what information is appropriate for which level of command? How will the filters work? How will automated information processing systems work? How will they deal with ambiguity, relevance and contradiction? How will staffs come to develop shared understandings? Will these shared understandings be functionally adequate?

A Theory of War in the Information Age

Proponents of Network Centric Warfare have a bold hypothesis. It asserts that to each type of society there is a corresponding form of warfare and a corresponding form of C4ISR. Embedding recommendations about C4ISTAR systems in a larger theory of history "makes sense" of current debates by contextualizing them, and provides a massive rhetorical apparatus with which to defend and legitimize the C2 choices.

The hypothesis may be summarized in the following table:

Agrarian age	directive command and control
Early industrial age	directive command and control
Mature industrial age	mission command and control
Information age	self-synchronization

The scheme serves its purpose. For a historically-minded sociologist however, the Toffler scheme is open to a number of serious objections. The one that is most pertinent for this paper is the assertion that to each "age" in the history of mankind there corresponds one, and only one, form of command and control. As I have argued earlier, at any given time organizations are faced with a choice between centralized and decentralized systems of command and control. The dilemma occurs in every historical epoch. It takes different forms as societies change, but it does not do away. To suggest that the "information age" (if, indeed, that were an accurate and adequate characterization of our times) necessarily implies that self-synchronization is the most functionally suitable form of command and control is a form of organizational ideology, not social science.

In fact, as an examination of the scheme reveals, the authors have engaged in a sleight of hand: the industrial age has two different forms of command and control, directive and mission. Only by dividing the industrial age into two segments can the notion of a direct correspondence between "ages" and C2 systems be maintained.

Intellectual Origins of Network Centric Warfare

I want to turn now to the broader intellectual context in which these theories of network-centric warfare, a system of systems, complex adaptive systems, self-synchronization, etc. appeared and made their way into military thinking.

Military defeat often provokes new thinking. The American defeat in Vietnam produced what some commentators have referred to as a renaissance of American military thought, in which a variety of new concepts were developed in an effort to introduce more agility into U.S. military doctrine. There was a return to the classic texts (above all, Thucydides, Sun Tzu, and Clausewitz) in an effort to rethink the fundamentals of warfare. This effort produced a number of offshoots.

Some of the stimuli to new ways of thinking about warfare were immediate and practical. During the Vietnam War the Air Force became alarmed at the high loss rates in air to air combat over North Vietnam. This led eventually to the establishment of much more realistic training for fighter pilots (the Red Flag exercises) and to better kill ratios. The key was to train American pilots to operate within the opponent's decision cycle, to think faster. This would later be developed by John Boyd, a fighter pilot, to a set of general propositions about speed being the essence of combat. Boyd was to popularize the notion

of the cycle of decision-making which he dubbed "the OODA loop," observe, orient, decide, act.

At about the same time, a reevaluation of Soviet conventional preponderance in Europe pushed Army doctrine writers to think about how to beat the Soviets while seriously outnumbered. The answer was to fight smarter and faster. It required the use of better technology, better training, and a more professional army to offset weight of numbers.

In a direct appropriation from Soviet military doctrine, the U.S. Army placed a new emphasis on the operational level of war, a focus which suggested the importance of maneuver and the rapid and decisive defeat of enemy armies. Not surprisingly, the early Blitzkrieg operations of the German Army became something of a model for American military thinkers.

Other influences were less direct. Reflection on the causes of defeat in Vietnam and careful study of Clausewitz led to a concern with notions of "centers of gravity" and "critical vulnerabilities." Fighting smart meant knowing where to hit the enemy so that it hurt. This approach rapidly led to an emphasis on the "enemy's will" – lifted straight from Clausewitz – as the key center of gravity. The aim of military operations, it was now argued, was not simply to destroy enemy forces in a battle of attrition, but to disrupt and disorganize enemy forces so that they could no longer act in a coherent manner. Tightly coupled complex systems (such as the military generally) have a high probability of catastrophic failure. Indeed, this is one way of making sense of the phenomenon of military organizations collapsing suddenly when they have suffered 15-20% casualties. Military organizations are defeated not primarily by the direct destruction of soldiers and weapons but by inducing collapse of the organizational system.[22]

The notion of "shock and awe," for all its fancifulness, and allied notions that the enemy system might have vulnerable nodes (centers of gravity) which, if disrupted would bring the system to a grinding halt, are based on similar understandings of the behavior of complex, tightly coupled systems. Such beliefs about the tight coupling of enemy systems often co-existed, indeed co-evolved, with beliefs that one's own military organization was a loosely-coupled complex adaptive system. Indeed, the two currents of systems thinking – the deterministic and the dynamic complex models – coexisted as streams of thought on which the military drew throughout the period since the Second World War.

Systems thinking in the military has a long history. Robert McNamara attempted to introduce the kind of systems thinking used by the Ford Motor Company into the Pentagon in the 1960s. While McNamara was (and remains) universally disliked by the military, the notion that warfare could be seen in terms of systems had been implanted in the military, and was available for reappropriation in the future.

[22] I think that this insight about the collapse of military organizations makes a lot of sense. As an illustration, the ability of the Wehrmacht to continue fighting after suffering enormous casualties (and when units were cut off from higher headquarters) was probably due to the decentralized and loosely-coupled nature of German C2 systems.

In the 1960s, systems thinking was primarily directed to conceptualizing the American military. It was about getting the best bang for the buck. It was facilitated by the development of mainframe computers and systems thinking in economics and operations research. Many of these intellectual strands came together at RAND.

Earlier intellectual efforts along these lines had begun when Air Force strategic bombing theorists had begun, in the 1930s, to develop theories about the enemy as a system. Considering ways to use strategic bombing to best effect, they argued that a modern industrial economy was a tightly integrated web. Destroying key nodes (oil refineries, ball bearing plants, etc.) would, they believed, bring the enemy economy to a rapid halt.

This approach did not succeed in the Second World War, but the notion of a direct attack on the enemy system, as opposed to the long, painful process of invasion, destruction of the enemy's armed forces, and occupation, continued to be an attractive one. The invention of precision-guided munitions during the Vietnam war offered air power theorists a new technology that promised to turn the strategic bombing visions of the 1930s into reality. In the months before the Gulf War of 1990-91, Air Force colonel John Warden resuscitated some of the precision bombing theories that had been developed in the 1930s and argued that precision targeting would now enable them to be put into effect. His plans were accepted, and the Gulf War show-cased the dramatic transformation in American military capabilities that had been building up for a couple of decades.

In a widely-read article in the Air Power Journal entitled "The Enemy as a System," Warden argued that all social systems could be seen as a series of concentric rings, with leadership in the center and fielded military forces on the outside. Picking up on the Douhetian notion of leaping over the enemy army to strike at the heart of the enemy system, Warden argued for a bombing campaign that would target the Iraqi leadership. Warden employed a metaphor drawn from biology, one that is often used by military thinkers: the enemy system was like a human body. Although this metaphor was a biological one, it was employed to suggest a tightly-coupled system: a blow to the heart would defeat the enemy in short order.[23]

What all these approaches had in common was a shift away from the attritional frontal methods of combat that the military reformers argued had characterized U.S. operations in the Second World War, to an emphasis on maneuver, speed, and precision as a way to compensate for mass. These words – rapid, decisive – became a mantra.

All these developments occurred more or less endogenously within the military, sparked by developments in military technology and by the constant effort to outmatch the enemy. Other influences came from intellectual currents in society as a whole.

[23] Even in his own terms, Warden's analogy did not make a lot of sense; there are, after all, many ways of disabling a human, and striking at the heart is not necessarily the most appropriate. It is, perhaps, the largely unconscious use of this metaphor that reveals just how profoundly the notion of centralized control is embedded in Warden's thinking.

Perhaps the most important of these was the work of Alvin and Heidi Toffler. In a series of futurist books beginning with Future Shock, (1970) the Tofflers offered a simple and technologically deterministic – and therefore popular – theory of human history.[24] These works were avidly taken up by the American military. The US military now universally and uncritically subscribes to the notion that we are in the early stages of a transition from the industrial age to the information age. This leads military analysts to propose a checklist of differences between industrial age military organizations and information age ones. A typical checklist[25] looks like this:

Industrial Age	vs	Information Age
Linear/sequential processes	vs	Simultaneous/parallel processes
stovepiped systems	vs	interoperable systems
info hierarchically available	vs	info universally available
limited ability to collaborate	vs	virtual collaboration

Another source of intellectual inspiration was business theories. The Cold War had produced a huge permanent military organization, deeply embedded with the economy. It required managers to run it, and military officers now found themselves, as sociologist Morris Janowitz pointed out, as much corporate executives as warriors. Not surprisingly, they turned to business literature, particularly the more popular inspirational kind, for guidance.

The shake-up of the American economy in the 1980s and 1990s produced a number of popular business books emphasizing "re-invention," "downsizing," "virtual corporations," and so on. The Japanese model offered the concept of "just-in-time" operations. The established American business model came under considerable scrutiny, and there was a renewed emphasis on innovation and competitiveness. These theories were eagerly devoured by the post-Vietnam military. (One offshoot was a substantial literature on military innovation using historical case-studies.)

What was lacking was a way to integrate all these new ideas into a single, overarching theory. Chaos and complexity theory seemed to offer the solution. The key here was the concept of the "information age," and the contrast with the "industrial age." If the

[24] The Tofflers argue that human history may be divided into three stages: the agrarian age, the industrial age, and the information age. This seems to me to be far too schematic to be very useful, and too technologically-based. It is, however, the most common intellectual construct in the contemporary U.S. military, and rather than engage here in a full-blown critique of the Tofflers, I have simply taken their framework as given.

[25] Adapted from "Joint Command and Control Functional Concept: Agile Command and Control Information Brief" by COL Susan Lawrence, 13 June 2003, available at JFCOM working papers at http://www.jointforcecommandandcontrol.org/

industrial age was mechanical, and drew its metaphors from Newtonian physics (things going "like clockwork" or like a "well-oiled machine,") the information age would draw its metaphors from the organic images of the "new sciences." Drawn in substantial part from the new work in evolutionary ecology, a central notion was that organizations would do best if they were able to adapt to a changing environment. This meant an organizational design that maximized learning, adaptability and responsiveness. This happened in organizations that were flatter, and where decision-making was devolved downwards. In its most extreme formulation, the idea was that the component units of the organization could "self-synchronize" without central direction, and that the organization as a whole would resemble a "complex adaptive system."

The advent of the internet (and later, theories of globalization) further stimulated thinking along these lines. By the 1990s, complexity theory and notions of networks, together with the overarching notion that we are entering into the information age, reworked many of the central concepts and metaphors underpinning their theories of warfare.

To summarize: the ideas that would be avidly taken up in the aftermath of the Gulf War had been "in the air" for some time. They had been gleaned from diverse fields, but particularly from business ideologies, by military intellectuals who sought to use them as metaphors to use in their thinking about the changing nature of warfare. As I have argued, these ideas did not point unmistakably in a single direction; the mish-mash of concepts floating around actually suggested two divergent paths for command and control. The question was how the various component parts of the military organization would seize upon the ideas and use them to push particular organizational agendas.

Service Responses

The military is not a monolithic organization. The Army, Navy, Air Force and Marine Corps are all organized differently and have different approaches to warfare.

Taking the continuum of command and control (centralization-decentralization) as the key measure, where are the services located?

At one extreme is the Air Force with its philosophy of with its "centralized control, decentralized execution." Official Air Force doctrine states that

> "a balance exists between too much and too little centralized control… Undercontrolling aerospace power fails to capitalize on joint force integration and orchestration… Vertical information flow is fundamental to centralized control… Horizontal information flow is essential for common situational awareness."[26]
>
> "… good horizontal and vertical information flows… and their timely fusion, enable… centralized control and decentralized execution."[27]

[26] AFDD 2-8, "Command and Control" 16 February 2001, pp. 5-6
[27] AFDD 2-8, p. 47

This was best illustrated in the Air Tasking Order, the massive document specifying the flight plan, ordnance, and target for each aircraft in an attack. During the Gulf War the ATO took 72 hours to develop. It was too unwieldy to respond rapidly to a quickly changing situation, much less to attacks on moving targets. Since the Gulf War the Air Force has reduced the time required to produce the ATO and has developed the capability to send attack coordinates to bombers en route to the area of combat. The Air Force targeting system remains, however, in principle a highly centralized one. The dominance of strategic air bombardment theories, and the continuing need to deconflict flight paths, means that the Air Force is the service least likely to favor organic metaphors.

On the other hand, if one looks at the thinking of some Air Force intellectuals like John Boyd, one sees clear indications of a radically different approach to command and control, one stressing decentralization as the driving principle.

At the other extreme is the Marine Corps. This was where complexity theory first entered military thinking in a serious way. As an organization which had a long history of seeing itself as light, aggressive, and fast-moving, the Marine Corps was more open to philosophies of warfare that utilized organic metaphors. Their core doctrinal publications[28] to great lengths to note the salience of uncertainty in war. The doctrine writers (John Schmitt and Chris Bassford) of Marine Corps Doctrinal Publication 6, Command and Control (1996) were heavily influenced by complexity theory.

> "The fundamental point is that any military system, by its very nature a complex system, will exhibit messy, unpredictable, and often chaotic behavior that defies orderly, efficient, and precise control. Our approach to command and control must find a way to cope with this inherent complexity."[29]
>
> "Military professionals often seek a "scientific" understanding of war. This approach is appealing because the human mind tends to organize its perceptions according to familiar analogies, like the powerful images of traditional Newtonian physics… Our military doctrine abounds with terms like "center of gravity," "mass," and "friction."… The appropriate imagery, however, is not that of Newtonian physics. Rather, we need to think in terms of biology and particularly ecology. To survive over time, the various members of any ecosystem must adapt—not only to the external environment, but to each other…. A system created by such interaction is called a complex adaptive system. Such systems are inherently dynamic… Slight changes… can send the system into convulsions of growth or collapse… The reason we use the complex adaptive system as a model is that it provides insight into human political constructs… The unpredictable nature of these complex systems makes it difficult to predict the outcome of specific events… When we say that politics and war are unpredictable, we do not mean that they are composed of absolute chaos, without any semblance of order."[30]

[28] MCDP 1 "Warfighting", MCDP 6, "Command and Control"
[29] MCDP 6, "Command and Control"
[30] MCDP 1-1 "Strategy"

The Army was slow to embrace this view of war. While the Army stressed mission command and control, it also placed tremendous emphasis on staff work and deliberative planning. Combined armed warfare required a lot of deliberate, planned, coordination. Staff officers were expected to develop multiple courses of action, each with a set of "branches and sequels." The Army was used to thinking about long, massive campaigns with their need for careful planning and massive logistical support.

Not surprisingly, the Army manual is the longest – over 230 pages with a great deal of detailed discussion and many historical examples. The Army manual, like the Marines, stresses that uncertainty can never be eliminated:

> "C2 systems strive to reduce uncertainty to manageable levels… However, effective commanders accept that uncertainty can never be eliminated. Therefore, commanders and their C2 systems must be able to function effectively in uncertain environments. The best method of doing this is through decentralized execution of operations. Decentralized execution – based on a common understanding of the commander's intent, mission orders, and sharing available information – allows lower level commanders to cope with uncertainty by exercising subordinates' initiative.
> Well-trained staffs within mature C2 systems use information management to reduce uncertainty."[31]

> "Military operations are struggles between independent human wills. Commanders face thinking, uncooperative, and adaptive enemies."[32]

Explicitly addressing the impact and use of new information technology, the manual notes that "C2 systems… are in a period of transition."[33] "Never have commanders had more ability to exercise increased direct control, yet never have they had less reason to do so."[34]

Superficially the Army seems to have embraced the same philosophy as the Marines. However, in their training, indoctrination and in their concepts of operations, the two services reveal differences in their C2 philosophy. The Marine Corps emphasis is on distributed operations, the Army on co-ordination and co-operation. The Army never embraced the extreme view of self-synchronization that lies at the heart of Marine Corps command and control philosophy.

Of the four services, it is hardest to characterize the Navy. Navy official doctrine on command and control is less clear and more self-contradictory than doctrine for the other services. In my judgment, it is all over the map, perhaps because the principal documents

[31] FM 6-0, "Mission Command: Command and Control of Army Forces," August 2003, p. 1-11
[32] FM 6-0 p. 1-10
[33] FM 6-0 p. 5-29
[34] FM 6-0 p. 1-20

were jointly produced by the Navy and the Marine Corps.[35] At one point a highly centralizing metaphor is introduced:

> "… command and control can be compared to the functioning of the central nervous system in the human body… The brain… decides on a course of action, and send the appropriate instructions to the muscles via the motor nerves. In this analogy, the commander is the conscious brain of the military body and command and control is the system of nerves that carry information to him from the senses (the information-gathering units and sensors) and relay instructions from him to the muscles (the military units that will execute the plan."[36]

Elsewhere in the same document we find a statement that "the command of naval operations has been – by necessity – decentralized."[37] When the document moves into a discussion of maneuver warfare, it picks up on Marine Corps themes:

> "Initiative is crucial to the success of a maneuver warfare strategy, which is characterized by the high operational tempo generated when commanders at the lowest level are free to recognize and exploit enemy vulnerabilities as they present themselves during combat… Given the disorderly and chaotic nature of war, each naval commander must balance his desire to orchestrate events with an understanding that success in combat demands freedom of action for subordinates."[38]

In the end, official Naval doctrine remains agnostic on the choice between centralized and decentralized command:

> "Historically, in striking a balance between orchestrating operations and granting freedom of action to subordinates, commanders have used two methods of control – detailed control and mission control… In practice, no commander will rely solely on either detailed or mission control."[39]

They Navy is schizophrenic. Interestingly, it has produced the two leading theorists – Owens and Cebrowski – of the two extreme views of command and control.

To sum up, there are clear service differences in their approaches to command and control. The Marine Corps appears unambiguously at one end of the continuum. The Army occupies a position closer to the middle. However, when we look closely at the Air Force and the Navy, we find that they can be found at both ends of the spectrum. Some Naval officers and some Air Force officers advocate a tightly coupled form of command and control, others an extremely decentralized one. This is a puzzle. One way to resolve it

[35] The Navy and the Marine Corps together form the Department of the Navy.
[36] NDP 6, "Naval Command and Control," chapter 1, p.4
[37] NDP 6 chapter 1, p.6
[38] NDP 6, chapter 1 p.7
[39] NDP 6, chapter 2, pp. 8-9

is to move down a level of specificity in the organizational hierarchy and look at what are known as the "warfighting communities" rather than the services.

The "Warfighting Communities"

Admiral Owens is, as we have seen, a leading advocate of the system of systems approach, whereas Admiral Cebrowski, with his ideas about complexity theory, was the leading theorist of self-synchronization. In the Air Force Colonel John Warden thought about military operations as involving tightly coupled systems, and the ATO was a classic example of such a tightly coupled system. Colonel John Boyd, however, was the originator of the OODA loop and the emphasis on getting inside the enemy's decision cycle. He can reasonably claim to be one of the intellectual fathers of what would eventually become the self-synchronization school.

The mystery is cleared up when we enquire about these men's careers. Bill Owen was a submariner, and then commander of a surface fleet. Art Cebrowski was a naval aviator, a fighter pilot. Boyd was a fighter pilot, too. John Warden, on the other hand, was a bomber pilot. Why is this relevant?

Both bomber pilots and fighter pilots fly planes. But they do so in vastly different ways. Bomber pilots need to go from point A to point B and deliver their bombs with as much accuracy as possible. When USAF bombing was first developed, during the Second World War, bombers flew in large formations, both to protect themselves against enemy fighter aircraft and for improved navigational accuracy. Bombers operated as part of a large team. Even in the development of theoretical rationales for their operations, bomber intellectuals in the USAF focused on a model of the enemy economy which came to be known as the "industrial web" theory. This saw the enemy as a tightly coupled economic system which would be best attacked by destroying key nodes such as ball-bearing plants or POL installations. All these factors produced a mind-set disposed to think along the lines of tightly-coupled deterministic systems. This habitus was reinforced during the Cold War by the development of elaborate systems of nuclear deterrence. The dual requirements for prompt response on warning of a Soviet attack and for safeguards to prevent an accidental launch of U.S. weapons, allied to the main-frame computing methods prevalent at that time, further solidified the organizational disposition towards deterministic systems and their associated methods of command and control.

Fighter pilots were different; and they thought of themselves as different. They were the heroes of popular imagination, they had "the right stuff." Their self-image was of the single-plane dogfight. They were the knights of the sky. Fighter planes generally had a crew of one, the pilot, whereas bombers might have a crew of half-a-dozen specialized officers. (In reality, they would operate in small units of between two and six aircraft, but this did nothing to detract from the notion of individual combat as the defining feature of what it meant to be a fighter pilot.) Fighter pilots, in short, were individualists relatively unconstrained by directive command and control systems. The Red Flag exercises introduced during the Vietnam war reaffirmed the importance of individual skill and of speed of reaction.

It was in this context that John Boyd developed his theory of the OODA loop.[40] The OODA loop had two injunctions: speed kills – get inside the enemy's decision cycle; and Get inside the enemy's mind – treat him as an active, thinking individual. Both injunctions pushed thinkers away from deterministic systems and in the direction of biological metaphors.

(The use of bombers as tactical support aircraft in both CAS and BAI roles tended to shift bombers towards looser methods of control. The distinctions between fighter aircraft and bomber aircraft were also somewhat eroded as increasing numbers of fighter aircraft were configured for a ground attack role as part of the growing efforts to halt an expected Soviet armored thrust into Northern Europe. This trend culminated in the development of AirLand Battle doctrine in the 1980s and "tank plinking" in the Gulf War. These trends towards the erosion of the hitherto clear distinction between bombers and fighters generated a great deal of doctrinal noise as community identities were redefined or re-affirmed.)

Naval aviation developed largely along the fighter, rather than the bomber, model. Because of the technical requirements of carrier-launched aircraft, and the elusive nature of naval targets (the enemy fleet), navy bombers (usually dive bombers or torpedo bombers) were quite similar to fighter aircraft, both technically and in terms of employment. This produced in them similar dispositions to those of Air Force fighter pilots.

The story for commanders of naval vessels is different. It contains opposing elements. On the one hand, the captain of a ship has traditionally been regarded as a monarch in his domain. He gives the order, and the ship turns into the attack. All subordinates are more or less automata, and a highly directive system of command and control is typical. This disposition is reinforced when naval vessels typically operate individually, as was the case of American submarines during the Second World War and the Cold War.[41]

But ships typically operated in fleets. The paradigm for this was established by the carrier task forces of the Second World War, which have continued to provide the template for naval organization to this day. The capital ships, the carriers, would be protected and sustained by a number of cruisers, destroyers, frigates and supply ships. These were not intended to operate independently, except in tactical situations, and were tightly coupled

[40] It should be noted parenthetically that the ideas of a decision cycle were "in the air" at the time. Both social psychologists and systems engineers had developed such concepts in the 1940s and 1950s. In sociology Talcott Parsons produced a similar notion in his Latency-Integration-Goal Attainment-Adaptation (LIGA) cycle. Regrettably, neither of the biographies of Boyd develop this point.

[41] An important distinction needs to be made. During the Second World War, with their primary mission the sinking of enemy merchant shipping, submarine commanders were given wide latitude by their superiors. During the Cold War, with their missions linked to nuclear deterrence, there was enormous pressure to tightly control submarine commanders in order to prevent the unintended initiation of hostilities. Given the difficulty of communicating with submarines when under water, this posed serious difficulties.

to the carriers, like a dog on a leash. This posed a problem for naval command and control. While each ship captain was an autocratic within the confines of his vessel, they were each subordinated to the task of protecting and supplying the carriers. It would seem that this set-up called for the degree of flexibility inherent in commander's intent systems. In reality, given the ability to communicate between ships, the Navy opted for further tight coupling.

These established dispositions were then reinforced when computers were linked to radar and radio. The key conceptual innovation was the notion that sensors on one ship could cue weapons on another ship, and that the entire fleet could be formed into a single network, acting as a single unit. This line of thinking was a natural extension of tight coupling. But a curious thing happened.

The language of networks suggests loose coupling. Networks are typically contrasted with hierarchical systems, and quite unintentionally a host of analogies and connotations from biology and evolution are imported into the discussion whenever military officers talk about networks. The fleet came to be seen as an organic entity, a sort of ants' nest or bee hive, where the component parts would operate together to create emergence. This image now sits (rather awkwardly in my opinion) side by side with the image of the fleet as a single machine under the direction of a single director. One image is jazz, the other a classical concert. The two images can be reconciled via the realization that no individual ant or bee acts consciously as an individual with its own purposes; in some sense, all ants and bees are organic automata. As Philip Mirowski would say, this is a cyborg vision.[42]

I should add at this point that the very top leadership of the Air Force has shifted over time between the bomber and the fighter "mafias."[43] Intra-organizational politics have resulted in shifting strengths of each of these communities within the Air Force and a consequent shifting of doctrinal emphasis in command and control debates. A similar dynamic is at work in the Navy. The Army and the Marine Corps are also composed of differentiated communities; however, their need for combined arms operations has operated to attenuate the importance of community-level differences in organizational culture. This is particularly so in the Marine Corps, with its insistence on "every Marine a rifleman" and on the MAGTF (Marine Air-Ground Task Force) as the basic unit of operation.

What Kind of an Explanation am I Proposing?

Let me attempt to relate my argument to sociological theory. I am arguing, in part, that military organizations adopt theories about how they should organize themselves as a result of fads and fashions, much as business organizations do. They are influenced by models presented by successful organizations in the field. In part, certain ideas and metaphors are "in the air" at any given time. They are part of a large culture in which the military is embedded. The way to demonstrate this is through the process tracing of ideas

[42] Philip Mirowski, Machine Dreams, Economics Becomes a Cyborg Science, 2002
[43] Worden, The Rise of the Fighter Generals

and concepts as is done in the history of ideas and in some kinds of social studies of science work.

However, isomorphism has its limits. Some models are seen to work better than others, and there is not a completely free range of theories that may be adopted. I also believe that certain kinds of ideas will resonate with particular component parts of the military than will others. This has more to do with the history and self-image of these organizations than the technology they use.

At times my argument veers close to a form of technological determinism. Although at the most general level, I assume that C4ISTAR technology is neutral between tightly coupled, centralized systems and loosely coupled decentralized systems, I argue that military organizations (whether services or communities) have a predisposition towards one or other style of C2.

My explanation is couched in terms of how these organizations have adapted *in the past* to the demands of modern war. The organizations I examine have been (and still are, despite all the talk of network-centric, rather than platform-centric, operations) organized around the machine-human interface. Technology is central to this explanation, but technology organized into a social (or cyborg) system. Since at any given time there is usually more than one way to employ technology, what I argue is that *over time* military organizations develop dispositions and repertoires that define their organizational essence and identity. The division of labor in modern warfare between different kinds of organizations and weapons reinforces these varying identities.

What I do not see happening is the straightforward operation of organizational interests, leading to the adoption of theories which favor those interests and the rejection of theories which are inimical to those interests. (One can find plenty of evidence for this sort of process at a more detailed level of specificity. When it comes to the retention or acquisition of particular weapons systems, for example, interest-based models work relatively well.)

My approach to "culture" is to create a set of instantiations of culture. It is an effort to create a reasonably large "n" from what appears to be a small number of cases (at its extreme, a single case: the U.S. military.)

In this paper, I take one issue (C4ISTAR) and eight military organizations (the services and communities) at one point in time (the present.) In the book I am writing, I take several issues (counterinsurgency, asymmetry, urban combat, expeditionary operations, effects-based operations, information warfare, peer competitors, space, etc), and specify time periods more precisely so that I examine these over several time periods (late 1980s, immediate aftermath of Desert Storm, late 1990s, immediate aftermath of 9/11, aftermath of Iraq invasion.) The periods are not "years" but theoretically meaningful blocks of time between important events. This generates a three-dimensional matrix of issues, organizations, and periods. In my case, I have 12 X 12 X 5 = 720 possibilities. Even allowing for the fact that many cells are empty, this gives enough instantiations to allow

one to make meaningful statements about correlation and causality. It is possible to expand the matrix further by comparing across nations and by expanding the temporal dimension.

[If one were to situate the contemporary American military in a broader cross-national and historical context, it would occupy a smaller part of the C2 continuum. The Iraqi army, for example, was centralized and tightly-coupled to an extreme. That is one reason why it performed so badly against the Americans. Similarly, the linear formations that dominated European warfare in the seventeenth and eighteenth centuries had highly directive C2 systems and were also tightly-coupled. At the other extreme, nomadic warriors like the Mongols or the Plains Indians, resembled complex, adaptive self-synchronizing systems in ways that existed only in the fantasy of Marine Corps theorists.]

We need to show how organizational responses develop over time. If the notion of organizational culture is to be useful, we must assume (or demonstrate) that organizational dispositions are relatively stable over stretches of time, and that they change in ways that we can satisfactorily explain. Organizational dispositions are the aggregate of instantiations at any given time; we can track how they change over time and ask what explains such changes as we observe.

Warfare is dynamic and inherently disruptive. If we think of the history of warfare as a form of punctuated equilibrium – periods of relative stability interrupted by "revolutions in military affairs" – and if we think of the "modern system" of warfare as running from roughly 1917 to 1991, then it is the set of central defining moments in this period that will determine how American military organizations think of themselves. For most U.S. military organizations, the foundational moment was the Second World War.[44] The next question concerns organizational history since 1945. What, if anything, happened to these organizations to lead them to solidify or alter their self-understandings? There are two sorts of factors that come into play. The first set is the ways in which military organizations assimilate the "lessons" of previous wars. It is a generally accepted proposition in studies of military innovation[45] that military organizations tend to reproduce whatever it was that they believe won them the last successful campaign. Only defeat produces a major re-thinking.

With the partial exception of Vietnam, American forces have not seen themselves as defeated since 1945.[46] One would therefore expect a considerable degree of continuity in military culture. The military adapted to the Soviet threat by preparing to fight a war much like World War II, only better and faster. The Gulf War of 1991 and the invasion of Iraq in 2003 can be seen as the fullest development of this approach to modern war.

[44] This point about the centrality of the Second World War in the self-definition of the US military can be disputed and nuanced. To do so would lengthen an already overly long paper well beyond the reader's patience.

[45] There is a large and high-quality literature on military innovation, written almost exclusively by historians and political scientists, of which sociologists of organization seem to be only dimly aware.

[46] The predominant response to defeat in the Vietnam war by the US military was to deny that it was a military defeat; much of the blame was cast on political leaders.

Arguably, they do not represent a break with modern war (an RMA) so much as an elaboration of it.[47]

The second set of factors are those structural changes that generate pressures for change. These generally are exogenous to military organizations, and comprise things like the extension of mass citizenship, public attitudes to war, democratization, and technical change. In the remainder of this paper I want to shift the focus from a static cross-sectional analysis to an analysis over time by situating the current debates over C4ISTAR in a broader discussion of trends in military organization and warfare.

Theories of Historical Development of Warfare

I want now to consider how new theories of command and control fit into a larger, dynamic view of the history of warfare. I take three cuts at this: changes in command and control itself, changes in forms of military organization, and changes in the nature of warfare.

I have already provided the reader with a brief synopsis of changes in command and control from Waterloo (1815) and the Somme (1916) to the present. As is common with most sociological analyses of technology, I have argued that while technology offers both constraints and possibilities, there is a range of ways that technologies can be incorporated. I have attempted to explain dispositions towards one or other type of control in terms of organizational culture as manifested in historical experience, lessons learned, and organizational identity.

Let me turn to the second cut: changes in the form of military organization.

I need to preface this with a slight digression on how military history is generally conceptualized. I would like to contrast an organization-centered history of the military with a technology-centered one. The technology-centered account of military history is by far the most common and familiar one: it sees developments in military operations as largely driven by innovations in weapons: the stirrup, the cross-bow, gunpowder, rifles and machine guns, tanks and aircraft, atomic weapons, precision-guided munitions. Sophisticated versions of this account note that different military organizations adopt (or fail to adopt) technical innovations into their practice in various, socially-structured ways; that larger societal factors are important in their own right and as providing a context for technical innovation; and include technologies that are not weapons (radios, railways) in the account.

The organization-centric account focuses on the social organization of violence. It is about how armies are organized by states. This view of military history argues that the conduct of warfare changed radically when states created permanent standing armies. This produced the effort to create a monopoly of coercive violence on the part of the state

[47] I am open-minded on this question. My guess is that it is most useful to think of US military operations since 1990 as neo-modern, rather than "post-modern," whatever that much-abused term might mean for the military.

(and hence Max Weber's famous definition of the state) and a whole series of consequences for state financing and economic development explored by Charles Tilly and Michael Mann, inter alia. The second step was the expansion in the size of armies resulting from the growth of citizenship. As Clausewitz noted, this was most dramatically observed in the wars of the French revolution. The third development, closely linked to two non-military technologies (railways and telegraphs), was the rise of general staffs to coordinate and control these huge and increasingly complex military organizations. In this context, the debates about C4ISTAR must be seen in terms of their implications for military organization. The system of system approach is likely to continue the trend towards larger and larger staffs. Allied to concepts of stand-off precision strike, the number of soldiers at the sharp end of war will diminish.[48] The self-synchronization view, on the other hand, while it may have a similar view of military operations, suggests that staffs can be radically reduced. It holds out the possibility of another major change in the organizational structure of fighting forces.

At this point, we need to contemplate the "strategic corporal." During the various peace or MOOTW (military operations other than war)[49] operations of the 1990s, military commanders noted, with some concern, that low-ranking soldiers were often in situations where they had to make decisions – should I fire on this crowd of demonstrators? Should I arrest this local warlord? -- that had the potential to hit the international media and cause a major ruckus. Failure to act – standing aside while civilians were slaughtered – could also lead to international incidents. Rank-and-file soldiers and junior officers were taking decisions that often had major strategic consequences. They were dubbed "the strategic corporal," and lionized by the senior military leadership as examples of the superb quality of American fighting men and women.

What has this to do with command and control and Army organization? Everything. The strategic corporal is an instance of the failure of a command and control system. Enlisted soldiers and officers are trained to perform tasks within the limits of their competence and authority. Each decision is, in principle, best made at a specified level of command. The military hierarchy is designed to ensure that decisions are made at the appropriate level of competence and authority. Corporals have neither the authority nor the competence to make decisions of strategy and policy. That is what colonels and generals are for. The celebration of the strategic corporal by American generals was a face-saving way to avoid recognizing a serious deficiency in the command and control system.

To anticipate the outcome of the third historical cut: to the extent that future operations by the U.S. military take the form of counterinsurgency, "nation-building," or peace operations, the issue of the strategic corporal will bedevil command and control systems.

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[48] This view is encapsulated in Rumsfeld's vision of the lessons that the invasion of Afghanistan holds: a handful of Special Forces operators, mounted on horses, linked to a global C4ISTAR system calling in air strikes.

[49] The notion of "other than" implies, of course, a radical dichotomy between peace and war, a dichotomy which sociologists should not accept uncritically. The organizational implication of MOOTW is that armies should avoid it.

The solution, I suggest, is likely to be found in the "all-officer Army." To argue this case, let me turn immediately to the third historical cut.

The third part of the historical account concerns trends in warfare itself. For the last 500 years or so, the driver behind warfare has been the long-running conflicts between core powers for dominance in the world system. The Euro-centric nature of much military history reflects the reality of the modern age: military innovation and the development of modern war have been driven by competition between core powers (and would-be entrants to the core, such as Japan.)

Some social scientists – and many military strategists – believe that great power competition will continue to drive trends in warfare. Paul Kennedy's book, The Rise and Fall of Great Powers is a typical example of this line of thinking. In political science it is represented by "realist" theories, in sociology by world-systems thinking. In the military it takes form as a preoccupation with potential challenges from "peer competitors" and a vigilance towards Chinese military modernization. I don't think this line of reasoning can be entirely discounted, but there are alternative ways of viewing recent trends in warfare which, I believe, are more plausible.

John Mueller and Martin Shaw have argued that the kind of conflict that drove military innovation came to an end in two stages. The end of the Second World War saw the permanent outbreak of peace in Europe. Quite simply, the idea that war is possible between European powers went out of fashion; and the end of the Cold War removed the last great power competition, that between the US and the USSR. There are now two new features of the global security environment: the democratic peace between established democracies, and the unipolar dominance of the United States. Quite how this (possibly temporary) unipolar dominance will play itself out is the stuff of current debates about American "imperialism." While "balancing" by China or some other power (or alliance) might produce war, I think this is unlikely. War between the stable democracies has become unthinkable.

Because war between great powers has declined, the incidence of warfare has shifted to the Third World, and increasingly to parts of the Third World. There is a widespread perception that armed conflict is on the rise in the Third World, and this has given rise to all sorts of speculation about ethnic conflict, state failure, Islamic rage, and so on. The Third World is seen as a boiling cauldron of conflict. If we are to believe those who track the incidence of armed conflict across the globe, the reality differs significantly from popular perceptions. The incidence of armed conflict, after a blip in the immediate aftermath of the dissolution of the Soviet Union, seems to be steadily declining. Moreover, it is increasingly confined to a sub-set of Third World countries.

What keeps armed conflict going in that sub-set of countries is less deeply-rooted hatred than state weakness, absence of democracy, and predation on primary-product exports.[50] I do not wish to be Panglossian here. The tasks of moving these countries over the development hump, particularly in terms of state-building and democratization, are

[50] Paul Collier et al, Breaking the Conflict Trap: Civil War and Development Policy, World Bank, 2003

formidable, and conflict in these countries will be with us for a long time to come. This is what the future face of war will look like: machetes and AK-47s will be the standard weapons, not F-22s and Joint Strike Fighters.

American military forces will operate in this warfare terrain. They have done so for over a century. But they dislike such operations and there is organizational resistance to learning from such conflicts and preparing to fight them. The organizational culture of the US military as a whole (with the Marine Corps as a partial exception) is that of a modern military designed to fight its mirror-image, another modern military. All other forms of combat are seen as "lesser included cases." I have argued in a paper on counterinsurgency that this organizational identity makes it extremely difficult for the US military to conduct counterinsurgency operations effectively, and means that it never develops an institutional "memory" of previous experiences. It must learn how to do counterinsurgency each time.

If my reasoning about the future trend of warfare is accurate, then one must ask whether or not the U.S. military is preparing for the wrong war. As a whole, it has a predisposition towards "modern" or neomodern warfare. All the talk about dealing with asymmetrical opponents is largely hot air, unrelated to the quotidian practice of the military organization. This seems to be particularly true of the highly elaborate C4ISTAR systems that are currently being developed. These systems are designed to find tanks and aircraft, and to bring fires to bear on rapidly moving targets. They are not designed to discover whether someone harbors anti-American thoughts in his head, or whether he intends to plant a roadside IED. Whole elaborate intellectual constructs built around hi-tempo operations with dominant battlespace knowledge aiming at rapid, decisive victory are simply meaningless in the kind of warfare environment that is likely in the future.

There are two reservations that must be made. There are two warfare scenarios in which neomodern concepts of operations and C4ISTAR systems may be entirely appropriate. These are "rogue states" armed with WMD and the emergence of China as a peer competitor. Even if such scenarios turn out to be low-probability events, they pose such potentially catastrophic outcomes that prudent defense decision-makers would feel a pressing need to hedge against such possibilities by maintaining a hi-tech modern military.

But the workaday military operations will, as I have argued, most likely occur in the Third World. What form of command and control is most suited to such operations? At this point, we must return to the story of the "strategic corporal."

It seems clear that if a soldier at a roadblock or on patrol in a Third World city might be faced with making a decision that has strategic consequences, then that person should be properly equipped to do so. There are two ways to do this. The first is reachback up the chain of command to the appropriate level of authority and competence. This can be done with modern communications. It would establish a directive system of command and control with micromanagement and surveillance. The other solution is to physically place the appropriate kind of commander in that roadblock or patrol. If a colonel with fifteen or

twenty years' experience and a War College course in strategy and politics under his or her belt is the kind of person who should be making those decisions, then they should be leading the patrol.

Towards an All-Officer Army?

What would this mean for the structure of military organizations, particularly the Army? It would mean a dramatic expansion of senior field-grade officers (colonels) and a general flattening of the officer hierarchy. Officers below the rank of colonel would essentially be trainees rather than managers and commanders in their own right. Rank would be decoupled from responsibility. The number of colonels required would be very large. Moreover, it would be important to maximize the tenure of colonels in the Army, rather than (as is done currently) forcing them to retire if they aren't promoted to flag officer rank in a few years.

In terms of enlisted men and women, they would be there not to exercise judgment, but simply to carry weapons and equipment. Non-commissioned officers with years of experience (and emotional maturity) would be in greater demand than would young, recently recruited soldiers. At this level the regular Army would look more like Special Forces.

This sort of organization is not as far-fetched as it might seem, though it would require a major upheaval in army organization. The army would shift from being a very hierarchical organization with a parallel career of professional advancement to being composed largely of senior officers backed by technical specialists and served by drones excluded from decision-making. The command and control arrangements most suited for this kind of force is a collaborative sharing amongst professional equals. This would be commander's intent for the twenty-first century.

This is, in fact, the Air Force model. As the most "modern" of the services, the Air Force may perhaps be an indicator of the future. All decision-makers in the Air Force and the Navy are officers. Each pilot is an officer. And when the captain of a naval vessel orders "Hard starboard; engage the enemy!" every cook and bottle-washer on board turns with the ship. In the Army and Marine Corps, things are different. When the commanding officer calls "Follow me!" there exists the possibility that his men will not advance into enemy fire. When the commanding officer instructs his subordinate to "take that hill," the subordinate officer may mistake which hill he is to attack, may decide that he cannot attack successfully, or may not realize that when he was instructed to take the hill, his commander meant him to stay there and occupy it rather than simply clear the enemy off it and move on. Armies pose problems of coordination that are not shared (or are shared only to a lesser extent) by the other services. That is why issues of trust and command presence are so important, and why modern armies tend to opt for a commander's intent style of command.

Let me end with a fairly obvious prediction: Army culture – its self-definition as a modern warfighting organization – will be a major obstacle to adopting an organizational structure and C4ISTAR system appropriate for the changed circumstances of war.

Appendix 1: Definitions.

Command is generally taken to mean that set of procedures and decisions centering on the course of action to be followed.

> Command is the decision to order a unit to "attack that hill" versus "By-pass enemy strong points."

Control is that set of procedures and organizational arrangements aimed at ensuring that commands are implemented.

> It is designed to ensure that the appropriate unit (1) actually attacks (rather than remaining in their trenches), (2) attacks the right hill (rather than an adjacent hill), and (3) does so at the time that the commander wants. Inevitably, things go wrong. When this happens, control is the set of procedures for getting action back on track or initiating a sequence of decisions resulting in a modification of the command decision. The attacking unit might, for example, encounter heavier-than-expected enemy resistance. The control element informs the commander of the new situation, and tells them how to respond while the commander reassesses the situation. Additional units may be ordered to join in the attack, or the attack may be postponed or cancelled.

Discussions of command and control range in scope from the grand strategic to the minor tactical level. In this paper my focus will generally be on tactical and operational levels. In recent years, the term "command and control" (C2) has been semantically enlarged, through a variety of intermediate steps – C3, C3I, C4I, to C4ISR and, more recently, to C4ISTAR. **C4ISR** is Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance. **C4ISTAR** adds target acquisition. (I recently saw someone try to introduce C5ISR as a term, with the fifth "C' referring to combat systems.) This semantic shift from C2 suggests that something interesting is happening in real life. At the risk of betraying my age and being utterly anachronistic, I am inclined to quote the first two lines of the Buffalo Springfield song: "There's something happening here; what it is ain't exactly clear"

The OODA loop is Observation, Orientation, Decision and Action. It is alternatively referred to as the **decision cycle**. OODA is intended to describe the sequence of actions involving definition of a problem, making a decision, and implementing it. Whether one characterizes it in these four components or in some other way, the basic point is that the decision cycle takes time and has components.

I use the term "**military analyst**" (and equivalent phrases such as military thinker) to refer to those, whether uniformed military officers or civilian employees, who work for the Department of Defense, either directly or by contract (usually through a civilian think-tank), in the business of developing strategy and operational concepts. Giving a precise definition of this group of people has its problems, but for the purpose of this paper it is sufficient that the reader have a general sense of what I mean by the term.

The term **Network Centric Warfare** is subject to differing interpretations. It is intended to refer to a state of affairs in which the military force is robustly networked with the capacity to share information very broadly and thereby achieve information superiority over an enemy.[51]

When I talk about military **doctrine** I refer to the body of authoritative precepts about how military operations should generally be conducted. Doctrine is the set of beliefs held by a military organization about what war (and other kinds of military operations) is about, and about how military organizations ought to go about their business. Doctrine can be informal; in the modern military it is usually formalized in doctrine manuals.

[51] Ibid 3-10

Appendix 2: Complexity Theory

For those who are familiar with complexity theory, please skip ahead; for those who need to be brought up to speed, what follows is my amateurish effort to reduce a complex (sic) theory to those few essentials that are relevant to the discussion here.

Complexity theory is a branch of chaos theory and may be seen either as a later modification of chaos theory or as a subset of chaos theory. The central proposition is that order is often visible in apparently chaotic systems, and that order evolves out of chaos. Many kinds of systems exhibit these properties: natural physical systems such as fluid dynamics, biological systems such as the co-evolution of predators and prey in an ecological system, and social systems. Complexity theory is taken seriously by many scientists as a powerful theory (which can be expressed mathematically) that enables us to see similarities among a range of superficially quite disparate phenomena. It has been imported into the social sciences primarily through two overlapping routes. On the one hand, some futurologists thinking about the "information age" believed that complexity theory was the "new science" of the future and that it would displace the mechanical, linear scientific paradigms and metaphors of the industrial age. On the other hand, some people working in business schools and management theory have been concerned to understand the sources of competitiveness, innovation, and success in a highly turbulent organizational environment. From both sources complexity theory was discovered by the U.S. military in the early 1990s. To some extent it was treated more as metaphor than as a serious scientific paradigm, and in the hands of some futurologists, very large (in my view, exaggerated) claims were made about how this was a scientific paradigm that would completely overturn the mechanical, linear, Newtonian world. In the hands of some management gurus, complexity theory came to resemble a sort of inspirational "how to achieve success" airplane reading for executives.

While I believe that these arguments about a "new science for a new age" are often devoid of any serious scientific foundation, and should be treated as ideology, I also think that there is a serious scientific core to thinking about complex systems and that some social systems may well exhibit elements of complexity. This means that, as an analyst of belief systems, when it comes to metaphors and propositions from complexity, my stance is one of respectful, open-minded skepticism. I have tried to sort out where military discourse reasonably applies complexity theory from those instances where it takes a metaphor and makes it do work that is not scientifically justifiable.

To resume the exposition of complexity theory, it is common to distinguish three states or phases that a system may be in: chaos, complexity and stability. In the chaotic state, the individual units of the system interact with each other in ways that do not produce any pattern at all. All outcomes are unpredictable. At the other extreme, in the stable state, the units of a system have settled into stable and predictable interactions. In this state there is no change. The interest of complexity theorists lies in the intermediate state between chaos and complexity. In this phase state, the units of a system interact in such a way as to produce patterned behavior which displays order, but which is not predictable in a

linear manner. For example, in a physical system objects might oscillate around one or more points (“strange attractors”) and these oscillations might fall within a clearly definable zone. But – and this is the key point – the objects do not repeat oscillations in any predictable manner. We can define the zone through which an object will pass, but we know that it will never take the same route (except randomly.) There are thus things that are susceptible to prediction, and other things that are not.

The next step is to show how order emerges out of this complexity. There is already an element of order, but there is not yet much predictability. In a complex adaptive system – a term borrowed from the use of complexity theory in ecology and evolution – the interactions of the units eventually leads to stable and predictable patterns of behavior. The units “co-evolve” as a result of their interactions. There need be no master plan, no conscious intersubjective understanding. Order emerges simply as a result of interactions. An example from social systems that complexity theorists frequently use is the emergence of order in a city. The millions of inhabitants of a city, they say, do not organize their lives with the purpose of creating regularity and predictability in the system. Rather, they each pursue individual goals, and do not consult others. There is no intersubjective understanding. The outcome, however, is a highly structured and predictable social system.

At this point in the exposition, a professional sociologist will no doubt begin to wonder what all the fuss is about. She will see this as the rediscovery of the (sociological wheel) by people with a generally unsociological understanding of the world. There is much truth to this observation, but that is almost beside the point. One thing that happens in lay belief-systems about society is the rediscovery or the partial and distorted incorporation of sociological concepts. For a student of belief systems, it is important to understand how non-sociologists come to visualize the social world, how they reinvent or adapt sociological concepts to serve their rather different purposes. There is little point in lamenting this; we should, however, seek to understand how our concepts are rediscovered or appropriated and put to other purposes by other people.

All this, as will by now be apparent, can be re-phrased in a sociological vocabulary. We are quite familiar with the notion that order (or patterns) emerges as the unanticipated outcome of many interactions. We are familiar with the notion of social systems, their functional requisites and structural tensions. Indeed, for many of us, this IS sociology. Not surprisingly, sociologists have reacted to complexity theory in two quite opposite ways. Some have cried, "Eureka: at last we have found the key to the universe!” They stress the parallels between social and natural systems. Others have remarked, in a bored way, that we have known about unanticipated outcomes and emergent order all along, and have promptly ignored the complexity enthusiasts as a bunch of faddists who have reinvented the wheel when it comes to social systems. They are skeptical about the utility of claiming that social and natural systems are fundamentally similar. I am inclined to the latter view, but cannot ignore the complexity enthusiasts because they are an important part of the story I am trying to tell about the development of military belief-systems.

There is a point often made by people who write about complexity which puzzles me, and which I can only attribute to ignorance of mathematics. Sometimes writers assert that only linear systems are predictable, and that non-linear systems are unpredictable. This is simply wrong; since non-linear systems such as y = x2 are quite predictable, even if there might be more than one solution. The image these writers wish to convey is of two diametrically opposed situations: linearity and predictability on the one hand, and complexity and unpredictability on the other. This opposition may serve ideological functions in a belief system, but it is a misreading of the science of complexity. The implication of the science of complexity, it seems to me, is that we can have all sorts of patterned nonlinearity, and that this is predictable in some ways, and unpredictable in others. There is nothing remarkable about this insight.

I should say a few more words about complex adaptive systems and co-evolution. The complexity take on evolution is that complex adaptive systems (those that respond to changes in the environment through actions of component parts which are not centrally coordinated or planned) adapt to changes in their environment. A term that is frequently employed here is “self-synchronization.” The bottom-line deduction from complexity theory was that, in the right circumstances, lower level units could act autonomously in such a way that out of a large number of independent actions order would emerge. The term for this is self-synchronization. Systems capable of self-synchronization are termed complex adaptive systems. They adapt to changes in the environment via a series of responses on the part of individual units. These are uncoordinated in any directive manner. Together, they move the system to a new level of complexity.

Further, other complex adaptive systems which are also part of this environment or ecology, all evolve in a similar manner. There is thus co-evolution, rather than a series of distinct separate evolutions. To the extent that the environment is a congeries of other complex adaptive systems, evolution becomes co-evolution. This is perfectly sound as science; it can take on mystical overtones when used as metaphor. As we will see in the body of my paper, a central question concerns the applicability of these concepts to the military realm. What criteria can we employ to determine if a system really is adaptive, and what do we mean by this? (Many of these issues were raised in the discussions of functionalism in sociology in the 1960s. They have yet to be seriously addressed by contemporary military thinkers.)