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The Command *or* Control Dilemma

When Technology and Organizational Orientation Collide

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Foreword

In this well-researched and insightful study, Lt Col Gregory A. Roman examines the relationships between military organizational hierarchies and the impact of battlespace information. Drawing on a sophisticated range of studies and data and using numerous illustrations, the author contends that the outmoded effects of traditionally centralized (and technologically proliferating) command and control orientations preclude the US military (and particularly the Air Force) from effectively applying and acting upon the benefits of information-age technologies in an age of information warfare. The author sees future warfare characterized by faster decision making, faster operational tempos, and a torrent of tactical battlefield information. These new realities necessitate greater decentralization of control, more flexible information gathering, and creative, nontraditional military organizational arrangements.

Of particular relevance to the Air Force is the joint force air component commander (JFACC) structure and air tasking order (ATO) process. Colonel Roman argues that these products of traditional hierarchical organizations and mindsets significantly impede flexibility in responding to ongoing battlefield developments. As currently composed, the JFACC and ATO reflect inflexible, traditional industrial-age warfare doctrine arrangements. Moreover, USAF doctrine (unlike Army, Navy, and Marine doctrine) does not permit decentralization of control. Some Air Force proponents have even advocated increasingly centralized execution, the basis of a new micromanagement. The author recommends that the Air Force move to decentralized control and execution in which shared information gathering by "networked" organizations—with decentralized and more autonomous decision making operating within flattened hierarchies—would bypass unnecessary command layers. Such arrangements would allow much more rapid responses to mobile, agile targets presented by adaptive and flexible adversaries. The author also contends that US commanders could increase their operations tempos and initiatives without sacrificing the ability to concentrate effort. Given a 5,000-page, 72-hour ATO in Operation Desert

Storm, it is little wonder that Gen Merrill A. McPeak remarked, "It is a disgrace that modern air forces are still shackled to a planning and execution process that lasts three days. We have hitched our jets to a hot air balloon." Colonel Roman's analysis and recommendations need to be read by a wide community of operators and planners.

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About the Author

Lt Col Gregory A. Roman is a career intelligence officer who has been stationed in Greece, Korea, Germany, Panama, and Japan. He is a graduate of the US Air Force Academy and holds a master of science degree from Troy State University. His duty assignments include tours as an operations officer and squadron commander for EC-130 and RC-135 operations. While assigned to the Pentagon, he served as the tactical cryptologic program element monitor, executive officer to the assistant chief of the Air Force/Intelligence, and on the Secretary of the Air Force Legislative Liaison staff. Colonel Roman is a distinguished graduate of Squadron Officer School and a graduate of Air Command and Staff College. He is a 1996 graduate of Air War College.

The Command *or* Control Dilemma

When Technology and Organizational Orientation Collide

The functions of command are eternal.
—Martin L. van Creveld, 1985

Once upon a time, everybody understood what commanders did. They commanded. This was simple enough and sufficient for a thousand years or more . . . now, commanders would exercise command and control.
—Greg Todd, 1985

One of the least controversial things that can be said about command and control is that it is controversial, poorly understood, and subject to wildly different interpretation. The term can mean almost everything from military computers to the art of generalship: whatever the user wishes it to mean.
—Kenneth Moll, 1978

Command and control (C^2), a term very familiar to the military, is subject to much confusion and misinterpretation. What does command and control really mean, and is the current C^2 orientation the proper one for an information-age military?[1] These are important questions as the US military grapples with the potentially revolutionary changes brought on by modern information technology. If information-age technology is indeed contributing to a revolution of military affairs (RMA), then organizational structures and associated C^2 orientation must change. In 1995, Secretary of Defense William J. Perry stated, "Historically, an RMA occurs when the incorporation of new technologies into military systems combines with the innovative operational concepts and organizational adaptations to fundamentally alter the character and conduct of military operations."[2]

These organizational changes are occurring in the business world, but can the same be said for the military? The USAF Scientific Advisory Board's *New World Vistas* (Com-

munications Volume, 1995) draft report notes that "even the most casual glance at business history makes it clear that each time a new information infrastructure becomes available (e.g., railroad, telegraph, telephone) the entities which are ultimately most successful are also the first to reshape their structures in order to gain maximum advantage of the new information conduits. The new networks emerging today are 'geodesic,' that is global, nonhierarchical, and without any central node."[3]

The board concludes with the optimistic view that, "It is a safe bet that our [military] organizations will follow suit."[4] However, this may be easier said than done given the historical resistance of military organizations in adapting to new organizational orientations.

Thus far the US military services have failed to create the innovative operational concepts and make the organizational adaptations needed for the information age. The US military remains rooted in an industrial-age C^2 paradigm, where control is emphasized over command. As pointed out in the draft *Warfighting Vision 2010*, "technological enhancements may have made 'control' an anathema to 'command.'"[5] This is certainly true of the modern US military. The dilemma is that for an information-age military the correct organizational orientation may no longer be one of command *and* control but one of command *or* control. Centralized control exercised by hierarchical organizations may no longer be possible or desirable in a fast tempo war.

Failure to address this dilemma could result in a military not being prepared for the operations tempo of information-age warfare. As Maj Gen J. F. C. Fuller points out, "The highest inventive genius must be sought not so much amongst those who invent new weapons as among those who devise new fighting organizations."[6] However, creating new organizational orientations has never been easy. Brig J. P. Kiszely expands Fuller's view by stating, "Without originality, let alone genius, the new technologies will merely be grafted on to existing organizations and doctrines in a way designed to cause the least inconvenience and least unpleasantness in peacetime. The risks of having operated on this principle in the past are as nothing to the dangers of doing so in the future."[7]

Unfortunately, by viewing the benefits of information technology within the current military C^2 orientation, technology may be used in a manner that is the exact opposite of what is most desired.

The seductiveness of information technology stimulates military organizational orientation towards greater centralized control and more rigid hierarchical organizations instead of the desired orientation of decentralized control and more flexible organizations. Unless the US military recognizes the danger of succumbing to technological temptation, control functions may take priority over command functions, resulting in both a less efficient and less effective military. While this applies to all US military services, the command *or* control dilemma particularly impacts those organizations where centralized control is part of doctrine.

This paper argues that the corrosive effect of an outdated C^2 orientation prevents the US military from fully applying the benefits of information technology. Future warfare, characterized by faster operations tempo, requires a new orientation based not on "centralized control" but on greater decentralized control and more flexible organizational orientation. To better understand this, the definitions of command and control are examined to explain why there is so much confusion and misunderstanding. Next, organizational orientation theory is discussed to show how the military traditionally responds to new information technology by emphasizing greater centralized control and rigid hierarchical organizational structures. Then, through the use of an information-gathering and decision-making model, it can be determined why current US military orientation of centralized control and hierarchical organizational structures is not suited for the high-tempo operations expected in the information age. Finally, from theoretical and model analyses, some recommendations are given on what the correct military organizational orientation for the future must be.

Frame of Reference

Our familiarity with the words *command* and *control* may lead one to believe that a problem does not exist. After all,

these two words sound like they were meant for each other, causing few to fully appreciate their separate meanings. This cozy word association also gives the impression of equal weighting, value, and importance. While few would challenge this observation, the truth is that there is no agreement on what command and control really means.

In *Command and Control for War and Peace*, Thomas Coakley addresses some of the origins behind these two words. He notes that there is little mention of control by the early biographers of the great captains of battle. Control was viewed as an organic function of command. However, the word *control* appears in literature during World War I and more frequently in World War II literature, possibly from the increased automation and sophistication of weapon systems.[8] This led to a belief that one commands people but controls things.[9] For example, a distinction can be made that one commands the aircrew who, in turn, controls nuclear weapons. Others make the distinction that command is strategic and operational, while control is tactical. Analogies have been made with the human nervous system with the command brain controlling the rest of the body.[10] Another view is that command is an art while control is more a science. John R. Boyd wrestles with the differences in describing the epitome of command, which is to direct, order, or compel, while control means to regulate, restrain, or hold to a certain standard.[11] Boyd further suggests that "leadership and monitoring" are more accurate and descriptive than are "command and control."[12]

Attempts to clarify the command and control muddle highlight the difficulty in associating these words. Is this word association healthy, and what happens when certain words fall out of favor? One solution is to invent new word associations.[13] For example, C^2 has expanded to C^3 (communications), C^4 (computers), C^4I (intelligence), and C^4I^2 (interoperability). The US Marine Corps is advocating an orientation of "command and coordination" as part of their future war-fighting concept called Sea Dragon, while the Air Force is championing an orientation called C^4ISR (surveillance and reconnaissance).[14] One wonders which word will be added next? Perhaps C^5I^2 (coordination), or C^6I^2 (cooperation)? Unfortunately, each new word association that tries to describe new thinking or new

technology does so at the expense of the most important word *command*, or what Greg Todd calls "C_1."[15]

The Joint Chiefs of Staff (JCS) provide little help in clarifying the confusion over the term *command* and *control*. JCS Pub 1-02, *Department of Defense Dictionary of Military and Associated Terms*, defines command as "the authority that a commander in the Military Service lawfully exercises over subordinates by virtue of rank or assignment. Command includes the authority and responsibility for effectively using available resources and for planning the employment of, organizing, directing, coordinating, and *controlling* military forces for the accomplishment of assigned missions."[16]

By definition then, control is a component of command. Why then is a distinction made between the word *command* and the word *control*, and why give preferential treatment to the notion of control but not to those of organizing, directing, or coordinating? Perhaps it is because the US military fails to see the difference. There are many obvious similarities when comparing Joint Pub 1-02's definition of command with the definition of command and control, "The exercise of authority *and direction* by a properly designated commander over assigned forces in the accomplishment of the mission. *Command and control functions are performed through an arrangement of personnel, equipment, communications, facilities, and procedures employed by a commander* in planning, directing, coordinating, and controlling forces and operations in the accomplishment of the mission."[17]

The differences between these two definitions are italicized. The latter describes the orientation, which will be discussed later, through which a commander exercises command and control. For now, let us focus on the italicized word *direction*. Does this imply control? If so, then one would logically expect that the JCS definition of control to be the exercise of direction by a properly designated commander over assigned and attached forces in the accomplishment of the mission.

This would make sense in explaining that command is the exercise of authority while control is the exercise of direction. However, things are not this easy. Control is also exercised by civilian leadership, such as President John F. Kennedy's handling of the Cuban missile crisis; or military

personnel, like air traffic or weapons controllers, as part of their official duties. Thus, control also applies to people in noncommand functions.

Unfortunately, the JCS Joint Pub 1-02 definition of control does little to clear up the confusion by describing it as an authority which may be less than full command exercised by a commander over part of the activities of subordinate or other organizations.[18] These definitions, unfortunately, do little to clarify the command or control definition dilemma. Is command defined by "authority for full command exercised by a commander," while control is defined as "authority of less than full command exercised by a commander?" And, if so, what exactly does that mean? It would appear that more accurate, unambiguous, and descriptive definitions are the first step in resolving the command *or* control dilemma.

Perhaps what is needed is a fresher and simpler perspective. The JCS definition of command is a good one and already contains all the essential ingredients necessary for accomplishing the assigned mission. Associating command with control is, at the least, redundant, and at worst, creates an incorrect paradigm that impacts how we organize for future warfare. As Todd points out, "If atoms could be split, so could the act of command. Now, commanders would exercise command and control. Eureka! Never mind that command already implied control. Never mind that without control one could not command."[19] By recalling Martin L. van Creveld's statement about "the eternal nature of command," then the US military must assume responsibility for the confusion. JCS Joint Pub 1, *Joint Warfare of the US Armed Forces,* reminds us that "the primary emphasis in command relations should be to keep the chain of command short and simple so that it is clear who is in charge of what."[20] Command, by its very eternal nature, provides that simple orientation that stands the test of time and introduction of new technology.

An Organizational Orientation Model

While van Creveld points out that the functions of command do not change over time, the means to carry out that

command change quite often.[21] He divides the means of command into three categories: organizations, procedures, and the technical means which help determine the degree of control exercised by that commander.[22] For example, sensor and communications technologies have changed at a more rapid rate than have organizational structures and operating procedures for employing them. Today's military services have progressed from the telegraph to modern age microburst transmitters but still operate under the same centralized control and hierarchical organizational orientation employed by Frederick the Great and Napoléon. The danger is that this industrial-age C^2 orientation corrodes the benefits offered by this new information technology. The primary impact will be felt if a commander's information-gathering and decision-making processes do not keep up with the increased operations tempo of future warfare.

A key characteristic of future warfare is increased operations tempo which stresses a commander's ability to observe and react to changes in the battlespace. JCS Pub 3, *Doctrine for Joint Operations*, acknowledges that "the tempo of warfare has increased over time as technological advancements and innovative doctrines have been applied to military requirements."[23] Thus, the commander operating at a slower tempo than the opposing commander is at a greater disadvantage because there is a greater degree of uncertainty. This happens because the commander operating at a faster tempo will always be one step ahead of an adversary and is actually setting the tempo. Boyd addresses the commander's decision-making process as a continuous four-step mental process—observation, orientation, decision, and action (OODA).[24] Using the Boyd model, successful commanders are those with the capability to operate within their adversaries' OODA loop.

The ability to observe, orient, decide, and act faster than your opponent is necessary for future warfare. In *War in the Information Age*, Gen Gordon R. Sullivan, a former US Army chief of staff, observes that throughout history the tempo of operations caused by the impact of technology in warfare has accelerated (table 1).[25] Information technology has decreased the time available for commanders to gather information and make decisions. Notice that the time dif-

ferential between orienting (finding out "What is actually happening?") and deciding ("What can I or should I do about it?") has compressed to the point that in information-age warfare, orienting and deciding can no longer be sequential actions but must be simultaneous and continuous ones. Thus, organizational orientation and procedures are critical components in determining the tempo of a commander's OODA loop.

To better understand this process, it is worth consider-

Table 1
Tempo and Command

	Revolutionary War	Civil War	World War II	Gulf War	War of Tomorrow
Observe	Telescope	Telegraph	Radio/ Wire	Near Real Time	Real Time
Orient	Weeks	Days	Hours	Minutes	Continuous
Decide	Months	Weeks	Days	Hours	Immediate
Act	A Season	A Month	A Week	A Day	< An Hour

ing the OODA loop in a different paradigm; as really two separate cycles, or processes, operating at the same time (fig. 1). The first cycle is the information-gathering cycle, which addresses the commander's need to find out "What is actually happening?" The second cycle is the decision-making cycle, which addresses the commander's need to decide "What can I or should I do about it?" In this model, the information cycle loosely incorporates Boyd's observa-

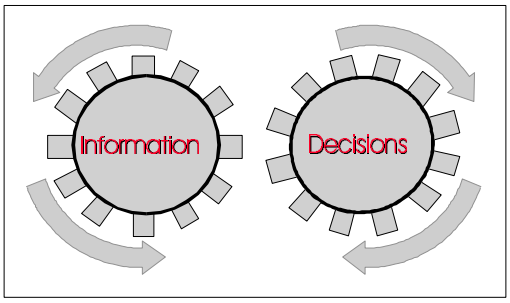

Figure 1. C^2 Dynamics

tion and orient functions while the decision-making cycle incorporates the decision and action functions.[26] With the use of this model, one can examine the impact of tempo and technology on organizational orientation.

First, consider the commander with a very effective information-gathering capability who defers a decision, refuses to make decision, or makes a wrong decision. While his ability to observe and orient is high, the commander may not have the temperament or capability to decide and act on that information. The model suggests that his information-gathering cycle is operating faster than his decision-making cycle, creating an imbalance. While his uncertainty level may be relatively low, it ill behooves the troops commanded because he is incapable of using his control process to command appropriate action.

Second, consider the commander with poor information-gathering capability, yet who decides and acts correctly at the right time based on *whatever* information was available. While the commander's information gathering was poor or incomplete, by temperament, training, doctrine, and faith, such commanders overcome uncertainty and decide the best course of action. In this case, the commander's decision-making cycle is operating relatively faster than his information-gathering cycle, again creating an imbalance. Even the most decisive of commanders will eventually make poor decisions given poor information.

The balance between the information-gathering cycle and decision-making cycle is critical because it defines a commander's operating tempo. As Boyd points out, from an external viewpoint it is critical for a commander to operate faster than an adversary or within an adversary's OODA loop. The means to do so, however, require internal balance between a commander's information-gathering and decision-making cycles. Faster decisions can be possible because of faster information technology. Of course, faster does not imply better information, or even better decisions. Even under ideal conditions, it is difficult to always have perfect information and to always make perfect decisions, a state where the information-gathering and decision-making cycles are working in harmony. While friction will always be a factor, it is technology, organization, and

procedures that either act as a lubricant or throw a wrench into the balancing of the information-gathering and decision-making cycles (fig. 2). It is the balance between information gathering and decision making that also determines the amount of uncertainty in the system.

Organizational orientation determines the degree of un-

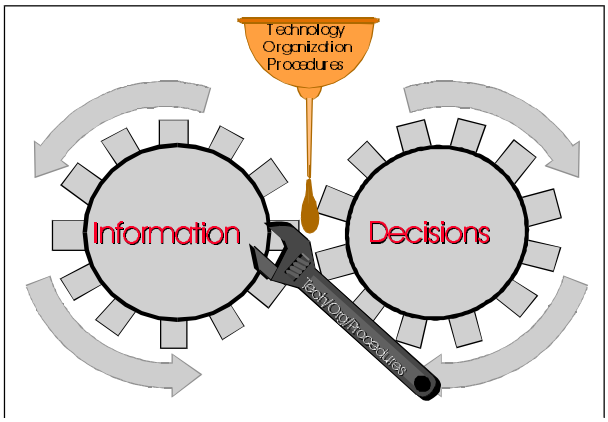

Figure 2. Technology/Organization Procedures Impact

certainty a commander is willing to tolerate. Van Creveld declares that the history of warfare is an endless quest of decreasing the "realm of uncertainty, resulting in a race between more information and the ability of technology to keep up with it."[27] Thus, the choice between centralized or decentralized control involves the distribution of uncertainty. Van Creveld believes that while centralized control reduces uncertainty at the top, it increases uncertainty at the bottom. Decentralized control has the opposite effect.[28] Thus, it is human nature for higher level commanders to reduce their uncertainty, driving organizational orientation to greater centralized control. However, the cost for less uncertainty at the top is more uncertainty at the bottom. The cost for greater control by commanders is less autonomy in the field.

Unfortunately, the greater the level of control, the less opportunities for initiative and flexibility where it is needed most to cope with the dynamics of warfare: at the lower levels of command. Frank M. Snyder points out that prior

to reliable long-distance communications, commanders wrote orders with objectives at a level high enough to give lower level commanders the flexibility to adjust their actions according to current events.[29] Commanders expected that communications would be unreliable and planned accordingly. This is no longer true today because information technology is making communications more available and more reliable. For example, the number of radio sets rose from one for every 38.6 soldiers in World War II to one for every 4.5 soldiers in Vietnam, an 857 percent increase.[30] Moreover, communications are more reliable. During Operation Desert Storm, the US military had a 98 percent communications reliability rate in handling 700,000 telephone calls, 700,000 messages per day, and more than 30,000 radio frequencies.[31] Better information technology decreases the need for flexibility and initiative.

Modern technological advances, particularly in the area of computers and communications systems, increase the likelihood that the information-gathering and decision-making cycles will be imbalanced. In fact, technology is the contributing factor for having two separate cycles. In preindustrial warfare, Alexander the Great's personal command style was such that his information-gathering process and decision-making cycles were in harmony. He saw what was happening on the battlefield, made decisions, and took actions based on his personal observations. This is the classic OODA loop, a very sequential process. In preindustrial-age warfare, technology, organization, and procedures were relatively simple.

One of the major characteristics of industrial-age warfare is movement made possible by the internal combustion engine. Vehicles, and the things they transport, move at high speeds. Armies are mechanized and mounted. There are relevant objects in space and beneath the sea. All of these fast-moving objects must be observed for one to properly orient. Thus, faster operations tempo contributes to greater uncertainty. Faster information-gathering capabilities increase the potential for dealing with panoramic, multimedia changes, suspicious, contradictory or incomplete information, making the decision-making process more difficult. This increase in information-gathering capa-

bilities is a result of technological advances in the information, intelligence, computer, and communications fields. The volume of data processing is growing exponentially, with capacities doubling approximately every 18 months. The maximum communications throughput of two megabits per second in Operation Desert Storm will seem slow when compared to the impending capacity of 30 megabits per second.[32] The result is a technologically driven faster information-gathering cycle, but a decision-making cycle that has not gotten appreciably faster since the days of Alexander the Great. Decision making is still very much a human chore.

Unfortunately, advances in decision-making technology, such as computer-assisted logic tools and artificial intelligence, have not progressed as rapidly as information-gathering technology. Technology is making more and more information available, but the commander's ability to process and act on that information is still limited to how much the commander's brain can comprehend. As van Creveld states, "The paradox is that, though nothing is more important in war than unity of command, it is impossible for one man to know everything. The larger and more complex the forces that he commands, the more true this becomes."[33]

It is the organization and procedures that try and reestablish the balance between the process of information gathering and the process of decision making. Technology and operating procedures can either add friction or mitigate it. Both technology and operating procedures are strongly affected by organizational structure and organizational orientation.

As mentioned earlier, information gathering is critical to addressing the problem of uncertainty. As John F. Schmitt explains, there are two possible responses. One is to pursue certainty as the basis for command and control. The second is to accept uncertainty as a fact of war and function with it.[34] The first response is to eliminate uncertainty by creating a highly efficient C^2 structure based on the quest for close control, "In such a system, the commander controls with a 'tight rein.' Command and control is centralized, formal, and inflexible . . . detailed control re-

quires strict obedience and minimizes subordinate decision making and initiative."[35] Thus, there may be greater certainty at the top but decreased certainty at the bottom. As Schmitt points out, if war is inherently uncertain, then this kind of orientation attempts to overcome a fundamental nature of war; there will always be some level of uncertainty that one cannot overcome.[36]

This makes the second approach, that of operating with a certain amount of uncertainty, a more pragmatic C^2 orientation. Schmitt states that "rather than increasing the degree of certainty we *achieve*, we reduce the degree of certainty that we *need*."[37] The result is a C^2 orientation that is decentralized. "In such a system, the commander controls with a loose rein, allowing subordinates significant freedom of action and requiring them to act with initiative . . . command and control is decentralized, informal, and flexible . . . [which] seeks to increase tempo and improve the ability to deal with fluid and disorderly situation."[38]

Decentralized control allows for some uncertainty at the top to facilitate greater certainty and decision making at the bottom. The greater the degree of control, the less the number of alternatives available to solving a problem.[39] For example, numerous laboratory tests indicate that teams placed under increased stress operate more efficiently and correctly when there is less shared uncertainty coupled with decentralized decision making.[40] Thus, the ability to gather vital information and make appropriate decisions rapidly is very dependent on the C^2 orientation.

The two most common types of C^2 organizational orientations, and hence structures, are hierarchical and networked. The traditional military C^2 orientation is hierarchical, because traditionally hierarchical organizations required less communications and substantially simplified the planning and control process.[41] Maj George E. Orr describes a hierarchical organization as one that "attempts to turn the entire military force into an extension of the commander. Subordinate levels respond in precise and standardized ways to his orders and provide him with the data necessary to control the entire military apparatus. The emphasis is upon connectivity hierarchy, upon global infor-

mation gathering or upon passing locally obtained information to higher levels, and upon centralized management of the global battle."[42] The key is that both information gathering and decision making are under the personal control of the commander. Power at each level of command within the hierarchical organization is a function of both how much information and the kind of information controlled.

However, the first problem is that the very nature of controlling information defeats the optimum use of that information. Information gathering and decision making must be made at each level of command before that information is moved on. At each level of command, the information is filtered, added, deleted, and modified, which is time consuming and often resulting in information not reaching the right people or getting there too late to be of any use. This process creates a cascading effect, such that controlled information becomes slow information. This last point is often cited as a failure of intelligence not getting to the right people on time. Perhaps the problem is not with the intelligence process but rather the hierarchical organization it is supporting. Information must move with a degree of freedom at all levels of command to better balance decision making at all levels of command.

A second problem with hierarchical organizations is a tendency to control decision making at the highest levels of the organization. Again, technological advances drive higher levels of centralized control, threatening to stifle ingenuity and initiative at the lower levels. Combating this temptation requires trust in subordinates. During the Civil War, Gen Ulysses S. Grant, though he had the technical capacity to centrally manage the war, was successful because he "trusted subordinates thoroughly, giving only general directions, not hampering them with petty instructions."[43] Gen Dwight D. Eisenhower seemed to support this approach on the art of high command: "He can and should delegate tactical responsibility and avoid interference in the authority of his selected subordinates."[44] Gen H. Norman Schwarzkopf applied this lesson into joint war fighting by attesting, "I built trust among my components because I trusted them. . . . If you want true jointness, a

CINC should not dabble in the details of component business."[45] This freedom from interference is extremely important, as Sir William Slim explains, "Commanders at all levels had to act more on their own; they were given greater latitude to work out their own plans to achieve what they knew was the Army Commander's intention. In time they developed to a marked degree a flexibility of mind and a firmness of decision that enabled them to act swiftly to take advantage of sudden information or changing circumstances without reference to their superiors."[46] Thus, faster decision making in response to the faster tempo of war requires an orientation of decentralized control.

Unlike hierarchical organizations, networked organizations offer a decentralized control orientation that makes better use of information technology. RAND Corporation's John Arquilla and David Ronfeldt point out that the advances in computers and information technologies influence related innovations in organization and management theory.[47] This is reinforced by John Naisbitt's book *Megatrends* and the USAF's Scientific Advisory Board, which predicts that organizational changes will result as industrial-based society transitions to an information-based society.[48] This trend will drive hierarchical organizations in becoming more networked and centralized control yielding to decentralized control. Orr defines a networked organization as one that "views the commander as controlling only in the sense of directing a cooperative problem-solving effort. The emphasis in this style is on autonomous operation at all levels, upon the development of distributed systems and architectures, upon networking to share the elements needed to detect and resolve possible conflicts, and upon distributed decision making processes."[49] In a networked organization, the information-gathering process will be more equally distributed and more information will be available more rapidly to all levels of command. Commanders will share rather than control information, resulting in faster decision making at all levels of command.

A networked sharing of information is much different than that of the hierarchical control of information. A faster decision-making cycle is possible with shared information because all levels of command have the same level

of certainty. It also eliminates irritants. For example, Rear Adm Joseph Metcalf III, Task Force 120 commander during Operation Urgent Fury, remembered his experiences from Vietnam with the "long distance screwdriver."[50] To prevent recurrence, he worked hard at increasing the confidence and certainty of his superiors by providing them with masses of information during the operation to liberate Grenada.[51] This accomplished the desired effect in allowing Admiral Metcalf to accomplish the mission with minimal interference.

More important than the elimination of irritants, however, is another advantage: troops engaged will have and generate more information than the headquarters. If warfare is chaotic, the chaos arises from adding information or energy to a system. Since troops in contact will be the first to observe that information, they must be empowered to use it for their decision making. What appears to be chaotic and uncertain to the headquarters may be much less chaotic and much more certain to troops empowered to respond to local conditions. Headquarters, then, can use information technology, as Boyd suggests, to monitor.

The need to balance legitimate requests for information while allowing subordinate commanders the freedom of action is a difficult one. Prussian leader Helmuth von Moltke "the Elder" was one of the first to appreciate the value of the telegraph, but he also recognized the increased tendency in using it to find out what was happening at the front.[52] In his *Thoughts on Command*, von Moltke writes that "the most unfortunate of all supreme commanders is the one who is under close supervision, who has to give an account of his plans and intentions every hour of every day. This supervision may be exercised through a delegate of the highest authority at his headquarters or *a telegraph wire attached to his back*. In such a case all independence, *rapid decision*, and audacious risk, without which no war can be conducted, *ceases*."[53] Gen George S. Patton, reflecting in his *Diaries* about World War II, complained frequently about being tied to the radio and telephone, noting, "The hardest thing I have to do is to do nothing. There is a terrible temptation to interfere."[54] And

frequently, this temptation became too great to ignore, as General Fuller explains from his World War I experience.

> As the general became more and more bound to his office, and, consequently, divorced from his men, he relied for contact not upon the personal factor, but upon the mechanical telegraph and telephone. They could establish contact, but they could accomplish this only by dragging subordinate commanders out of the firing line, or more often persuading them not to go into it, so that they might be at the beck and call of their superiors. In the World War nothing was more dreadful to witness than a chain of men starting with a battalion commander and ending with an army commander, sitting in telephone boxes, improvised or actual, talking, talking, in place of leading, leading.[55]

The key to less interference and greater flexibility and initiative lies in an organizational orientation that promotes sharing of information at all levels.

While the principle of sharing information at all levels of command is important, it is modern information technology that makes it possible. With better communications and computer technology, US Central Command forces shared information during Operation Earnest Will in the Persian Gulf with great success. Vice Adm Jerry O. Tuttle, then director of the Command, Control, and Communications Directorate of the Joint Staff (J-6), provided communications equipment for sharing information with national- and theater-level commanders.[56] "With the on-scene commander, Rear Admiral Less, the CINC (Admiral Crist in Tampa, Florida), and the Secretary [of Defense] and the Chairman [of the JCS] all having the same picture and same databases, the requirement to communicate diminished markedly. By having red and blue forces depicted in one composite picture, the relative urgency for decision making could be readily determined and priorities set more intelligently."[57] While shared information decreases uncertainty, it has the added benefit of fostering decision making at lower levels of command. Admiral Crist discovered that because the national command authority received the same shared information, they did not feel compelled to monitor or control the operation by "skip echelon."[58] As Paul Strassmann writes, "The more people share information, the more its importance will increase."[59] Shared information provides the means to faster and decentralized decision making. To achieve faster decision

making, it is critical that all levels of command are operating from a shared vision or commander's intent. "The commander's intent describes the desired end state. It is a concise expression of the purpose of the operation and must be understood two echelons below the issuing commander. It must clearly state the purpose of the mission. It is the single unifying focus for all subordinate elements. . . . Its purpose is to focus subordinates on the desired end state."[60] Through a unifying commander's intent, initiative is generated. Boyd supports this assertion when discussing the ability to act faster than an opponent, "This is best accomplished by the exercise of *initiative* at the lower levels within a chain-of-command. However, this decentralized control of how things are done must be guided by a centralized command of what and why things are done."[61] US Marine Corps Fleet Marine Force Manual (FMFM) 1-1, *Campaigning,* echoes this by stating, "We generate tempo by creating a command system based on decentralized decision making within the framework of a unifying intent."[62] Therefore, the commander's role establishes the boundaries within which subordinate commanders can make decisions and increase operating tempo.

However, while a networked organization is better for sharing information, it may prove unsuitable for military commanders dealing with tough decisions in combat. Unlike their business counterparts, military commanders must really make life and death decisions and put subordinates at risk. In a networked organization, who among the collaborators will make those decisions? War requires commanders, not collaborators. Thus, decision making may require a more hierarchical process. Decisions need not always be shared. For example, the success of a deception plan usually requires fooling your own troops. During Operation Desert Storm, the US marines afloat off the coast of Kuwait may have conducted their daily preparations and routines differently, even subconsciously, had they been aware that their amphibious landing preparations were only a ruse. Their subtle changes in behavior or an inadvertent communications transmission might have been detected by the Iraqis, thus compromising the deception plan. Thus, some type of hierarchical organization is

needed to support the decision-making process, though it can be made more effective.

The answer is a flattened hierarchical organization that greatly facilitates a commander's decision-making process. Eliminating layers of command between the commander and operational forces facilitates the execution of those decisions. The goal is combining a clearly defined commander's intent with decentralized control at all levels of command allowing for greater flexibility, ingenuity, and initiative. The German concept of *Auftragstaktik* during the Second World War demonstrates how this works. German commanders at each echelon, when out of contact with higher echelons, were free to operate in meeting objectives at two levels higher than their command without permission. Each level of command understood the commander's intent and what other commanders were expected to do.[63] This German decentralized decision-making cycle was able to operate at a faster tempo than that of their opponents. For example, German counterattacks were often conducted within 30 minutes after losing a position, while American, British, Russian, and French counterattacks usually took hours.[64] The German decision-making process, facilitated by decentralized control, allowed them to operate within the OODA loop of their adversary.

Thus, the ideal C^2 organization combines the shared information-gathering advantages of the networked organization with the decision-making advantages of a decentralized, flattened hierarchical organization (fig. 3).[65] Col John Warden III's experiences from the Gulf War support this orientation by noting:

> The coalition managed its own information requirements acceptably, even though it was organized in the same way Frederick the Great had organized himself. Clear for the future is the requirement to redesign our organizations so they are built to exploit modern information-handling equipment. This also means flattening organizations, eliminating most middle management, pushing decision making to very low levels, and forming worldwide neural networks to capitalize on the ability of units in and out of the direct conflict area.[66]

Thus, to maximize the advantages from information technology, one must redesign the military organizational orientation where the emphasis is on command not control.

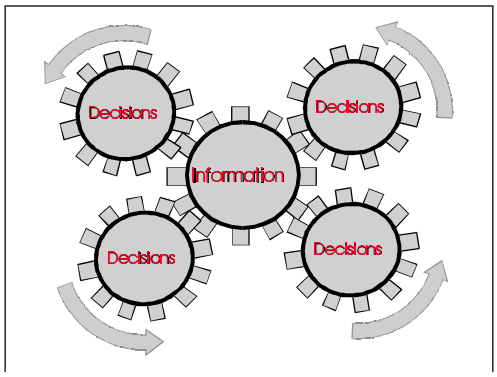

Figure 3. Shared Information/Decision Process

Modern technology can help redesign a military organization based on a theory of "centralized command—decentralized control and execution" which mirrors the "massively parallel" designs of modern computers.[67] To support information gathering, "Each [basic action unit] BAU has direct access to the situation model. This is achieved by linking all the units together in a single data net. . . . The BAU commanders can then access the battlefield model and pull out the information they need to accomplish their objectives."[68] To support decision making, "The command unit does not issue explicit orders but instead identifies mission objectives and a focus of main effort. . . . The BAUs are given wide latitude in conducting their mission. Coherence is achieved because all the units share a common doctrine, a common goal, and a common view of the situation. . . . Instead of waiting for exact orders to funnel through intermediate units, each BAU will access its mission order against the common model and act accordingly."[69] This concept of a shared information-gathering cycle and a decentralized decision-making cycle is being discussed among the military services, but there is no consensus on what organizational orientation is best suited to take advantage of information technology. The only agreement is that organizational change eventually will happen.

Organizational Orientation Reality

The US military services' organizational orientation for information-age warfare is striking in their contrast. Yet,

each service must respond to the certainty of high-tempo operations in the future, because there is little argument that the operations tempo of Operation Desert Storm will seem slow compared to that of future wars. Military service doctrine defines tempo as follows.

US Army

> Tempo is the rate of speed of military action; controlling or altering that rate is essential for maintaining the initiative. . . . A quick tempo demands an ability to make tactical decisions quickly, to execute operations that deny the enemy a pause, and to exploit opportunities according to commander's intent.[70]

US Marines

> Tempo is a rate or rhythm of activity. Tempo is a significant weapon because it is through a faster tempo that we seize the initiative and dictate the terms of war.[71]

US Navy

> Tempo is the pace of action—the rate at which we drive events. One way of doing this is to exploit the dynamics of warfighting by maintaining a high tempo.[72]

US Air Force

> No mention of tempo in current or proposed Air Force doctrine. However, "speed" is mentioned as a characteristic of airpower.[73]

Why does the Air Force emphasize speed over tempo? Tempo is speed over time—the consistent ability to operate fast.[74] One might argue that a more accurate description of a desired characteristic of airpower is tempo, not speed. For example, a characteristic of airpower technology is speed, that is the speed of the aircraft, or how long it takes to hit the target, but a more accurate characteristic of C^2 orientation is tempo. In a 1995 speech, the Air Force chief of staff stated that "not too far in the next century, we may be able to engage 1,500 targets within the first hour, if not the first minutes, of a conflict."[75] This describes speed, not tempo. The question is, What happens after the first strike? Does the USAF have a C^2 orientation that maintains and even increases the tempo of operations to keep those 1,500 targets at risk? If Air Force doctrine remains one of "centralized control, decentralized execution," then the answer is no. Much worse is the risk of unsynchronized joint high-tempo operations.

With the exception of the Air Force, every US military service recognizes that increased operations tempo requires decentralized control and decision making to the lowest level. These service observations are fairly clear.

US Army

> Initiative requires the decentralization of decision authority to the lowest practical level.[76]

US Marines

> In order to generate the tempo of operations we desire and to best cope with the uncertainty, disorder, and fluidity of combat, command must be decentralized.[77]

US Navy

> A rapid tempo requires that commanders be provided . . . enough decentralization to allow subordinate commanders to exploit opportunities.[78]

US Air Force

> To exploit speed, range, flexibility, precision, and lethality that makes air and space so versatile, their organization must make it possible for missions to be *centrally controlled*.
>
> The need to respond to and exploit unforeseeable events requires that these same forces are capable of decentralized execution.[79]

In the aftermath of Operation Desert Storm, the Army Force XXI concept and Marine Corps Sea Dragon concept are the respective services' thinking about future warfare which emphasizes decentralized control and decision making. The Air Force has no such new paradigm. The Air Force is taking a much different direction because it remains rooted to an orientation of "centralized control—decentralized execution," which Eliot Cohen describes as "a catchphrase of Air Force doctrine, much as 'don't divide the fleet' preoccupied American naval strategists in earlier times."[80] Although Air Force doctrine has changed 12 times, based on 50 years of experience (another change is in draft), doctrine is now the basis for increased centralized control through the joint force air component commander (JFACC) concept and the air tasking order (ATO) process.[81]

The seductive effect of information technology is seen in those proponents advocating stronger centralized control. For example, some have advocated that future aerospace operations not only require greater centralized control but

increasingly *centralized execution*. Jeffery R. Barnett, in his book *Future War*, argues that "only a centralized C^2 system has the potential to deconflict these factors in the chaos of war . . . decentralized execution, effective in past wars, won't answer this challenge."[82] He suggests that the JFACC has the technology and should conduct future warfare from the continental United States. Unfortunately, this thinking increases the danger of military micromanagement at a time when just the opposite is desired. As Cohen argues, "A general in Washington, an admiral in a command ship or a theater commander in rear head-quarters may have access to almost the same information as a forward commander, and in some cases more. Those distant commanders will often succumb to the temptation to manipulate individual units in combat accordingly."[83] In many ways, the ATO reflects JFACC micromanagement of airpower through centralized control.

Highly centralized, the ATO is the tool of inflexibility. The *Gulf War Air Power Survey (GWAPS) Summary Report* notes that "the ATO process used by the air planners and commanders in Riyadh merely modified an approach long used within NATO; it also bore a striking family resemblance to the way American planners had constructed and executed air campaigns as far back as WWII."[84] A common understanding was that "an airplane didn't fly unless it was in the ATO."[85] The reaction of one squadron commander to the ATO was typical: "By day three, the ATO was basically a historical document that described what we were supposed to do after we have already done it. Virtually all our tasking was received by phone and changes were the rule."[86] Twenty percent of all air missions were changed during the few hours between the printing of the ATO and the time the aircrew launched. Still more changes were made before the ATO was officially released or after the aircraft had left their bases.[87] Much as our model predicts and as Cohen points out, "Sometimes these decisions made sense; other times they did not. In all cases they created great uncertainty among the pilots flying the missions."[88]

The reaction of other services to the slow ATO process was equally harsh. One US marine described the ATO

process as "an attempt to run a minute-by-minute air war at a 72 hour pace."[89] US Marine Corps General Moore comments, "It [ATO] does not respond well to a quick-action battlefield. If you're trying to build a war for the next 72 to 96 hours, you can probably build a pretty good war. But if you're trying to fight a fluid battlefield like we were on, then you need a system that can react."[90] There was even criticism from a US Navy admiral claiming that the Iraqis had figured out the 72-hour nature of the ATO and were moving aircraft around within that window.[91] That Saddam Hussein was able to operate within the OODA loop of the Air Force gives him more credit than he deserves and is probably more reflective of service parochialism about the JFACC and ATO process than an accurate characteristic of one of the world's worst generals. However, the admiral is correct about the ATO process being a dinosaur of industrial-age warfare, because the timeliness of the ATO calls into question its value in a high-tempo war.

Perhaps the concept of "centralized command—decentralized control and execution" is an idea whose time has come. Fast tempo warfare, with the need for balanced information sharing and decision making, requires a new command and control orientation. Cohen describes "a new concept of high command, one that acknowledges that technology inevitably diffuses authority will have to take root."[92] Certainly, if technology provides the means for transmitting a 300-page ATO, that same technology could be applied in making airpower more responsive. The *GWAPS Summary Report* points out that "coalition commanders relied on an air-tasking system whose cycle times . . . had not changed appreciably from the Vietnam era."[93] It is little wonder then that the US Air Force had much greater success against stationary targets than against the mobile Scud launchers; and this was against a relatively benign enemy with a snail-like operations tempo. As US Navy Capt Lyle G. Bien observes, "The 48-hour ATO cycle did not permit rapid response to mobile targets."[94] This becomes critical in the future if the number of mobile targets increase, or if enemies become more agile.

An organizational orientation is required that will take advantage of this information technology for faster infor-

mation-gathering and faster decision-making cycles. As General Sullivan points out, "The present, regular, 'conveyor-belt' pace of the machine age is over. Only fast-paced, adaptive organizations will succeed. . . ."[95] This requires greater emphasis on decentralized decision making at all levels of command. As Lt Col Michael Straight points out, "Decentralized decision making, guided by command's intent, can help keep decentralized execution focused on the JFACC's centralized priorities as the information revolution increases the number of decision-action cycles that occur inside the ATO's two-to-three-day limits."[96]

Are there disadvantages to an organizational orientation that emphasizes less control and decentralized decision making? Of course, there are those who argue that airpower is different from land and sea forces, justifying the need for greater, not lesser, centralized control. Colonel Straight emphasizes that the Air Force works with a much narrower span of control with less emphasis on a doctrinal concept meant to guard tempo, flexibility, and initiative.[97] However, he also points out that without an Air Force commander's intent, higher operations tempo is difficult because subordinate initiative is limited.

Any discussion of decentralized control immediately brings forth historical failures of airpower, such as "penny packets" during the North African campaign of World War II and "route packaging" of Vietnam.[98] Less control and greater decentralized decision making increases the danger of fratricide, air space coordination problems, and missed opportunities. However, these tactical-level problems which the ATO addresses need to be balanced with the operational-level benefits. Information technology has come a long way in 25 years, calling into question a 50-year-old process. A fresh organizational orientation is needed that will increase operations tempo and initiative without sacrificing the ability to concentrate effect.

The advantages of decentralized control in the fast-paced tempo of future wars makes it essential for the Air Force to relook the ATO process. Former Air Force chief of staff general Larry Welch said, "I believe we overcontrolled in Desert Storm. We did focus on the CINC's intent . . . but it took us 5000 pages and 72 hours to produce an ATO."[99]

Gen Merrill A. McPeak, the Air Force chief of staff during Operation Desert Storm, expressed interest in exploring mission-type orders to try and shorten the ATO cycle, "It is a disgrace that modern air forces are still shackled to a planning and execution cycle that lasts three days. We have hitched our jets to a hot air balloon. Even when this lackluster C^2 system works properly, we are bound to forfeit much of the combat edge we know accrues to airpower because of its flexibility and speed of response."[100] As one Air Force officer notes, "Mission-type orders are the laxative for constipated communications."[101] However, institutional orientation continues to be that the ATO must be centralized at the top. Thus, the only improvements sought will be in shortening the ATO cycle, rather than looking at alternatives. In any case, there appears to be little interest in the Air Force joining the other services in advocating a new command and control orientation. The high operations tempo of future wars demands the Air Force to take a fresh orientational perspective.

Recommendations and Conclusion

Technology is a tool, and humans decide how they will organize and how they will use the tools available. A screwdriver can be used as an icepick, and one can pound nails with a laptop computer. Information technology— computer machines and communications devices—can enable us to fight more effectively. If fighting more effectively is the goal, the correct organizational orientation—one of more command, less control—is needed. The following actions must be taken.

$ Establish useful definitions clarifying the distinction between command and control. By reinforcing the importance of command, and decreasing the need for control, the US military will go a long way in eliminating the confusion and misunderstanding. In its present context, command embraces planning, organizing, directing, coordinating, and controlling. Command is also a timeless concept in spite of organizational changes and technological advances. The US military must resist efforts to hang addi-

tional attributes on the function of command because it dilutes the most critical component of war: Command.

$ Recognize that information, by its very nature, is most useful when not controlled. A characteristic of military hierarchies is control of information. The US military must take advantage of networked organizational orientation in providing access to shared information at all levels of command. Shared information reduces uncertainty and improves a commander's decision-making cycle. Given the danger of information overload, new technological innovations such as computer smart agents and data mining will allow commanders to tailor their information-gathering capabilities to meet their specific needs. Shared information gathering allows for increased operations tempo.

$ Create flattened hierarchical organizations that promote decentralized decision making. Eliminating layers of command provides the means for operating at higher tempos. Decentralized control, with the unifying vision of commander's intent, also encourages innovation and initiative at the lowest levels of command.

$ Reexamine the doctrine of "centralized control, decentralized execution" against an information-age adversary. The JFACC and ATO concepts are a product of hierarchical organizations and centralized control, perhaps the last vestiges of excessive concern over "independence." While effective in industrial-age warfare, the limitations centralized control places on timeliness, flexibility, and tempo create potentially serious problems should the US military face an adversary operating at a faster operations tempo. The same technology that promotes greater centralized control can also apply to decentralized control. At the operational level, Boyd points out that the JFACC's primary role is that of "monitoring" and not "controlling." Future enemies will be smarter than Saddam Hussein.[102] Defeating them requires synchronized joint operations that promote decentralized decision making and initiative.

In conclusion, van Creveld points out the relationship between technology, organizational orientation, and procedures. Too often, the US military has failed to exploit the benefits of new technology because it is difficult to embrace a new organizational paradigm. Basil H. Liddell Hart states

that this is not an easy challenge. Yet, in order to fight the high-tempo wars of the future where information technology will be critical, it is essential that the US military take on this challenge.

Centralized control exercised through hierarchical organizations reflects old and dangerous thinking against future enemies operating at a faster decision-making cycle. As Carl H. Builder reminds us, "Each age of warfare required different treasured capabilities. In agrarian-age warfare, strength and cunning were valued. In industrial-age warfare, organization and discipline were valued. In information-age warfare, the treasured capabilities are knowledge and creativity."[103] Greater access to shared information and decentralized decision making are key to operating at the high tempos required in information-age warfare. The US military must have the organizational orientation to take advantage of these capabilities. This requires more emphasis on command and less on control. Failure to do so may result in a US military ill prepared for information-age warfare.

Notes

1. Alvin and Heidi Toffler, *War and Anti-War: Survival at the Dawn of the 21st Century* (Boston: Little, Brown and Company, 1993). These authors describe the differences between agrarian, industrial, and information-age societies and militaries. While some have criticized this categorization as oversimplified, the Tofflers' writings are influential within the US military.

2. Department of Defense, *Annual Report to the President and the Congress* (Washington, D.C.: Government Printing Office, 1995), 107.

3. USAF Scientific Advisory Board, *New World Vistas: Air and Space Power for the 21st Century,* Communications Volume draft (Washington, D.C.: Department of the Air Force, 1996), 17.

4. Ibid.

5. Joint Warfighting Center, draft, *Warfighting Vision 2010* (Fort Monroe, Va.: Joint Chiefs of Staff, 1 August 1995), 19.

6. Maj Gen J. F. C. Fuller, *Armament and History: A Study of the Influence of Armament on History from the Dawn of Classical Warfare to the Second World War* (New York: C. Scribner's Sons, 1945), 158. Of note, on page 146, Fuller gives a scathing critique of Giulio Douhet's motives by stating, "The secret which Douhet could not grasp was that inventive genius when stirred by the instinct of self-preservation knows no bounds. He was a wonderful salesman, and like many people—a prophet of the ridiculous."

7. Brig J. P. Kiszely, MC, "The Contribution of Originality to Military Success," in *The Science of War,* ed. Brian H. Reid (London: Routledge, 1993), 44–45.

8. Thomas P. Coakley, *Command and Control for War and Peace* (Washington, D.C.: National Defense University Press, 1992), 36.

9. Ibid.

10. Ibid., 41–42; and Martin van Creveld, *Command in War* (Cambridge, Mass.: Harvard University Press, 1985), 263.

11. John R. Boyd, "Organic Design for Command and Control," an excerpt from *A Discourse on Winning and Losing*, a selection of unpublished notes and visual aids, compiled from 1976 to 1992, 32.

12. Ibid.

13. This word association may be more psychological than practical. My thanks to Lt Col Chancel T. French, Retired, for educating me on a possibility of our habit of word association having historical origins dating to the Battle of Hastings in 1066. One outcome was the mingling of English, French, and Latin words on legal documents and in every day usage. As a result, word associations like *cease* and *desist, have* and *hold, search* and *destroy*, and *command* and *control* are now common jargon. My thanks also to Col Richard Szafranski for explaining the Russian usage of "duty terms" when talking about certain military subjects. Command and control is a duty term.

14. Provided by US Marine Corps and US Air Force briefers during the Air War College academic year 1995–1996. Used with permission.

15. Greg Todd, "C_1 Catharsis," *Army,* February 1986, 14.

16. JCS Pub 1-02, *Department of Defense Dictionary of Military and Associated Terms*, 23 March 1994, 78. Emphasis added.

17. Ibid. Emphasis added.

18. Joint Pub 6-0, *Doctrine for Command, Control, Communications, and Computer (C^4) Systems Support* (Washington, D.C.: Joint Chiefs of Staff, 30 May 1995), GL-6.

19. Todd, 14.

20. Joint Pub 1, *Joint Warfare of the United States Armed Forces* (Washington, D.C.: National Defense University Press, 10 January 1995), III-9.

21. Van Creveld, 9.

22. Ibid., 10.

23. JCS Pub 3, *Doctrine for Joint Operations* (Washington, D.C.: Joint Chiefs of Staff, 1 February 1995), III-15.

24. Boyd, 5–12.

25. Gen Gordon R. Sullivan and Col James M. Dubik, *War in the Information Age* (Carlisle Barracks, Pa.: US Army War College, 4 June 1994), 5.

26. Although Colonel Boyd cautioned against separating these functions in a telephone interview on 20 March 1996, it is just this kind of "analysis" (or destructive deduction) he argues for in his 3 September 1976 "Creation and Destruction" notes, 5–17.

27. Frank M. Snyder, *Command and Control: The Literature and Commentaries* (Washington, D.C.: National Defense University Press, 1993), 148.

28. Ibid.
29. Ibid., 61.
30. Van Creveld, 238.
31. Alan D. Campen, ed., *The First Information War* (Fairfax, Va.: AFCEA International Press, 1992), 1.
32. US Space Command briefing given to the Air War College during academic year 1995–1996. Used with permission.
33. Martin van Creveld, *The Transformation of War* (New York: The Free Press, 1991), 109.
34. John F. Schmitt, "A Concept for Marine Corps Command and Control," in *Science of Command and Control: Part III*, eds. Alexander H. Levis and Ilze S. Levis (Fairfax, Va.: AFCEA International Press, 1994), 17.
35. Ibid.
36. Ibid.
37. Ibid.
38. Ibid.
39. John P. Crecine and Michael D. Salomone, "Organization Theory and C^3," in *Science of Command and Control: Part II*, eds. Stuart E. Johnson and Alexander H. Levis (Fairfax, Va.: AFCEA International Press, 1989), 50.
40. Proceedings of the 1992 Symposium on Command and Control Research, held at the Naval Postgraduate School, Monterey, Calif., 12–14 June 1992, and compiled by Science Applications International Corp., McLean, Va. Some of the better studies include "A C^3 Workstation Utilizing Value-Based Message Scheduling" by J. E. Bake, L. P. Clare, J. R. Agree, and W. Heyman; "Horizontal and Vertical Structures in Small Teams: Team Performance and Communication Patterns" by Clint A. Bowers, Paul B. Kline, and Ben B. Morgan Jr.; "The Application of a Model of Adaptive Decision Making to the Collection and Analysis of Domain Expertise" by Peter D. Morgan; and "Examining Cognitive Processing in Command Crises: New HEAT Experiments on Shared Battle Graphics and Time Tagging" by Dr. Paul J. Hiniker and Dr. Elliot E. Entin.
41. Crecine and Salomone, 50.
42. Maj George E. Orr, *Combat Operations C^3I: Fundamentals and Interactions* (Maxwell AFB, Ala.: Air University Press, 1983), 87–88.
43. Maj John M. Vermillion, "The Pillars of Generalship," *Parameters*, Summer 1987, 11.
44. Edgar F. Puryear Jr., *Nineteen Stars: A Study in Military Character and Leadership* (Novato, Calif.: Presidio Press, 1981), 229.
45. Joint Pub 1, II-6.
46. Sir William Slim, *Defeat into Victory* (London: Cassell and Company, 1956), 292.
47. John Arquilla and David Ronfeldt, "Cyberwar Is Coming" (RAND Study P-7791, Air University Library, Document No. M-U 30352-16, no. 7791), 2.
48. John Naisbitt, *Megatrends* (New York: Warner Books, 1982), 1–2.
49. Orr, 88.
50. Raymond C. Bjorklund, *The Dollars and Sense of Command and Control* (Washington, D.C.: National Defense University Press, 1995), 79.
51. Ibid.

52. Van Creveld, *Command in War,* 108.

53. Daniel J. Hughes, ed., *Moltke and the Art of War: Selected Writings* (Novato, Calif.: Presidio Press, 1993), 77. Italics added to highlight the relationship between technology (i.e., the telegraph) and rapid decision making.

54. Roger Beaumont, *The Nerves of War* (Fairfax, Va.: AFCEA International Press, 1986), 28.

55. Maj Gen J. F. C. Fuller, *Generalship: Its Diseases and Their Cure* (Harrisburg, Pa.: Military Service Publishing Co., 1936), 61.

56. Ibid., 83.

57. Vice Adm Jerry O. Tuttle, "C^3, An Operational Perspective," in *Science of Command and Control: Part II*, eds. Stuart E. Johnson and Alexander H. Levis (Fairfax, Va.: AFCEA International Press, 1989), 4.

58. Bjorklund, 83.

59. Ibid., 85.

60. FM 100-5, *Operations,* 14 June 1993, 6-6.

61. Maj David S. Fadok, *John Boyd and John Warden: Airpower's Quest for Strategic Paralysis* (Maxwell AFB, Ala.: Air University Press, February 1995), 15.

62. FMFM 1-1, *Campaigning,* 25 January 1990, 73.

63. James G. Hunt and John D. Blair, eds., *Leadership on the Future Battlefield* (London: Pergamon-Brassey's, 1985), 183.

64. Ibid.

65. I am deeply indebted to Maj Patrick Pope, a ***2025*** colleague, whose wise counsel, shared interest, energy, and computer wizardry helped channel many of my random thoughts into a coherent pattern.

66. Barry R. Schneider, "Principles of War for the Battlefield of the Future," in *Battlefield of the Future*, eds. Schneider and Lawrence E. Grinter (Maxwell AFB, Ala.: Air University Press, September 1995), 36–37.

67. 1st Lt Gary A. Vincent, "A New Approach to Command and Control: The Cybernetic Design," *Airpower Journal,* Summer 1993, 29 and 31.

68. Ibid., 30–31.

69. Ibid.

70. FM 100-5, 7-2 and 7-3.

71. FMFM 1-1, 72–73.

72. Naval Doctrine Publication (NDP) 1, *Naval Warfare,* 28 March 1994, 40–41.

73. Speed is referenced in both the draft *Air Force Doctrine Document (AFDD)1,* 15 August 1995, 24, and AFM 1-1, *Basic Aerospace Doctrine of the United States Air Force,* Vol. I, March 1992, 18. Of interest, the 1986 version of AFM 1-1 reflects the Air Force thinking about timing and tempo as a possible new principle of war, but any discussion of timing and tempos was dropped in later versions of AFM 1-1.

74. FMFM 1-1, 32.

75. Gen Ronald R. Fogleman, "Getting the Air Force into the 21st Century," speech to the Air Force Association's Air Warfare Symposium, Orlando, Fla., 24 February 1995.

76. FM 100-5, 2-6.

77. FMFM 1-1, 61–62.

78. NDP 1, 40.

79. *AFDD 1* draft, 24. Italics added.

80. Eliot A. Cohen, "The Mystique of US Air Power," *Foreign Affairs*, January/February 1994, 389.

81. It is interesting that during Operation Desert Storm, the Air Force correctly identified Saddam Hussein's hierarchical organizational orientation with its highly centralized control as a vulnerability. Destroying or disrupting key control facilities and communications paths was key to inducing strategic paralysis at all levels of Iraqi command. Yet, ironically, American-led airpower had a similar organizational orientation and, likewise, similar vulnerabilities.

82. Jeffery R. Barnett, *Future War: An Assessment of Aerospace Campaigns in 2010* (Maxwell AFB, Ala.: Air University Press, 1996), 33.

83. Cohen, 388.

84. Thomas A. Keaney and Eliot A. Cohen, *Gulf War Air Power Survey Summary Report* (Washington, D.C.: Department of the Air Force, 1993), 247.

85. John P. Hyde, Johann W. Pfeiffer, and Toby C. Logan, "CAFMS Goes to War," in *The First Information War*, ed. Alan D. Campen (Fairfax, Va.: AFCEA International Press, October 1992), 44.

86. Maj J. Scott Norwood, *Thunderbolts and Eggshells: Composite Air Operations during Desert Storm and Implications for USAF Doctrine and Force Structure* (Maxwell AFB, Ala.: Air University Press, 1994), 24.

87. Cohen, 386.

88. Ibid.

89. Keaney and Cohen, 150.

90. Col Stephen J. McNamara, *Air Power's Gordian Knot: Centralized versus Organic Control* (Maxwell AFB, Ala.: Air University Press, 1994), 131.

91. Michael R. Gordon and Gen Bernard E. Trainor, *The Generals' War: The Inside Story of the Conflict in the Gulf* (Boston: Little, Brown and Company, 1995), 320. Vice Adm Stanley Arthur, senior Navy officer in the Persian Gulf, said that his intelligence officers were telling him that the Iraqis were moving what combat planes remained in Iraq every day or so, having discovered that it took three days to get all but the most critical targets on the allies' target list.

92. Cohen, 118.

93. Keaney and Cohen, 237.

94. McNamara, 131.

95. Gordon and Dubik, 9.

96. Lt Col Michael Straight, "Commander's Intent: An Aerospace Tool for Command and Control?" *Airpower Journal*, Spring 1996, 48.

97. Ibid., 44.

98. One of my fondest memories of the Air War College experience will be spirited arguments in the seminar room. None were more heated than over the Air Force doctrinal (or to some, "dogmatic") issue of "centralized control." I am deeply indebted to Lt Col Pivo Pivarsky, Lt Col Joe Sokol, and Lt Col Gary Coleman—scholars and warriors all. Their intelligent, and usually emotional, debate helped keep me focused.

99. Maj Michael E. Fischer, *Mission-Type Orders in Joint Air Operations: The Empowerment of Air Leadership* (Maxwell AFB, Ala.: Air University Press, 1995), 55.

100. Maj James P. Marshall, *Near-Real-Time Intelligence on the Tactical Battlefield* (Maxwell AFB, Ala.: Air University Press, 1994), 66.

101. Lt Col J. Taylor Sink, *Rethinking the Air Operations Center*: *Air Force Command and Control in Conventional War* (Maxwell AFB, Ala.: Air University Press, 1994), 42.

102. The only officers more stupid than Saddam Hussein were his sons-in-laws. They were killed "by angry relatives" shortly after returning from self-imposed exile for denouncing their father-in-law.

103. Mentioned during one of Carl Builder's, a RAND analyst, many visits to Air University in support of the *Air Force* ***2025*** study.