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ABSTRACT

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by MAJ Lori L. S. Colodney, USA, 75 pages.

The focus of this monograph is to determine if present joint and service component command and control (C2) doctrine, organization, and support systems ensure adequate interoperability when different services are brought together to fight as part of a Joint Task Force (JTF).

Using an examination of the US-led invasion of Grenada on October 25, 1983 as a point of departure, this paper examines information flow, both voice and data, through individual service command and control support systems in a process called "stovepiping". A discussion of the evolution of doctrine, organization, and support systems, with regard to command and control, follows in order to bring the overall discussion into contemporary context.

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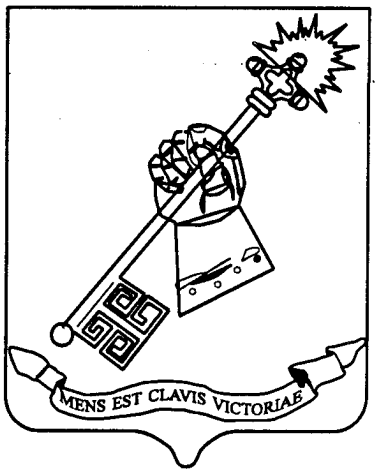
OPERATIONAL COMMAND AND CONTROL FOR JOINT AND COMPONENT COMMANDS: Integration or Duplication?

A Monograph
By
Major Lori L. Colodney
Signal Corps



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United States Army Command and General Staff College
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LTC James S. Patterson, MA — Monograph Director

COL Gregory Fontenot, MA, MMAS — Director, School of Advanced Military Studies

Philip J. Brookes, Ph.D. — Director, Graduate Degree Program

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Introduction.

Command and control has always been a fundamental concept of military theories. Its relevance can be traced throughout man's recorded thoughts on war. The earliest examples appear in the thoughts of Sun Tzu. He defines ideas very much like our modern concepts associated with command and control in his first chapters of *Art of War*.[1] Napoleonic theorists, such as Carl Von Clausewitz, also dealt with the need for command and control as evidenced when he wrote,

> **". . . the strategist must therefore define an aim for the entire operational side of the war that will be in accordance with its purpose. In other words, he will draft a plan of war, and . . .Detailed orders can then be given on the spot [by the strategist on the scene], allowing the general plan to be adjusted to the modifications that are continuously required. The strategist, in short, must maintain control throughout."[2]**

Today, effective command and control remains an essential battle component. The official history of Desert Storm states that, "Modern command, control, and communications technology forms the neurons and synapses that make agility possible by tying together the brains and muscles of a field army."[3] Clearly, an effective system for command and control supports the successful employment of armed forces.

The U.S. military defines command and control (C2) as "the exercise of authority and direction by a properly designated commander over assigned forces in the accomplishment of a mission."[4] The concept embeds the separate definitions of the words *command* and *control* into a mutually dependent concept dealing with how the commander communicates his decisions to the force, and then, monitors subsequent actions to ensure that subordinates are

operating in accordance with his operational vision. The commander is responsible to use his collective experience, vision, and will to achieve mission success.[5] Control, though inherent in command, is still thought to be more a staff function where all resources are brought to bear to achieve the commander's operational vision.[6] These ideas, carried in tandem, create the synergy that is the force behind command and control. The mechanism which binds command and control together for the U.S. military is doctrine.

Warfighting doctrine reflects what a military institution thinks about its role in the future and codifies these thoughts for use.[7] Historically doctrine has served as the both the binding force and as the agent of change.[8] Doctrine influences how commanders organize and execute battle plans. Commanders use doctrine as a guide to create command enhancing systems such as in the 19th century with fortification systems or in the 20th century with communications systems; basically making use of available resources and technology to support their plan. These command and control systems include a variety of resources, but most notably it is a combination of organization and resource employment.[9]

Command and control is a process which is a defined for use within doctrine and is evolutionary in nature as warfighters refine how they conduct war. One area that has a significant impact on doctrine is the rapid changes in technology. As systems used to support the command and control process change and become more powerful, the command and control process must evolve to adjust to that change.[10] Technological change also influences how operational

commanders shape their forces and how new tools for command and control are employed.[11] As such, the organization and tools are only as effective as the doctrine which helps the commander employ his resources to the best advantage possible.

Part of the change inherent in modern warfare is that commanders at the operational level of war are asked more and more to function within a joint task force (JTF) structure. Joint operations, as well as joint doctrine, are moving to a new level of maturity where multi-service environments are the rule, and not the exception. As such, it is important to examine joint command and control, both organizational structures and support systems, as they relate to joint warfighting. The 1981 U.S. operation in Grenada demonstrates problems associated with joint operations. The general nature of joint doctrine that existed in 1981 had a direct impact on the poor organizational structures and ineffectual communications across service boundaries during operations in Grenada. The result was poor command and control of the joint force.

Using the Grenada operation as a point of departure, this paper examines how the services use joint and service doctrine to drive their own organizational structures and systems employment. This examination will determine how well service specific doctrine, organizational structure, and command and control systems compliment their joint counterpart. It is only through such an analysis that one can discover whether or not joint doctrine requires refinement to improve interoperability and, ultimately,

joint operational capabilities. In this way we can better serve future joint commanders, and their task forces, since, as historian Michael Howard points out, ". . . it is the task of military science in an age of peace to prevent the doctrines from being too badly wrong."[12]

To this end, this analysis will bring forth conclusions as to whether or not command and control systems that support joint operations are integrated or duplicated. This evaluation will determine if reworking joint doctrine will sufficiently synchronize command and control support systems. The paper also will address how well service component command and control doctrine, organizational structure, and command and control systems meet both the service's internal needs as well as support joint warfighting in the 21st century. Any weaknesses identified, and recommendations made, will be in the spirit of attempting to keep U.S. joint doctrine from straying too badly wrong.

Methodology.

Before launching into a discussion of how to improve command and control, it is necessary to understand what command and control is not. It has become common practice among military professionals to use command and control with additional derivatives such as communications (C3), computers (C4), intelligence (C2I, C3I or C4I), and information (C2I2, C3I2, or C4I2). This plethora of acronyms, as well as other combinations, now are part of the military lexicon. Using terms derived from command and control implies each derivative is of equal importance. That is not true.

Added "C's and I's" to command and control (or C2 in the military vernacular) muddies the water with respect to what is most important; namely effectively supporting commanders in the act of leading and deciding. However, it is a mistake to equate the *means* of facilitating command and control with the *ends* which achieve it. Communications systems, computer automation systems, intelligence gathering systems, and information processing systems are all simply support systems or, in other words, tools to enhance the command and control process.

Commanders visualize the battle using products from available systems. Present joint doctrine tries to keep command and control as the separate and over-arching umbrella for which communications, computers, information, and intelligence are subordinate supporting systems. However, it does not successfully keep these added "C's and I's" disentangled from command and control. Consider the joint definition of command which is:

> **1. The authority that a commander in the Armed Forces 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. It also includes responsibility for health, welfare, morale, and discipline of assigned personnel. 2. An order given by a commander; that is, the will of the commander expressed for the purpose of bringing about a particular action. 3. A unit or units, an organization, or area under the command of one individual.**[13]

The doctrine then goes on to define command and control as the means to exercise that authority and responsibility.[14] It is in the supporting joint doctrinal manuals that command and control becomes diluted by the added "C's and I's".[15] This dilution of the term

command and control takes the emphasis away from command and tends to focus on control. Command must remain the primary focus of doctrine, organization, and C2 support systems if the armed forces of the U.S. are to be successful in the future.

Joint doctrine serves as a guide to help structure a joint task force so that major subordinate commands have a common point of reference. Using doctrine as a guide, commanders develop operational level organizational structures and use technology as the linking tool. Technology provides the most dynamic means within arrangements of personnel, equipment, communications, facilities, and procedures to improve command and control systems.[16] Through a combination of different types of staffs, a joint commander desires are emplaced and command and control systems employed to deal with the uncertainty and complexity of the modern battlefield. This is a notable aspect of the modern command and control process. However, it is still difficult to determine how to split out, layer, and inter-relate staffs of joint and service specific natures because of the vagueness of joint doctrine. This is the reason that modern staffs are increasingly reliant on technological systems to assist in the control process.

The "C's," representing communications systems, computers; or the "I's," representing information or intelligence; are the present means to implement command and control in joint warfare. As such, it is important to understand how these tools are presently used in order to determine their effectiveness. The measure of success in joint warfighting is how well technology

allows component commands to interoperate within a joint task force. Technology makes a positive impact on behalf of modern commanders. It allows friendly forces to bring fire to bear more decisively and to maneuver more effectively. For example, there is now a greater volume, as well as complexity, with regard to the number of munitions delivery systems. There is increasing concern with de-confliction of fires to prevent fratricide.[17] Command and control support systems are used to track, order, and analyze information so that staffs adequately control fires and also meet the commander's vision of how the battle should unfold. Staffs would be unable to manage the increased amounts of information were it not for data-processing.[18] Data-processing allows joint commanders to track enormous amounts of information over great distances enabling them to synchronize forces on land, sea, and air. Technology provides a way to sift rapidly through inconsequential data and find critical information.

The command and control system is the result of improved understanding brought about by effective doctrine, organization, and technology which strengthens the relationship between the commander and his forces. This strengthened relationship is the bonding force of command and control. Incumbent on the staff is making control function correctly for the commander. Proper and effective command and control functions are measured by how well the system does the following functions: monitoring enemy troop strengths and resources; monitoring one's own troop strengths and resources; planning and re-planning electronic warfare scenarios;

assessing warning signals and evaluating attack damage; assisting in choosing from among operational options and facilitating their execution while assessing and controlling the remaining military capabilities; assisting in reconstitution and redirection of forces; and negotiating with the enemy to terminate conflict.[19] For the purposes of this analysis, technologies which contribute the above stated functions meet the definition of a command and control system. The true power of joint doctrine is found in the effectiveness in which it facilitates the connection between organization and systems functionality to assist mission accomplishment in accordance with the will of the commander.

Interoperability is the physical manifestation of the connection between organizational structure and the supporting command and control systems. Its importance lies in the staff's ability to synchronize combat effects across service boundaries. Command and control systems at the operational level must assist the joint force commander (JFC) in exercising command by allowing the subunits to effectively work together.

In order to evaluate operational command and control, it is important to establish a rigorous evaluation criteria for the effectiveness of command and control support systems. To this end, the evaluation criteria in the joint service arena for interoper ability is clear and sufficient doctrine, effective organization, and adequate command and control systems.[20] This criteria allows one to judge whether the component commands of a joint force are truly interoperable and best support the JFC. These measures of

effectiveness help examine and analyze historical and present methodologies used for command and control to determine if they will be valid for use in future operational missions.

Command and Control Applications in Battle: Operation Urgent Fury

The U.S. kicked off the Grenada invasion on October 25, 1983 and ultimately, the Defense Department deemed it a success. Yet, command and control problems plagued the operation and tested the resolve of those who supported the plan. Deciding which problem was the most glaring is open for debate, but inadequate communications arguably was one of the most critical flaws because of the increased friction it produced. The problem was that voice and data moved up or down (not laterally) Army, Air Force, Navy, and Marine command and control support systems; a process called "stovepiping." Voice and paper messages could not reach a tactical level organization of another service until the message climbed through its own service's component "stove-pipe", moved across at the parent service level to the other parent service involved, and then down to that particular service's tactical component level command and control support system. The lack of direct inter-service links between combat units caused unacceptable delays and put combatants at risk.[21]

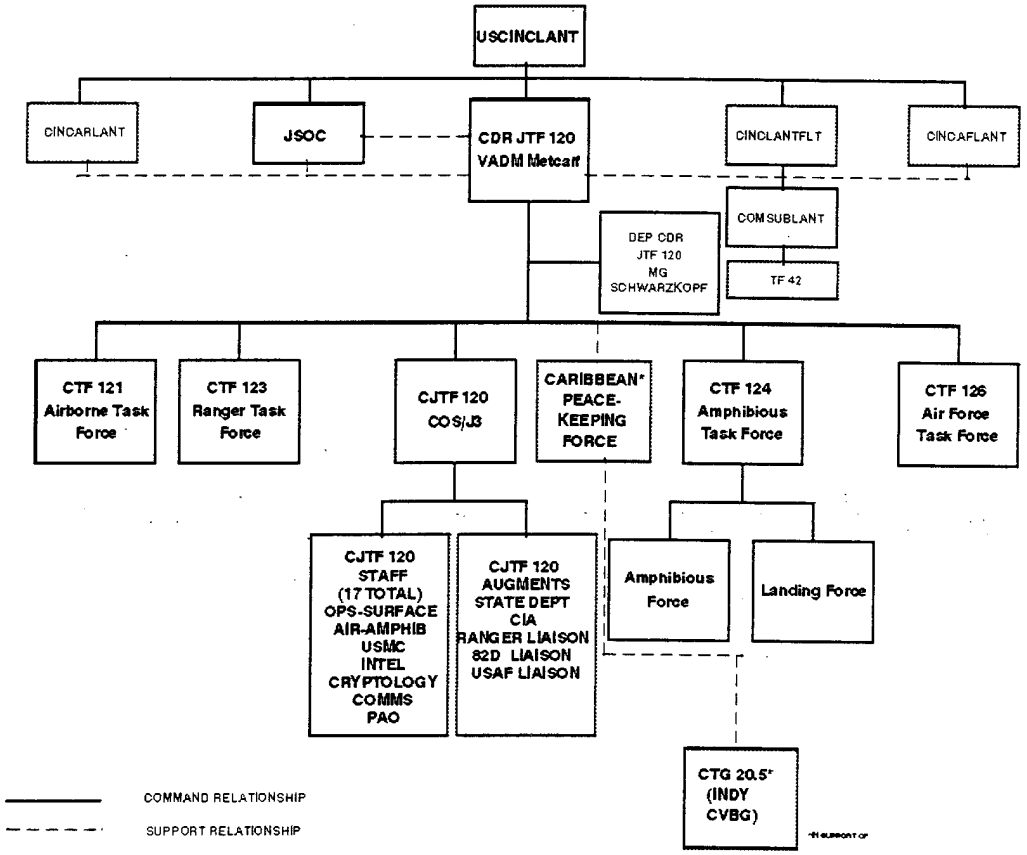
This situation was not different from preceding crisis operations like the U.S. Embassy hostage rescue attempt from Tehran, Iran, where command and control support systems were highly inefficient and complicated.[22] Urgent Fury succeeded despite command and control problems because of highly trained and

innovative people.[23] From the beginning of the Grenada Operation, President Reagan was determined not to repeat what he perceived as a key mistake that caused the downfall of the Vietnam War and the hostage rescue attempt; interference from the White House. For this reason, President Reagan gave the Joint Chiefs of Staff (JCS) full control of the operation.[24]

Problems started when the JCS created two command and control structures; one for special operations forces called the Joint Special Operations Command (JSOC), which reported directly to the JCS; and one for conventional forces, which reported to the Commander in Chief of Atlantic Command (CINCLANT).[25] This organizational structure violated the principle of unity of command. It replicated mistakes made during the Vietnam War and the hostage rescue attempt. (figure 1)[26] As Edward Luttwak, a senior fellow at Georgetown University's Center of Strategic Studies points out,

> **The two "unified" commands in charge of Vietnam - the Pacific Command in Honolulu and Saigon's MACV below it - manifested the same disease in much more varied form over a period of years, and so did Atlantic Command in planning the seizure of Grenada. No better result can be expected when plans are made and forces are commanded by a committee of bureaucracies. . .**[27]

The Joint Special Operations Command (JSOC) operated independently of the conventional forces and communications liaison between Admiral Joseph Metcalf III, Commander of Task Force 120assaulting the island of Grenada, and the special operations commander was minimal. The situation existed despite the overall plan developed by CINCLANT calling for a highly synchronized effort between conventional and special operations forces.[28] It is ironic



Operation Urgent Fury Task Organization and C2 Structure

Figure 1

that despite President Reagan's contrasting actions to both Presidents Johnson and Carter; the result was the same. The services did not talk or coordinate well with each other.[29]

The JSOC plan called for a total of seven operations involving most of the armed services' special operation forces (SOF) ranging from Navy SEAL to Army Delta Force teams. These operations were to begin simultaneously about one hour before dawn. Admiral Metcalf commanded the conventional forces composed of Marines and Army Rangers. The conventional forces were to launch at daybreak to constitute the main attack. The intent was to use overwhelming force in rapid surgical operations in order to minimize loss of life and property. The plan did not work as expected. The seven SOF operations had a variety of problems. Among the most serious was the inability of different SOF units to communicate operational difficulties to SOF from other services (Delta Force to SEAL). This inability to directly communicate exacerbated the operational problem and affected the overall success of the JSOC effort. They were also unable to achieve the surprise or provide regular forces with timely intelligence. The problematic SOF operations compromised the conventional force's attack and put them at risk.[30]

Significant problems with communications and intelligence dissemination added to the command and control difficulties in Grenada. Army officers could not call for supporting naval gunfire because of incompatible radio equipment. At the beginning of the operation, Army units called back to Fort Bragg via tactical satellite and had Fort Bragg relay fire missions to ships off the

coast of Grenada. The resourcefulness of the soldiers and sailors involved finally directly linked the two services using ham radios, heliborne couriers, and the few public telephones which were still working in the country.[31] This is not to say that the problems were confined to the Army and Navy. The Air Force also had tremendous difficulty interfacing its communications with the other two services.[32] In most cases the three components supporting Operation Urgent Fury ended up having to send voice and data communiques through their individual services command and control support systems at the tactical level and let the crossover occur at the strategic level. The operational level was left unlinked by inflexible procedures and equipment.[33]

The single secure voice line for Admiral Metcalf to speak to CINCLANT shows the fragility of the systems available to the fighting forces. There was constant contention for the use of this lone link. The alternative was to use the service's stovepiped data lines, but the procedures were such that it was impossible to receive data in a timely manner. Again, ingenuity and innovation turned these command and control support systems challenges into advantages. For example, Admiral Metcalf decided to use his secure line as a "party line". He was able to use it as a means to convey his intent to subordinate commanders who he knew were listening to the line; especially when he talked to CINCLANT.[34]

Ultimately, Operation Urgent Fury was successful despite the plan's inadequacies. While deciding which failure was the most glaring is arguable, the failure of the command and control support

systems and lack of service component command integration were among the most serious. The root cause was the absence of joint doctrine to bind together the organization and support systems which would have facilitated command and control of this joint force. The organization and support systems were both highly inefficient and complicated for Grenada. This failure allowed deficiencies like stovepiping and insufficient communications resources to occur. The criteria for effective operational command and control were clearly overlooked during Urgent Fury.

After examining the lessons learned from Grenada, the Joint Chiefs of Staff (JCS) recognized the need to correct deficiencies in command and control systems and directed greater adherence to congressional mandates for improved jointness. Department of Defense initiatives over the past decade have produced positive results. These improvements are especially important in this era where the U.S. no longer forward deploys assets, but responds to crises by rapidly projecting forces.[35] The JCS strives to improve its joint doctrine, organizational structure, and command and control systems employment to improve interoperability. It is a telling statistic that 49 of the 58 documents that comprise the Joint Publication 6 series entitled "Doctrine for C4 Systems Support of Joint Operations" were created since the Grenada invasion. As former Army Chief of Staff, General John A. Wickham, points out,

> **Grenada also highlighted that crises can occur with little warning and that plans need to be capable of rapid execution. Time may not be available for coping with the lack of jointness and C3I coordination. We must practice jointness. . . and we must undertake**

initiatives that coordinate programs of development and acquisition so that, when the equipment is delivered to fighting forces, the equipment not only will be reliable but also interoperable.[36]

It is evident by examining the joint concepts guiding command and control in joint publications that General Wickham is not alone in his opinion. JCS Publication 3-0 states that in wartime operations the combatant commander-in-charge (COCOM CINC which in this example is CINCLANT) must, "ensure that communications equipment is interoperable, redundant and complemented by standardized formats and procedures. Interpersonal communications should be in approved joint language, free of Service-unique terminology."[37]

After the Grenada invasion, the JCS reviewed the issue of ineffectual command and control systems. The result was joint doctrine that now stresses unity of command as a tenet of operational warfighting.[38] Joint doctrine also emphasizes interoperability for communications and intelligence systems from both technical and procedural perspectives. Clear doctrine, effective organization, and adequate command and control systems are the tools used to achieve such interoperability. However, recent warfighting experiences such as Operations Just Cause, Desert Storm, and Restore Peace indicate that further refinements are necessary to more adequately support joint forces in future conflicts.[39] This assertion is best explained through an examination of each of the services doctrine as well as current joint doctrine.

Joint Command and Control

Urgent Fury was a watershed event with respect to congressio-

nal and public awareness of the armed forces' inability to achieve true interoperability. However, the Department of Defense (DOD) addressed this issue long before that particular operation. DOD started promulgating joint policies regarding command and control and the systems supporting it in 1967. The initial effort, DOD Directive 4630.5, established policy and procedures for equipment interoperability. In a 1987 General Accounting Office (GAO) analysis on the progress of the armed services, GAO noted that 4630.5 directed,

> **As a matter of policy, the military departments were to develop and procure equipment that was either compatible or common when fulfilling similar operational requirements. A further objective of the policy was to minimize the addition of buffering, translative or similar devices for the purposes of achieving workable connections.**[40]

Implementation was incumbent on the joint staff, but was mostly ignored.[41] However, after the problems with Urgent Fury and increased pressures from Congress, the joint staff formed the Joint Tactical Command, Control, Communications Agency (JTC3A). The JTC3A, chartered in 1984 as a focal point to identify doctrinal problems and resolve interoperability issues, focused on architecture, standards, testing and evaluation, and technology assessment.[42] However, even after the very public embarrassment associated with command and control failures in Grenada, the mandates from JTC3A, initially, did not enjoy greater emphasis. The General Accounting Office (GAO) assessment, as late as 1987, noted that the services still lacked interoperability due to DOD's decentralized management approach, a lack of clear joint requirements, and the absence of an effective enforcement

authority.[43] It took the increasing ire from both Congress and the American public in the late 1980's to force the services to take a hard look at improving doctrine, organization, and systems in an effort to enhance joint warfighting capabilities.[44]

The Joint Chiefs of Staff (JCS) decided to use doctrine as the engine of change.[45] The centerpieces of this effort, with respect to joint operations, were Joint Pub 3-0 Doctrine for Joint Operations and Joint Pub 3-56 Command and Control for Joint Operations. Both manuals elucidate guidelines and principles for operational commanders. Each manual outlines the most current approach to joint warfighting with a view toward maximum coordination between the services.[46] However, both manuals are very general in nature; especially when outlining organizational constructs. They leave this very vital portion of the command and control process almost completely up to the individual joint task force commander inviting non-standard approaches. In contrast, they are much more specific about control mechanisms; especially in terms of available technology. This focus on the supporting systems tends to take the focus away from the operational commander and shifts attention to the staff.

An example of this shift in focus is found in Joint Pub 3-56 which talks in general terms on organization, but then goes into great detail about support systems.[47] It is important to understand how these command and control systems provide linkages. However, the usefulness of understanding service component command and control systems connectivity is only useful within the context of

how well they will then facilitate operational command. The joint control structure is simply a mechanism for joint commanders to deal with the complexity and uncertainty of using multi-service capabilities.[48]

Joint doctrine, by its vagueness, invites an organizational structure that is dependent on technology as the principle tool to bring to bear the unique capabilities of each service in a synergistic effect.[49] Staffs are supposed to be designed so they can effectively pull and push information rapidly from command and control systems throughout the mission planning and execution cycles. However, there is not a single method of developing a staff structure in the doctrine to make sure that efforts are integrated and not duplicated. The outlined joint staff structure within current doctrine gives commanders flexibility to form service component commands, subordinate joint task forces, or functional commands. The coordinating staffs within these constructs vary with respect to that unit's organization and mission. Often an individual subordinate commander will have command and staff functions in a process called "dual/multi-hatting." It becomes that commander's choice as to how to best layer or split his staff to meet this challenge. Non-standard organizational approaches coupled with differing command and staff functions bear discussion if support systems are to be effectively employed to meet operational needs.

Subordinate commands can be drawn up along service or functional lines. The service components are responsible for the

Joint Task Force Generic Structure

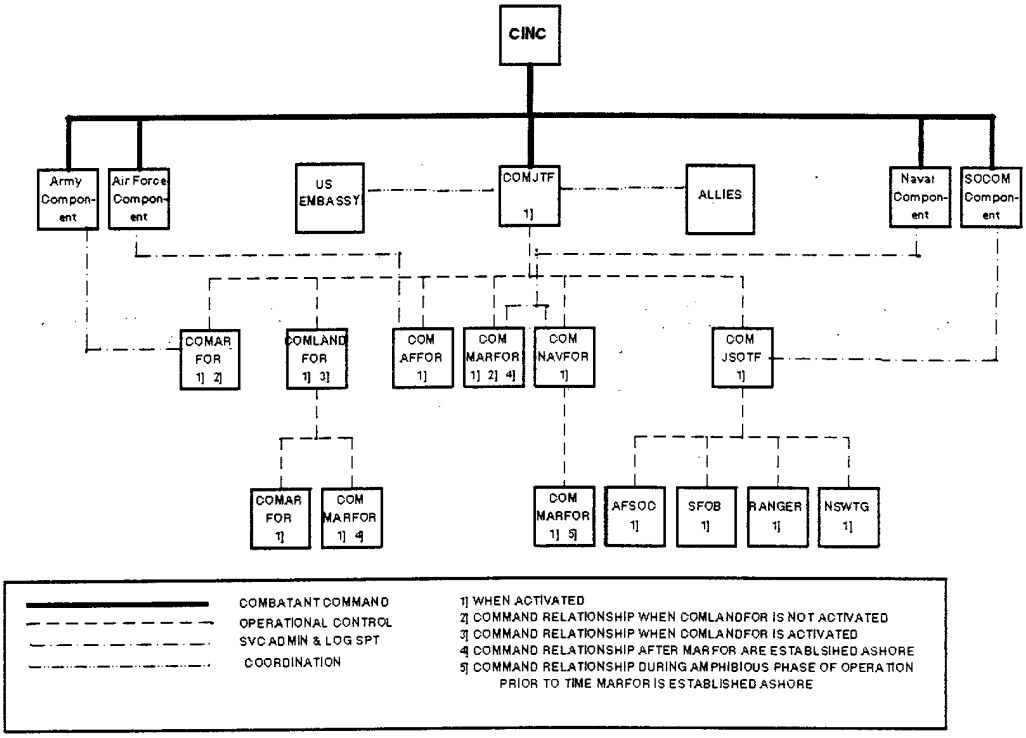
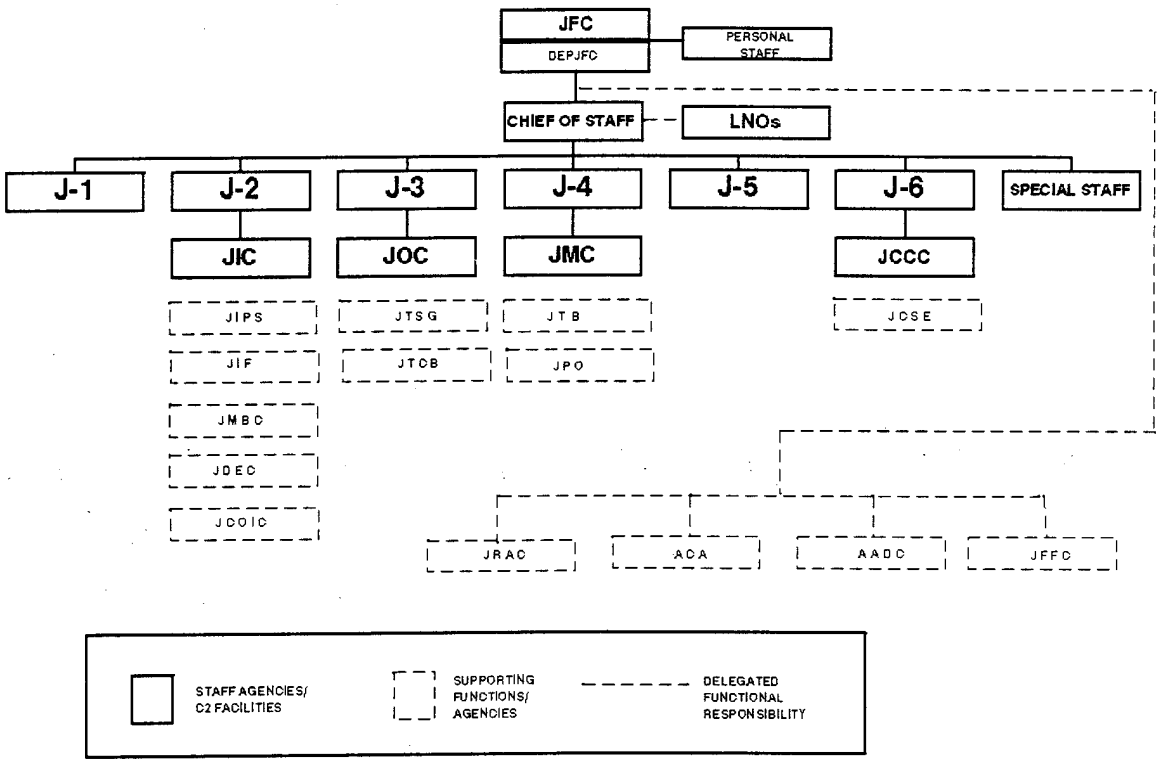


Figure 2

administrative and logistical support of the joint force. They make recommendations to the JFC on proper employment of their service's forces, accomplish assigned operational missions, as well as select and nominate specific units of the parent service for use by the JTF.[50] Functional components provide centralized direction and control and are normally made up of more than one service. They are appropriate when two or more services operate in the same dimension or medium. The service which provides the preponderance of forces normally assumes operational control (OPCON) of forces within such a functional command (figure 2).[51]

The coordinating staff is the joint force commander's tool for operational planning and execution. It typically is set up using the following conventions: manpower and personnel (J1); intelligence (J2); operations (J3); logistics (J4); plans and policy (J5); communications (J6); and other special staff agencies as deemed necessary by the commander. Joint force commanders may also have functional boards residing under these staff entities to coordinate complex issues such as targeting, fires, electronic warfare, and movement (figure 3)[52]. The key point, however, remains that staff and organizational structure repeatedly are re-invented and tailored. Though, Joint Pub 3-56 has a "sample" JTF structure, it is incumbent on the commander and staff to construct the unit. They must then make sure that command and control systems support their JTF construct.[53]

Once the organizational development piece is completed, the joint commander can make use of available joint command and control



GENERIC JTF HQ STAFF ORGANIZATION

Figure 3

systems.[54] The four main components of the joint command and control system structure: the Defense Communications System (DCS), the World Wide Military Command and Control System (WWMCCS), the National Military Command System (NMCS), and the Command and Control Systems of Combatant and Subordinate Commands are only available for use once the technological links based on organizational structure are employed.[55] Each of these joint systems will be discussed. However, it is important to note that all of these activities, with reference to organizational structuring and systems employment, imply an investment of timewhich is a critical and often a limited resource in a no-notice joint operation.

Joint Command and Control Systems

It is the joint force commander's responsibility to make sure that the command and control systems supporting his organizational design are interoperable, secure, reliable, and survivable or he risks mission accomplishment.[56] Joint commanders have strategic level systems at their disposal to assist them in mission planning and execution. The first of these is the DCS, which is a communications network designed for daily operations of the armed forces at the highest levels. However, it is also the command and control system which is central to the wartime communications needs of the National Command Authority (NCA), the Joint Chiefs of Staff (JCS), the Commanders-in-Chief (CINCs), and decision making process. It is the connection between the strategic and operational command and control support systems during deployment of forces. It consists of both government and commercial

facilities and circuits while still depending on all three military services to provide redundant long-haul systems. It is a hybrid digital-analog system made up of a variety of ground and satellite transmission media to provide reliability, survivability, and security.[57] It has ground entry points located throughout the globe to ensure strategic level leadership has connectivity anytime U.S. armed forces deploy.

The World-Wide Military Command and Control System (WWMCCS) is a command information system originated in the 1960s as a network of sensors, information systems, and communications networks to be used by the NCA, JCS, and CINCs to control U.S. forces throughout the world.[58] Its importance is illustrated by the annual investment of $1 billion and employment of 90,000 people to operate the various command centers .[59] These command centers are located at the Pentagon; Fort Ritchie, Maryland; the North American Aerospace Defense Command (NORAD) at Cheyenne, Colorado; and the Strategic Command at Omaha, Nebraska which is one of several locations providing airborne command post platforms.[60] WWMCCS provides information from the national command authority (NCA) down to the theater CINC. Information is sent to the NCA via a separate system called the NMCS.

The NMCS is a component of WWMCCS designed to support the President and Secretary of Defense. It is the heart of the global command and control system and includes command centers as well as communications facilities. The Secretary of Defense relies upon the Department of Defense system for his access to the NMCS.

Information is funneled to the White House via Presidential communications supplied by the White House Communications Agency (WHCA) which is a Defense Information Systems Agency (DISA) subordinate organization. It is through the NMCS that the NCA receives early warning/intelligence and has a mechanism for assigning military missions to combatant commanders.[61]

The only joint organization providing service to a CINC or JFC is the Joint Communications Support Element (JCSE). The joint staff controls its deployment and it is designed for contingency and crisis communications support. However, in accordance with JCS Memorandum of Policy (MOP) 3, these assets are not designed for missions exceeding forty-five days.[62] Desert Storm and other contingency operations have exceeded that timeline, but that is by exception and not the intent of employing the JCSE. Therefore, the CINC must rely on the command and control support systems provided by his subordinate service components for long term command and control of his JTF.

The final strategic systems to be discussed are those which the service component commands bring to the JTF. However, it should be noted that service components will have these joint systems in addition their own service specific systems. These added links and automation products enhance the overall inter-operability, survivability, reliability, and security for JTF command and control. The most important joint systems include the joint operational tactical system II (JOTS II), the joint surveillance system (JSS), the joint tactical information

distribution system (JTIDS), the joint interoperability evaluation system (JIES), and the MILSTAR Satellite Communications System. While this is not an all inclusive list of joint command and control support systems, it does cover those most essential to an operational commander.

Each of these joint support systems provides unique and important interconnectivity to tie together particular capabilities of one or more service in a synergistic effect. JOTS II is a battle management system used predominately by the Navy to provide a tactical display from all reporting sources with geographic, unit, weather, and satellite data for a comprehensive view of the battlespace.[63] JSS is a predominately Air Force system managing both a central and regional operations control centers (ROCC). This system provides the JTF with air defense surveillance and warning data as well as assisting with airborne warning and control systems (AWACS) command and control.[64] JTIDS is the joint communications system devised specifically for joint interoperability. One of the most ambitious projects to date, JTIDS terminals permit the transfer of critical battle information between aircraft, surface vessels, mobile or fixed land stations.[65] This communications or data system is both jam resistant and secure so to provide the JFC with unprecedented situational awareness. JIES is the means to ensure that JTIDS remains interoperable amongst the services. Finally, MILSTAR is a joint system designed to assist control of forces and to relay information and intelligence gathered by satellites and sensors. It is important

to note that the availability of all of these command and control support systems depends on the organizational structure of the JTF.

Joint doctrine should set up an organization which drives support systems employment in such a way that the massive amounts of data associated with the modern battlefield can be rapidly analyzed and ordered for decision-making. Information is only useful if derived and structured at high rates of speed and then offered as a range of options to operational commanders and staffs.[66] As important as technological systems are to the overall command and control of joint task forces, they will only be effective if they are correctly integrated into the organizational structure of combatant and subordinate commands. Doctrine must support the operational commander by providing structure which helps commanders effectively employ command and control systems. This is true at the joint and service specific levels. Component commands must organize and set up systems that support the JTF structure. Each service's doctrine, organization, and systems will be analyzed in detail (with the exception of the JSOTF which is anomalous and not considered in this discussion) to determine if they duplicate efforts or truly support interoperability.

Army Command and Control

The Army has a long history of trying to capture and convey fundamental principles for study and application and continues to publish extensive doctrine to this end.[67] Modern soldiers find current military thought in field manuals, pamphlets, and on-line databases. This body of knowledge covers a variety of operations

from Army only missions to joint warfighting environments.[68] Doctrine drives organizational structure which presently centers around the corps for joint missions.[69] The corps organization affects how the Army employs command and control support systems.

Army doctrine emphasizes force tailoring based upon mission, enemy, troops, terrain and weather, and time available (METT-T). These considerations are made in conjunction with strategic lift, pre-positioned assets, and host nation support when organizing its component command.[70] The Army Service Component Command (ASCC), like all components, is responsible for establishing linkage between itself and its parent service as well as connecting the army forces (ARFOR) headquarters and other components with the joint task force (JTF).[71] As such, the ASCC employs its systems in support of assigned operational tasks. The ASCC is also responsible for a myriad of tasks ranging from logistical functions to dissemination of intelligence for its own as well as other services in accordance with the joint force commander's (JFC) mandates and Title X executive agent responsibilities.[72]

The JFC also has the option to designate the senior Army commander as the Ground Component Commander (GCC) or Joint Forces Land Component Commander (JFLCC).[73] The joint commander could then place other land forces under operational (OPCON) or tactical (TACON) control. Correspondingly, the army forces (ARFOR) could be placed under a Marine Corps Commander filling the role of JFLCC. Regardless, the organizational structuring of the staff and major subordinate commands (MSC) remains the same with the exception that

the staff will have multi-service representatives.

Whether an Army commander is single or multi-hatted, he will organize and employ his systems according to the Army's basic guidelines. Army doctrine establishes the corps as the link between the operational and tactical levels of war.[74] It is considered best suited because of resources and staff. Corps have all types of combat, combat support, and combat service support units readily available to form a task force. This structure also has a staff experienced with synchronizing the combat effects of these different units. As previously mentioned, sometimes this corps commander will elect to "dual hat" his staff as both ASCC and ARFOR or he might chose to split his staff to accommodate these separate functions. Essentially the staff structure is similar and will be addressed as one and the same.

The Army generally follows the joint community in its general staff structure. Included is the commander's personal staff group, coordinating staff group, special staff group, liaison officers, and MSCs. (figure 4)[75] The personal staff is under the immediate control of the commander and assists him directly rather than working through a staff agency. Coordinating staffs provide similar functionality. The Army general staff structure will also include additional specific staff sections ranging from engineers to host nation/civil-military operations.[76] The special staff group includes added professional, technical, and functional areas such as legal, religious, and medical advisors. Liaison officers are representatives to or from the command for specific purposes or

Generic Army Component Command Organization

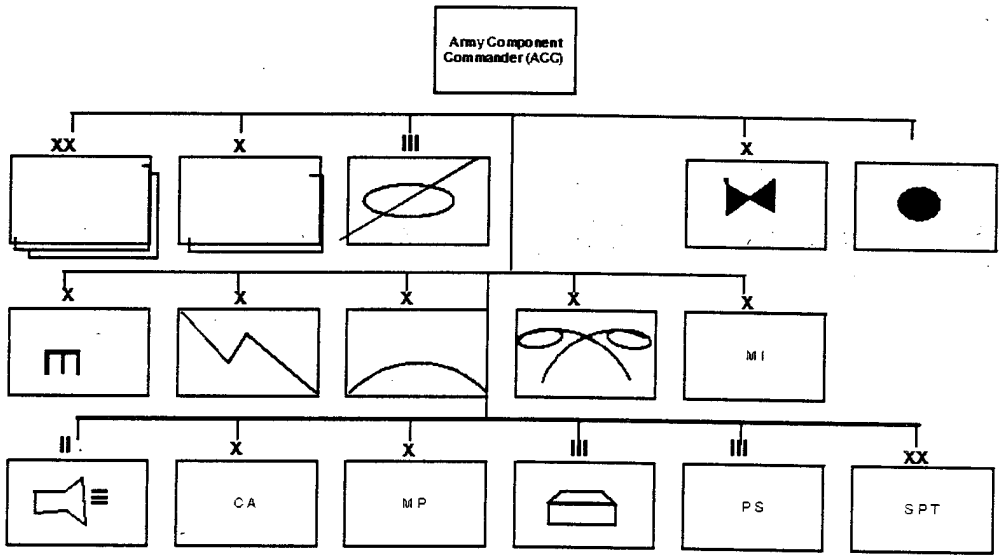
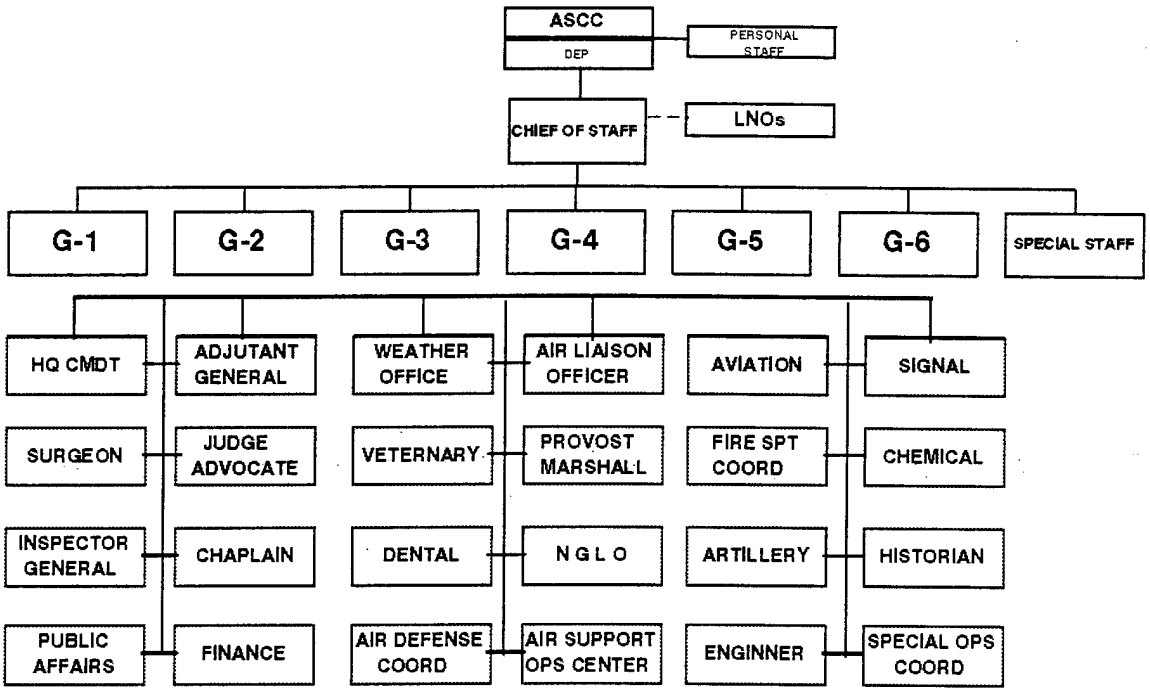


Figure 4

periods of time.

As similar as the organizations are between the ASCC and the ARFOR staffing, they have a very different focus. The ASCC acts much like a parent service responsible for training, maintaining, and sustaining the ARFOR.[77] The corps as ARFOR is concerned with successfully executing warfighting missions assigned by the JFC.[78] Splitting the staff to accomplish these separate functions has many problems. Corps headquarters are not designed to divide in this way. Separating into two staffs creates two thinly manned cells as well as breaking up experienced teams. Yet, "dual hatting" has negative aspects too. The staff sections have trouble keeping roles and information separate.[79] The complexity and sheer level of effort to plan and execute operations as both ASCC and ARFOR can quickly overcome a single staff.

Army doctrine also affects the organization of major subordinate commands (MSC) are organized. MSCs are both combat and functional commands. Combat elements can be intact allocated units such as the 82d Airborne Division, a task force (TF) built around mission requirements, or a combination of both. Functional commands are normally separate brigades that perform combat support (CS) and service support (CSS) duties. (figure 5)[80] The size and organization of the staff and units depends upon how the commander translates the operational objectives into detailed and specific operational battle plans. Despite the mission or composition, the staff directing the ARFOR must be the central point that synchronizes combat power to achieve an advantage over the enemy.[81]



GENERIC ARMY COMPONENT COMMAND STAFF ORGANIZATION

Figure 5

In contrast, the critical roles of the ASCC are mission planning, integration with the other service components, as well as coordination of combat effects and operating systems.[82] Accordingly, command and control systems must support these differing, but complimentary roles of the ASCC and the ARFOR. Army command and control support systems must provide for interoperable command and control systems vis a vis its communications networks in order to effectively tie in Army capabilities to the joint task force.

Major Army command and control support systems are incorporated in the Army Tactical Command and Control System (ATCCS). ATCCS consists of the Maneuver Control System (MCS), tactical fire direction (TACFIRE) system, forward air defense command, control, and intelligence (FAADC2I), all-source analysis system (ASAS), combat service support control system (CSSCS), and the army brigade and below (AB2) systems.[83] ATCCS feeds battlefield functional area (BFA) officers located in all various hierarchial command posts (CPs). The BFA officers receive data and make an analysis. They then feed this information to other parts of the staff and/or commander. In this way, the battlefield operating systems of fire support, intelligence, maneuver, air defense, combat service support, mobility and survivability, and command and control interoperate to provide the commander maximum flexibility for planning and executing campaign plans.[84]

The Army's communications system has four major subsystems: Satellite Communications (SATCOM), the Army Common User System (ACUS), combat net radio (CNR), and the data distribution system

(DDS).[85] SATCOM includes fixed and mobile multichannel and single channel ground stations which use joint or other service's satellite constellations. ACUS is the mobile telephone system capable of linking mobile "cell phone" like devices with wire line telephones in a reliable and secure system. Included in the ACUS is an international interface to link systems from other countries into the Army's communications network to facilitate combined operations. CNR includes the tactical radio system supporting units on the move. The CNR can be linked into the ACUS via a net radio interface (NRI) if needed. Finally, DDS is to consist of systems like the enhanced position locating reporting system (EPLRS) and JTIDS to add robustness to the network and take the load off ACUS which is predominately a voice system. All four of these systems work in concert with each other to provide both local area networks (LAN) and wide area networks (WAN) on the battlefield. In addition, they provide the connections back to the strategic base.

The Army's doctrine allows commanders sufficient flexibility to create a component along unit or functional lines. The problem with effectively organizing the staffs to deal with separate functionalities represents a challenge to the corps which is the unit most likely to serve as the ASCC and ARFOR in the joint warfighting environments. The corps organization no longer may be the most effective structure for future no-notice joint missions. Additionally, the organization of Army forces effects how well command and control systems are employed. If the Army updated its

doctrinal structure to account for the requirement to act as a part of a joint task force, it would improve its effective contribution to joint task forces. Army doctrine tries to make the same control structure work for service only and joint environments. This drives a staff structure which is not the most effective given austere manning. In addition, the command and control systems are set up the same for Army only and joint missions. This structuring creates a stove-piped system that only crosses over to the other services where liaisons are sent.[86] A more integrated approach is necessary when the corps serves as ASCC and ARFOR in order to improve its contribution to the JTF.

Air Force Command Control

Air Force doctrine clearly centers around centralized control and decentralized execution.[87] The idea that air power is decisive and must be wielded centrally effects the organizational structure of the Air Force Component Command (AFCC) and its associated command and control support systems. Much of what this service publishes either implies or explicitly states that the AFCC will function as the JFACC as well.[88] To this end, they structure air force forces (AFFOR) to meet this requirement. The command and control support systems which accompany this structure ensure reliability, survivability, flexibility, and security for the AFCC commander.

Air Force doctrine is very much in line with the joint idea that component commanders bring to bear specialized competence and forces in concert with the operational commander's vision.[89] The

Air Force's capstone manual for its doctrine AFM 1-1 Basic Aerospace Doctrine of the United States Air Force reminds warfighters that the AFCC is responsible for exercising aerospace power in the theater of war. Aerospace is considered the entire expanse above the earth's surface and aerospace power grows out of the ability to use a platform operating in or passing through the aerospace medium for military purposes.[90] The AFCC organizes and employs its systems to fight in this environment.

The AFCC can perform multiple roles and missions in order to meet the objectives of the JFC. In order to exercise aerospace power in the theater, the AFCC concentrates on four basic roles: aerospace control, force application, force enhancement, and force support. Aerospace control is assuring friendly use of the air space and denying the enemy similar freedom of action. Force application is bringing aerospace power to bear on surface targets without regard to weapon system or platform. Force enhancement is the idea of increasing the abilities of surface and aerospace forces when performing their assigned missions or tasks. Finally, force support deals with sustainment.[91] AFCC staffing to meet these mission requirements essentially mirrors the joint structure which has been sufficiently covered. However, the subordinate command structure is unique. The AFCC organizes into functional commands to facilitate the basic roles outlined above.

The organization of the AFFOR varies with respect to the operational tasks assigned. There is no stated doctrinal approach to staff and organizational structure. However, the organization

during Desert Storm serves as an excellent example of the functional groupings that are necessary to launch air operations and is often copied. (figure 6)[92] During the Gulf War Central Command Air Force Component (CENTAF) had four major functional areas designated to facilitate mission requirements; targeting, tasking, commanding, and liaison.[93] This construct, a derivative from USAF doctrine, enables the JFACC commander to attack a wide range of surface targets with appropriate force packages to mass the capabilities of the joint air forces. USAF command and control support systems employment facilitates this structure, but does not plug into and fully interoperate with the other Services support systems.[94] Much like the Army, the AFCC depends on liaison parties to achieve interoperability with other service component commands which sometimes adversely impacts timely information exchange.[95]

The command and control support systems serving the AFCC are a variety of joint (such as their mobile tactical systems) and Air Force specific systems. This discussion focuses on those C2 support systems that are Air Force specific. Command and control support systems include the Contingency Theater Air Control System Automated Planning System (CTAPS), the Airborne Battlefield Command Control Center (ABCCC), the Airborne Warning and Control System (AWACS), the Air Force Satellite Communications (AFSATCOM) System, the Tactical Air Operations Module (TAOM), and transportable air traffic control system.

CTAPS was developed to provide a common view of air, land, sea, and space for component and superior commanders based upon

GENERIC AFFOR/JFACC ORGANIZATION

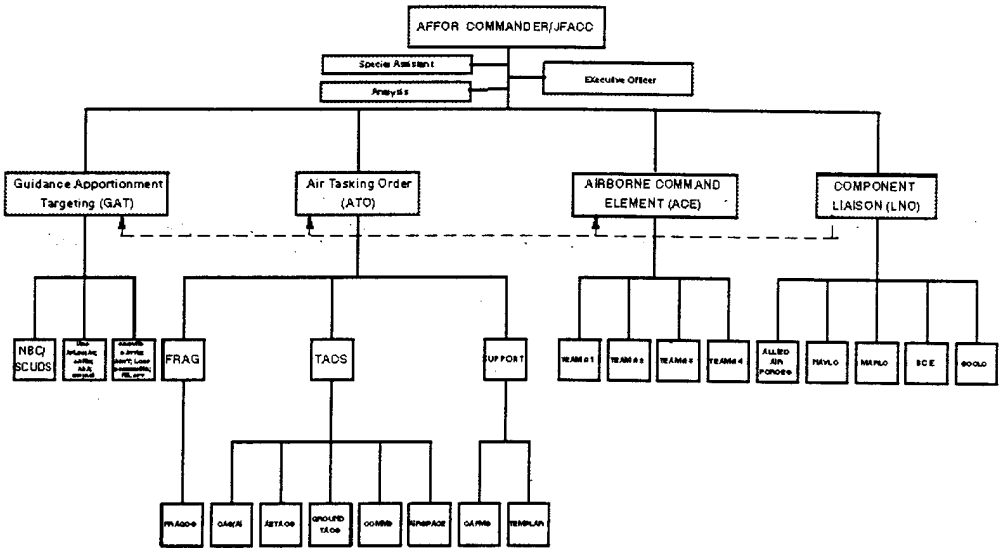


Figure 6

input from the wing level, the air operations center (AOC), and the air support operations center (ASOC).[96] ABCCC is designed to act as the coordination center for strike aircraft in forward areas of the battlefield as well as enabling communications between the Navy's E-3 and the Air Force's AWACS systems. AWACS is designed to track all aircraft in flight.[97] AFSATCOM is the Air Force sponsored satellite communications constellation scheduled for eventual replacement by the MILSTAR system.[98] Finally, TAOM is a transportable automated air command and control system for controlling and coordinating air defense, weapons, interceptors, and surface-to-air missiles.[99] Together these systems bring robust capabilities to enhance the JFACC commander's visualization of the battlefield as well as enhance synchronization of combat effects from air and space.

The Air Force's doctrine centers around centralized control and decentralized execution. As such, the AFCC assumes that it will function as the JFACC. Evidence of this premise is found in Air Force doctrine which either implies or explicitly states that the AFCC will function as the JFACC. The reason is that there is a fundamental belief that air power must be fought centrally to be decisive. This belief also effects the organizational structure of the Air Force Component Command (AFCC) and its associated command and control systems. The positive aspect of this type of functional organization is that it does have an operational as well as tactical focus. In this way it is a structure which does lend itself to joint warfighting. However, those command and control

systems not provided by the joint community are still very much stove-piped along component lines. USAF C2 support systems do not lend themselves to timely interoperation. Liaison is the key methodology upon which the USAF relies in order to work with the air forces of the other service components within the JTF.

Marine Command and Control

The vision driving Marine doctrine is based upon power projection operations defined as operational maneuver from the sea (OMFTS).[100] Their doctrine describes a strategy of force packaging units to meet mission requirements. Organizationally their staffs are remarkably similar to the joint structure, but their units are functionally delineated. Austerity is very much the hallmark of the Marine forces (MARFOR) and they rely heavily on other services for long term sustainment or infrastructure building.[101] Their command and control systems reflect this philosophy. Command and control support systems support the functional approach to warfighting in this service. In addition, like the Army and Air Force, the Marine Component Command (MCC) relies upon liaison for inter-component interoperability.[102]

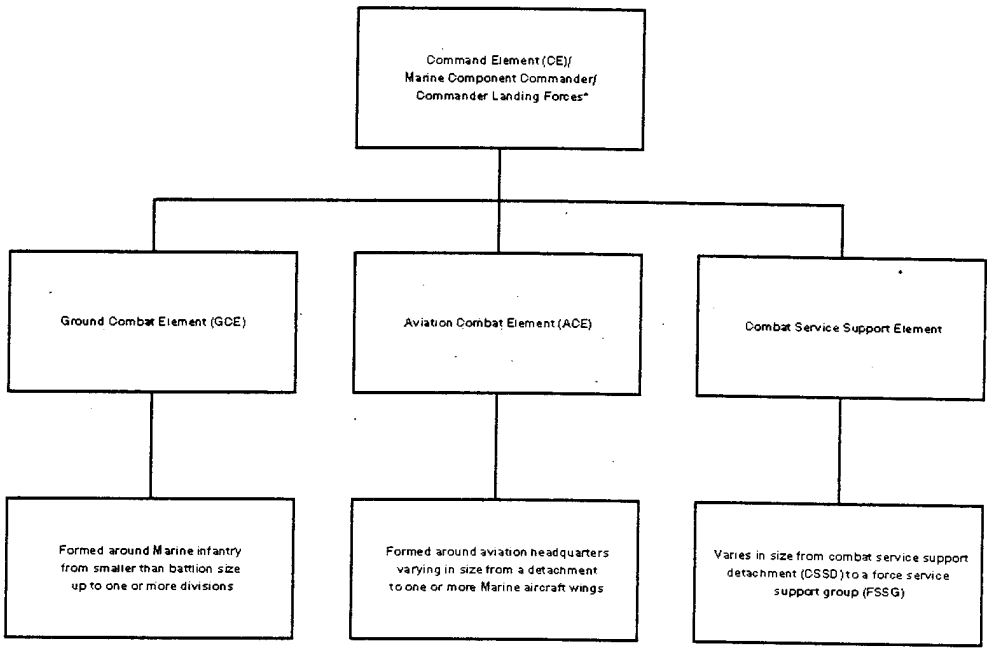
The salient difference between the Army and Marine Corps is the USMC modular approach to warfighting which reflects their operational power projection orientation. The Marines emphasize strategic mobility, strategic diversity, their capability for independent action, and a sea-land-air orientation.[103] As such, they normally fight as a Marine Air-Ground Task Force (MAGTF). The MAGTF is also well designed to serve as the Marine Component

Command (MCC) because it integrates both warfighting and logistical functions. As such, the MAGTF commander is generally "dual hatted" as the Marine Component Commander.[104]

The MCC is required to structure firepower, tactical mobility, and logistics into a self-contained force package which is strategically transportable in support of the assigned JTF mission. The Marines create the MAGTF using a building block approach to organizational structure ranging from small special purpose forces (SPF); Marine Expeditionary Units (MEU) for forward-deployments; Marine Expeditionary Brigades (MEB) for more sustained operations ashore; or Marine Expeditionary Forces (MEF) capable of prosecuting campaigns.[105] The support systems they employ for command and control compliment this structure.

The MAGTF will have coordinating staffs which include G/S1 through G/S6. This staff is the major part of the MAGTF command element manning. The command element will normally have a main command post, a jump command post which is a temporary element created from the main based upon mission exigencies, and a rear command post.[106] In addition, there are three major subordinate commands (MSC). MSCs include a combat service support element (CSSE), an aviation combat element (ACE), and a ground combat element (GCE) with an associated commander. (figure 7)[107] Yet,Marine forces normally support campaigns and do not unilaterally wage them.[108] This is the reason that they are reliant on the Army for logistics and theater infrastructure when time-lines exceed about sixty days.[109] This is not to say that they do not

Generic Organization of the Marine Component Command



*For Amphibious Assault Operations

Figure 7

have their own unique command and control support systems to support their component command; however, they do rely on the Army to provide robustness to their network.

The command and control architecture used by the Marine Corps consists of both Navy and Marine systems. The systems afloat will be discussed in detail during the discussion of the Navy Component Command. The Marine systems ashore consist mainly of the tri-service tactical (TRI-TAC) multichannel communications system still used by the Army at echelons above corps (EAC).[110] They use the Position Location Reporting System (PLRS) for rapid and secure data transmissions for enhanced battlefield awareness as well as delivery of fires.[111] In addition, the Marines are fielding Trojan Spirit II Communications System in conjunction with the Army. It is a tri-band satellite system designed to give MAGTF commanders secure, reliable, mobile data and voice capabilities.[112] The Marines also have their own aviation command and control support systems such as the Marine Air Traffic Control and Landing System (MATCALS) which provides automated air traffic and landing control as they come ashore. Future command and control support systems will be under the MAGTF C4I system which is a hardware and software system able to take input from tactical data systems. The first of this family will be the tactical combat operations (TCO) terminal.[113] All of these systems can network into joint and naval systems if links are made available.

Marine doctrine is operationally based looking at how to most effectively project power from the sea. Their doctrine drives an

organization which uses force packaging to execute missions given by the JFC. Their staffs are structured much like joint and Army coordinating staffs which does help ease information transfer. Their command and control systems are adequate to their internal needs and are technologically compatible with joint systems. However, they are not available in large enough numbers to ensure interoperability with the other commands component commands. Austerity being the hallmark of the MARFOR means that they must rely heavily on liaison teams for interoperability.

Navy Command and Control

The Navy's operational doctrine revolves around its three primary missions: sea control, power projection, and strategic lift.[114] It is in its role of power projection that the Navy would most likely be involved as a service component command in a joint task force. As such, the Navy configures a particular action group to be able to employ surface, submarine, and air forces to exploit strengths and minimize weaknesses. This design of the Navy's command and control support systems meets the needs of this functional approach to warfighting.

There are seven fundamental tasks when dealing with naval warfare. These tasks guide the organizational structure for this component command. The antiair warfare (AAW) mission concentrates on destruction of enemy air platforms and airborne weapons. The antisubmarine warfare (ASW) element is tasked to neutralize enemy submarine threats. Strike warfare (STW) is assaulting land from the sea in what are termed "feet dry" operations. The antisurface

warfare (ASUW) aspect deals with neutralization of enemy surface combatants or commercial ships. Amphibious warfare projects force from the sea to land on a hostile shore. Mine warfare encompasses mining and counter-mining efforts. Space and electronic warfare (SEW) covers the management of the electro-magnetic spectrum offensively and defensively. (figure 8)[115] The Navy looks at logistics, surveillance, and command and control as supporting tasks, but no less important to overall mission success.

The Navy supports it component commands with service unique command and control support systems. The unclassified systems at the highest levels are under the umbrella of the naval telecommunications system (NTS) which is a worldwide network controlled by four naval communications area master stations. The purpose of the system is the transmission of fleet broadcast information either on HF radio or UHF satellite communications.[116] In addition, the Navy has the naval tactical data system (NTDS) residing on most large vessels and amphibious ships to provide real-time tactical support information to ships and aircraft. It uses encrypted HF and UHF links to exchange high-speed strategic and tactical information from various platforms within the task force.[117] Information is sent to the naval task force from a variety of sources. One example is the global positioning (GPS) system which provides a task force commander a high order of situational awareness. GPS is but one element of the Navy's robust satellite network that includes the mobile access terminal network (MATNET) and the fleet satellite communications system (FLTSATCOM).[118] All of these

networks feed into sophisticated command and control automation systems located both ashore and aboard ships.

The Navy's approach to command and control support systems is to tie the automation design to the function of the ship or shore facility. Some of the more familiar shipboard systems include the Aegis command and control system, the fast frigate integrated shipboard tactical system II (FFISTS II), the integrated tactical command system (ITACS), and the rapidly deployable integrated command and control (RADIC) system. Equally familiar shore-based systems include the multiple input tracking control system (MTRACS), the coastal defense system, and various surveillance radars.[119] The overall task force commander has a rapidly deployable, integrated command and control support system; the advanced combat direction system (ACDS) naval tactical data system which processes, stores, and presents the information. In this way, the NCC takes care of its internal needs to command and control afloat. It is in the link to shore that problems arise.[120] The Navy does not have sufficient bandwidth to support connections with other service components. Augmentation in the form of liaison teams has to be provided to the NCC in order for it to communicate across service boundaries.[121]

The Navy's operational doctrine revolves around its unilateral mission to control the sea, project U.S. power from the sea, and moving ground forces and equipment to a theater of war. It task organizes combatants and support to meet these missions. This is also how the NCC organizes to support a JTF and execute the

Naval Component Command Generic Organization

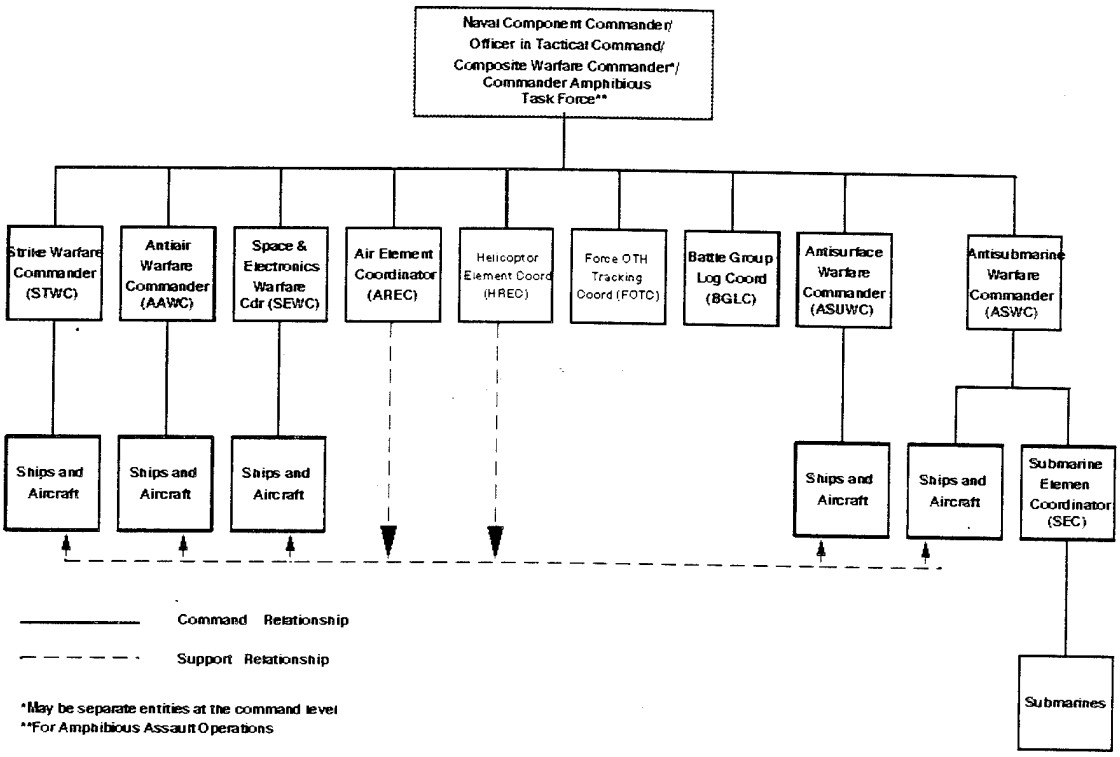


Figure 8

missions assigned by the JFC. The Navy configures an action group to be able to employ surface, submarine, and air forces to exploit strengths and minimize weaknesses. The Navy designs command and control support systems to meet the needs of this functional approach to warfighting. While the Navy does have some capability to interconnect with land forces, like other services, it depends on liaison teams to make component command interoperability work.

Conclusion

The services each have developed to varying degrees clear and sufficient doctrine to meet the roles and missions mandated by Congress under Title X. Service component command organizational structures and command and control support systems adequately take care of internal requirements, but do not always lend themselves as efficient constructs in the joint environment. As late as 1980, a MITRE Corporation report commissioned by the joint staff pointed out,

> **Each branch of the services likes to manage its own affairs by means of its own communications, which run up and down its chain of command. Organizing information flow in this manner causes delays and distortion. It makes it virtually impossible to achieve near-real-time coordination of combat elements of different services. Yet, such coordination lies at the heart of combined arms operations.**[122]

Unfortunately joint doctrine does not overcome this stove-piping at this time. In attempts to reach consensus, the doctrine stays very general in nature. The responsibility for creating organizations rests with the combatant commanders. As such, there is no standard organization and so it is extremely difficult to analyze where command and control shortcomings will occur with any consistency.

This means that command and control support systems which support the JFC and his task force continue to be piecemealed together.

Looking at the command and control support systems from each service it is readily apparent that each service has enough assets to take care of internal needs, but none have sufficient assets to be fully interoperable when functioning as a component command. It becomes a question of resources in a time of diminishing budgets. The services need to first address their internal needs, but do not always finish the effort by ensuring adequate lash up with other service support systems. This becomes increasingly problematic when service component commands split or "dual/multi-hat" their staff. The services are not given extra assets to meet the increased burdens of multiple mission responsibilities when deployed as an operational command element.

The problems are not insurmountable. The services have made strides over the years to improve interoperability. The problem is that liaison teams are not the answer to timely and responsive command and control. The military can overcome this problem through more directive joint doctrine, publishing standard component command structures, and exploring innovative ways to use the available technology to enhance the command and control systems. These enhancements will allow joint warfighters to more effectively synchronize the fight.

Joint Pub 5-00.2 Joint Task Force Planning Guidance and Procedures serves as an excellent microcosm for studying the problems with joint doctrine. This document devotes twenty-four

pages to JTF responsibilities, command and control, organization, operations, and staffing. The charts depicting command relationships never go lower than service component command/subordinate JTF level.[123] Charts referring to staffs simply show coordinating and special staffs without further elaboration.[124] Yet, this manual has eight appendixes consisting of hundreds of checklist items. Many of the listed checklist entries require staff support of other sections, but how this all lashes up, who has what responsibilities, and how information gets exchanged is not addressed.

One example will be used to illustrate this problem within joint doctrine. Under the J-6 checklist there is checklist question h., "Are close-hold and limited access procedures understood by all planners?" There is no documentation within this or subordinating publications which lets the J-6 know which sections have "planners." The manual does not clearly define who needs to be involved in this type of coordination. This checklist question does not help define who establishes "close-hold" and who must be aware that such information exists. Checklist items antecedent or subsequent to it do not clarify these questions. This is just one example of how the intermediate steps which are vital to smooth command and control of JTF are not available in the doctrine and left up to either the combatant commander or the JFC to establish. This is not the most effective way to address this problem since each time a JTF forms, the commander must re-establish these kinds of relationships. Having to "re-invent" an organization because of doctrinal weakness wastes valuable time

which could be devoted to crisis action planning.

Another area of improvement is the organizational structuring of JTFs. The charts that were used in this text to depict generic component commands were derivations of many joint and service specific doctrinal publications. In the future, the JCS should publish similar standard organizational charts for service component commands, with all major elements in addition to the generic JTF structure. These charts, in turn, should appear in all service capstone manuals to take on a more authoritative nature. Depicting generic structures does not diminish the JFC's ability to tailor these organizations based upon his mission analysis. However, these types of diagrams can serve as both a point of departure and a way to plan for and resource better command and control systems interoperability.

Finally, innovative uses of available technologies can enhance present battlefield command and control systems used by the different services and are applicable to the joint environment. Using commercially available integrated management tools much akin to online services can ease staff burdens and improve the operational commander's ability to get information and communicate decisions. This type of umbrella system will incorporate service specific as well as joint inputs and make them more readily available to all members of the JTF on a real-time basis. In addition, this type of technology can use available communications structures so new developments and investments are not necessary.

The idea of a living internet system is not new. LTG (R) John

Cushman speaks about such a system being of great value to operational commanders in his work, Thoughts for Joint Commanders.[125] The power of his suggestion is that commercial on-line services such as America Online, Prodigy, or CompuServe can provide the system to the military today. Using this software will provide ways to shatter conventional ideas about staffing, exchange of information, and efficient use of command and control systems. The online service software allows people to talk interactively and record these discussions. It allows customers to tap into services like airline reservations. This technology also provides integrated e-mail and an ability to tap into various databases. The military can use this software to eliminate present inefficiencies associated with joint command and control. It is possible to lease a copy of such a service's network interface software much like airlines rent reservation software from other airlines. In this way, the concept could be implemented right away with minimal cosmetic changes and paths created to pull in military systems. For purposes of this discussion, the proposed system will be called Joint Task Force Online (JTFO).

Today's planners physically meet to decide issues in what is referred to in doctrine as joint boards. JTFO can provide a medium for virtual boards who meet in electronic forum rooms at specific times for coordination. This method saves staff officers from physically relocating and an automatic hardcopy for "minutes" of the meeting can be produced. Other advantages of JTFO's easy to use interface package include: integrated with e-mail; access to

service specific and joint publications, bulletin board for non-time sensitive posting, real-time dissemination of command information, access to internet, access to defense digital network (DDN) for contact with outside JTF entities, interface with other systems (much like the airlines allow you to take a look and book flights the same can be true of TPFDL systems, and logistic systems). The power of JTFO is that it can be used today with the communications systems available so that there is a more cohesive approach to the joint and service component command and control process.

The joint battlefield requires more integration across service component commands without depending on liaison teams for command and control. Joint doctrine must follow the individual services who have developed clear doctrine for all levels to meet their congressionally mandated roles and missions. As joint doctrine matures and becomes more directive, the service component commands organizational structures and command and control systems will more adequately take care of external in addition to internal requirements. In this way, joint doctrine will assist in overcoming stove-piping. Innovative uses of available commercial technologies will also improve command and control in the joint environment. This improvement in doctrine, organization, and command and control systems will provide better joint warfighting in the future.

ENDNOTES

1. Phillips, Thomas R., Roots of Strategy. Vol. 1, The Art of War, by Sun Tzu, trans Lionel Giles, (Harrisburg, PA: Stackpole Books, 1985), 21-49. Sun Tzu explains that the commander is one of five constant factors in the art of war. He writes that, "The Commander stands for the virtues of wisdom, sincerity, benevolence, courage, and strictness." 21 The idea of control is found within his concept of method and discipline which, "are to be understood the marshaling of the army in its proper subdivisions, the graduations of rank among officers, the maintenance of roads by which supplies may reach the army, and the control of military expenditure." 22 Doctrine is not explicitly stated, but can be found in expressions such as, "He who knows [principles of terrain and maneuver], and puts his knowledge into practice, will win battles. He who knows them not, nor practices them, will surely be defeated." 49

2. Carl Von Clausewitz, On War, ed. and trans. Michael Howard and Peter Paret, (Princeton, N.J.: Princeton University Press, 1976), 177.

3. Robert H. Scales, Certain Victory: The US Army in the Gulf War, (Leavenworth, KS: Selected Reprint, US Army Command and General Staff College Press, 1994), 375.

4. JCS Pub 3-0 Doctrine for Joint Operations, (Washington, DC: Joint Chiefs of Staff, 9 September 1993), II-19.

5. Battle Command, (Ft. Leavenworth, KS: Battle Command Battle Labs, 22 April 1994), 11. "During operations the commander is personally responsible for formulating the single unifying concept for a mission,. . .Professional competence, personality, and the will of the commander represents a significant part of any unit's combat power."

6. Battle Command, (Ft. Leavenworth, KS: Battle Command Battle Labs, 22 April 1994), 17 and 65. In the graphic on page 17, control is defined as command posts and staff which compute requirements, allocate means, integrate efforts, and generate options. This is further elaborated in the text where it states,"Control monitors the status of organizational effectiveness and identifies deviations from set standards and corrects them. . . Skilled staffs work within command intent to direct and control units and resource allocations to support the desired end." 65. Much of the same discussion on command and control is echoed word for word in JCS Pub 3-0 Doctrine for Joint Operations, (Washington, DC: Joint Chiefs of Staff, 9 September 1993), II-19 - II-21.

7. Battle Labs: Maintaining the Edge, (Ft. Monroe, VA: United States Army Training and Doctrine Command, May 1994), 4.

8. Matthew Cooper, The German Army 1933-1945, (Chelsea, MI: Scarborough House Publishers, 1978), 131- 132. "At the basis of an army lies its *Kriegsführung* (war direction), the strategic doctrine that may be defined as the art of distribution and applying military means to fulfil the ends of policy. An army's strategy is the system of large-scale measures whereby its forces in the field are manoeuvred so as to bring the war to a conclusion, and it is this that gives an army its particular soul, its distinctive, unique character without which it would e just an incoherent, inanimate mass. Thus, a twentieth century force which bases its training, equipment, organization, and command on a defensive strategy of interlocking trench and fortification systems will be radically different in composition from one which relies on an aggressive doctrine of decisive manoeuvre. On the quality of its strategic direction, then, is based the fortune of the army and, consequently, of the entire nation. An army's *Kriegsführung* is its most treasured possession."

9. Gordon R. Sullivan, "America's Army-Focusing on the Future," Army: 1994-95 Green Book 44, no. 10 (October 1994): 27. General Sullivan writes about doctrine incorporating a vision which will bring about intellectual change and influence the future. He drives this point home when he says, "[d]octrine drives the Army . . ."

10. Alvin and Heidi Toffler, War and Anti-War, (New York: Little, Brown, and Company, 1993), 63. This notion of how technology changes armies is expressed by the Tofflers as they discuss how economies of scale are replaced by economies of speed. Time is now the critical resource which pressures leaders to deliver decisions in progress if they are to react faster than the competition.

11. JCS Pub 3-0 Doctrine for Joint Operations (Washington, DC: Joint Chiefs of Staff, 9 September 1993), II-21. Related tools for implementing decisions include communications, computers, intelligence, as well as space-based surveillance, navigation, and location systems.

12. Michael Howard, Chesney Memorial Gold Medal Lecture given on 3rd October 1973.

13. Joint Pub 0-2 Unified Action Armed Forces (UNAAF), (Washington, DC: The Joint Chiefs of Staff, 11 August 1994), GL-5.

14. Joint Pub 0-2 Unified Action Armed Forces (UNAAF), (Washington, DC: The Joint Chiefs of Staff, 11 August 1994), GL-

5. "The exercise of authority and direction by a properly designated commander over assigned and attached forces in the accomplishment of the mission. Command and control functions are performed thorough an arrangement of personnel, equipment, communications, facilities, and procedures employed by the commander in planning, directing, coordinating, and controlling forces and operations in the accomplishment of the mission."

15. It is interesting to note that JCS Pub 3 Joint Operations consistently uses the term command and control (C2) and only adds communications and computer (C4) when discussing the joint communications area (J6). However, when delving into subordinate doctrine such consistency is lost. Examples are as follows: Universal Joint Task List adds intelligence (C3I, p. 2-39 and 2-72); AFSC Pub 1 Joint Staff Officers Guide 1993 adds systems (C2, p. J-2), communications (C3, p. E-1 and J-2; C3S, p. J-2), intelligence (C3I, p. J-2); and computers (C4; C4I, p. J-2); AFSC Pub 2 Service Warfighting Philosophy and Synchronization of Joint Forces adds communications (C3, p. II-5-4) and intelligence (C3I, p. II-5-D-20); JCS Pub 3-56 (Draft) Command and Control Doctrine for Joint Operations adds communications (C3, p. III-1 and GL-2), intelligence (C3I, p. IV-22 and GL-2); and computers (C4I, p. GL-2); JCS Pub 5-00.2 Joint Task Force Planning Guidance and Procedures adds communications (C3, p. III-2, G-A-1 through 3) and computer systems (C4S, p. G-A-1); and JCS Pub 6-05.1 Employment of Joint Tactical Communications Systems adds communications and computers starting on page iii and this term is used throughout the text.

16. Joint Pub 0-2 Unified Action Armed Forces (UNAAF), (Washington, DC: The Joint Chiefs of Staff, 11 August 1994), GL-5.

17. James A. Winnefeld and Dana J. Johnson, Joint Air Operations Pursuit of Unity in Command and Control 1942-1991, (Annapolis, MD: Naval Institute Press, 1993 by RAND), 97-98.

18. Martin Van Creveld, Technology and War, (New York: The Free Press, 1989), 237.

19. Ann Marie Cunningham and Mariana Fitzpatrick, Future Fire: Weapons for the Apocalypse, (New York: Warner Books, 1983), 135.

20. John H. Cushman, Thoughts for Joint Commanders, (Annapolis, MD: Whitmore Printing, April 1993). This criteria is a synthesis of General Cushman's arguments on how to best put together a joint fighting force.

21. Richard A. Gabriel, Military Incompetence: Why the American Military Doesn't Win, (New York: Hill and Wang, 1985), 158. There were many examples, but the problem between Delta Force and the Navy SEAL teams is illustrative. The Delta Force operation

was compromised and it took four additional hours to extract them. There was no way to let the SEAL teams know that the alarm was sounded and that enemy forces had reinforced the transmitter station that was the SEAL team mission. The SEAL team came under unexpected heavy fire as a result and members of that team were killed.

22. Richard A. Gabriel, Military Incompetence: Why the American Military Doesn't Win, (New York: Hill and Wang, 19850, 91-92 and 96.

23. Joseph Metcalf III, "Decision Making and the Grenada Rescue Operation," in Ambiguity and Command, James G. March, ed., (New York: Harper Collins Publisher, 1986), 235.

24. Richard A. Gabriel, Military Incompetence: Why the American Military Doesn't Win, (New York: Hill and Wang, 1985), 151.

25. Joseph Metcalf III, "Decision Making and the Grenada Rescue Operation," in Ambiguity and Command, James G. March, ed., (New York: Harper Collins Publisher, 1986), 229.

26. Joseph Metcalf III, "Decision Making and the Grenada Rescue Operation," in Ambiguity and Command, James G. March, ed., (New York: Harper Collins Publisher, 1986), 228-232. This depiction is a synthesis of drawings and supporting statements made within the text of this article.

27. Edward N. Luttwak, The Pentagon and the Art of War, (New York: Simon and Schuster, 1984), 271.

28. Mark Adkin, Urgent Fury, (Lexington, MA: Lexington Books, 1989), 134. Statements such as, "A rapid turnover by the Special Forces to conventional units and the Caribbean contingents was fundamental to all planning." indicate the need for extensive coordination and communications to control the operation. This was not always successful.

29. Mark Adkin, Urgent Fury, (Lexington, MA: Lexington Books, 1989), 139. "The marine pilots had difficulty making any radio contact with the air force AC-130s or ground units; the radio frequencies give to the marines were incorrect. However, after a fruitless flight by the first pair of Cobras, marine captain Gary Watson, wingman to marine captain Douglas Diehl, picked up an army frequency.";(they were using different maps too!) 216; "Also worrying was [MG Trobaugh, Cdr 82d]'s position in the command setup. He was TF 121 commander, but the plan involved two other task forces operating on the ground in Grenada: JTF 123 under Scholtes, plus JTF 124 under Erie, with the marines ashore in the north. There was no ground force commander as such, and Trobaugh rightly foresaw coordination problems. These difficulties were exacerbated by poor to nonexistent direct radio

communications between the 82d Airborne, the marines, and Metcalf on the *Guam*. Eventually a special army communications team had to be set up on the *Guam* to try and resolve this situation." 221; "Equally frustrating was the fact that although he could see the USS *Guam* on the horizon, more often than not he was unable to speak to Metcalf. The army command post and the admiral commanding were in direct line of sight, only a few miles apart, yet radio contact was impossible, except occasionally via satellite." 229-230; "Without the knowledge of its commanding officer, who was at Pearls and not in radio contact with the *Guam*, 2d/8th BLT was scattered on a new mission." 246; Downed marine pilots were told to make their way on foot toward the 82d, but they did not have army radio frequencies which put them in danger of fratricide. 272

30. Mark Adkin, Urgent Fury, (Lexington, MA: Lexington Books, 1989), 128.

31. George Wilson and Michael Weisskopf, "Pentagon, Congress Seek Cure to Shortcomings Exposed in Grenada Invasion," Washington Post, 20 February 1986, A24.

32. Joseph Metcalf III, "Decision Making and the Grenada Rescue Operation," in Ambiguity and Command, ed. James G. March (New York: Harper Collins Publisher, 1986), 246.

33. Richard A. Gabriel, Military Incompetence: Why the American Military Doesn't Win, (New York: Hill and Wang, 1985). This is a synthesis of the chapter on Grenada, but specifically pages 178-179 talk about procedural and equipment failures practically unhinging the operation.

34. Joseph Metcalf III, "Decision Making and the Grenada Rescue Operation," in Ambiguity and Command, James G. March, ed., (New York: Harper Collins Publisher, 1986), 242.

35. JCS Pub 1 Joint Warfare of the US Armed Forces, (Washington, DC: Joint Chiefs of Staff, 11 November 1991), 2. ". . .the ability to project and sustain the entire range of military power over vast distances is a basic requirement for the US Armed Forces. . ."

36. John A. Wickham, "Jointness and Defense Decision Making," in Control of Joint Forces: A New Perspective, ed. Clarence McKnight, (Fairfax: AFCEA International Press, 1989), 113.

37. JCS Pub 3-0 (TEST) Doctrine for Unified and Joint Operations, (Washington, DC: Joint Chiefs of Staff, January 1990), III-11.

38. Joint Military Operations DOD's Renewed Emphasis on Interoperability Is Important but Not Adequate, (Washington, DC: General Accounting Office, October 1993), 2. This report states, "Although DOD placed special emphasis on addressing interoperability [and joint doctrine issues] nearly a decade ago and has made some improvements. . ." It goes on to address deficiencies, but does acknowledge that the situation has become better over time.

39. This is supported by various entries from the Army's on-line database managed by the Center for Army Lessons Learned.

40. Interoperability DOD's Efforts to Achieve Interoperability Among C3 Systems, (Washington, D.C.: General Accounting Office, 1987), 21.

41. Roger Beaumont, The Nerves of War: Emerging Issues in and References to Command and Control, (Washington, DC: AFCEA International Press, 1986), 22.

42. Jerry O. Tuttle, "CINC's Impact on C^3 Systems Planning and Acquisition" in Control of Joint Forces, Clarence Knight, ed. (Fairfax,VA: AFCEA International Press, 1989), 120.

43. Interoperability DOD's Efforts to Achieve Interoperability Among C3 Systems, (Washington, D.C.: General Accounting Office, 1987), 13.

44. Richard A. Gabriel, Military Incompetence: Why the American Military Doesn't Win, (New York: Hill and Wang, 1985) and Lorna Jaffe, The Development of the Base Force 1989 - 1992, (Washington, DC: The Joint History Office, July 1993). This is a synthesis of the final chapter of this book entitled, "Reform and the Future," and the work by the Joint History Office. Together these works discuss those events that led to the Goldwater-Nichols reform based upon continuous pressure for services to think more jointly.

45. JCS Pub 1 Joint Warfare of the US Armed Forces, (Washington, DC: Joint Chiefs of Staff, 11 November 1991), 5-6.

46. Joint Pub 3-0 Doctrine for Joint Operations was updated 9 September 1993 and Joint Pub 3-56 Command and Control for Joint Operations remains in draft with a date of September 1992.

47. JCS Pub 3-56 Command and Control Doctrine for Joint Operations, (Washington, DC: Joint Chiefs of Staff, September 1992). An example is how this manual discusses systems like the four main components of the joint command and control system structure: the Defense Communications System (DCS), the World Wide Military Command and Control System (WWMCCS), the National Military Command System (NMCS), and the Command and Control

Systems of Combatant and Subordinate Commands in very specific terms, but offers only "sample" organizations such as one for a joint staff organization on p. II-12.

48. Roger Beaumont, The Nerves of War: Emerging Issues in and References to Command and Control, (Washington, DC: AFCEA International Press, 1986), 31. This author provides great detail on how specific systems has made the battlefield more expensive, rapid, and complex. He goes on to discuss how commanders become more dependent on technology to deal with the resultant uncertainty and complexity.

49. This is a synthesis of a review of current joint doctrine by the author. It is also repeatedly implied in JCS Pub 1 Joint Warfare of the US Armed Forces by statements such as on p. 2, "This projection of power is inherently a joint undertaking, because of the inter-Service linkages of modern command, control, and communications. . ."; p. 3, "the rapid evolution of **technology** in the postindustrial era. . . has altered warfare."; and pp. 38-39, "The interaction of air, land, sea, special operations, and space capabilities offers the joint forces commander a powerful array of command, control, and communications countermeasures that can dramatically increase the shock effect, disorientation, and operational paralysis caused by joint force's operations against the enemy."

50. JCS Pub 3-0 (TEST) Doctrine for Unified and Joint Operations, (Washington, DC: Joint Chiefs of Staff, January 1990), II-16.

51. JCS Pub 3-0 (TEST) Doctrine for Unified and Joint Operations, (Washington, DC: Joint Chiefs of Staff, January 1990), II-17.

52. JCS Pub 3-56 (Draft) Command and Control Doctrine for Joint Operations, (Washington, DC: Joint Chiefs of Staff, September 1992), II-12.

53. JCS Pub 6-05.1 Employment of Joint Tactical Communications Systems, (Washington, DC: Joint Chiefs of Staff, 24 April 1992, II-2.

54. JCS Pub 6 Doctrine for Command, Control, Communications and Computer (C4) Systems Support to Joint Operations, (Washington, DC: Joint Chiefs of Staff, 3 June 1992, I-4. "Combatant commanders normally develop plans that integrate the DCS, NCS, and commercial and allied systems and organize joint and Service organic and component tactical communications systems into interoperable and compatible theater networks to support their mission."

55. JCS Pub 3-56 Command and Control Doctrine for Joint Operations, (Washington, DC: Joint Chiefs of Staff, September 1992), I-8 - I-9.

56. JCS Pub 6 Doctrine for Command, Control, Communications, and Computer (C4) Systems Support to Joint Operations, (Washington, DC: Joint Chiefs of Staff, 3 June 1992. This is a synthesis of various criteria discussed within the text.

57. Peter Rackham, ed., Jane's C3I Systems 1991 - 1992, (London: Butler and Tanner LTD, December 1991), 151.

58. Peter Rackham, ed., Jane's C3I Systems 1991 - 1992, (London: Butler and Tanner LTD, December 1991), 106.

59. Frank Barnaby, The Automated Battlefield, (London: Sidgwick and Jackson, 1986), 100.

60. Peter Rackham, Jane's C3I Systems 1991 - 1992, (London: Butler and Tanner LTD, December 1991), 106.

61. JCS Pub 3-56 Command and Control Doctrine for Joint Operations, (Washington, DC: Joint Chiefs of Staff, September 1992), II-1.

62. Lecture and unclassified briefing slide number 9 provided by Major Gerald Daniels, United States Army Signal Corps Officer and former operations officer for the JCSE, February 1994.

63. Peter Rackham, ed., Jane's C3I Systems 1991 - 1992, (London: Butler and Tanner LTD, December 1991), 95.

64. Peter Rackham, ed., Jane's C3I Systems 1991 - 1992, (London: Butler and Tanner LTD, December 1991), 95.

65. Peter Rackham, ed., Jane's C3I Systems 1991 - 1992, (London: Butler and Tanner LTD, December 1991), 156.

66. James P. Kahan, D. Robert Worley, and Cathleen Stasz, Understanding Commanders' Information Needs, (Santa Monica, CA: Rand Corporation, June 1989), vi. The authors correctly point out that, "Commanders typically seek options and assessments appropriate to their image rather than data."

67. Early works such as Infantry in Battle, (Richmond, VA: Garrett & Massie, 1939; reprint, Washington, DC: Government Printing Office, 1991) and Field Service Regulations: Operations, Washington, DC: Government Printing Office, 1941; reprint, Ft. Leavenworth, KS: U.S. Army Command and General Staff College Press, 1992) demonstrate the Army's history of publishing doctrinal manuals.

68. U. S. Department of the Army, Field Manual 100-5 Operations, (Washington, D. C.: Government Printing Office, June 1993). This manual is considered the capstone doctrinal piece by the Army and has chapters dedicated to single service missions as well as joint warfare.

69. U. S. Department of the Army, Field Manual 100-15 Corps Operations, (Washington, D. C.: Department of the Army, September 1989), 1-0.

70. U. S. Department of the Army, Field Manual 100-5 Operations, (Washington, D. C.: Government Printing Office, June 1993), 3-5.

71. JCS Pub 3-0 Doctrine for Joint Operations, (Washington, DC: Joint Chiefs of Staff, 9 September 1993), II-15 - II-16.

72. Department of Defense Reorganization Act, Public Law 99-433, 100 Stat. 992, (1986). This is a synthesis of the items appearing under Title V-Military Departments, Part A-Department of the Army.

73. JCS Pub 3-0 Doctrine for Joint Operations, (Washington, DC: Joint Chiefs of Staff, 9 September 1993), II-17.

74. U. S. Department of the Army, Field Manual 100-15 Corps Operations, (Washington, D. C.: Department of the Army, initial draft 15 July 1994), 1-3.

75. U. S. Department of the Army, Field Manual 101-5 Staff Organization and Operations, (Washington, D. C.: Department of the Army, 25 May 1984), 2-2.

76. U. S. Department of the Army, Field Manual 101-5 Staff Organization and Operations, (Washington, D. C.: Department of the Army, 25 May 1984), 2-6.

77. U. S. Department of the Army, Field Manual 100-5 Operations, (Washington, D. C.: Government Printing Office, June 1993), 4-4.

78. U. S. Department of the Army, Field Manual 100-15 Corps Operations, (Washington, D. C.: Department of the Army, September 1989), 1-1. "The planning and execution of tactical-level battles is the major role of the corps."

79. Joint Task Force (JTF) Headquarters (HQ) Nucleus, (United States Army Signal Corps Center for Lessons Learned Entry, Fort Gordon, GA: retrieved 11 February 1995). This entry discusses JTF staff formation problems stating, "[Corps] as tactical commands have experience in controlling fast moving, complex operations. They have the staff and organization to conduct around-the-clock operations. They do not have the required extensive personnel augmentation required. . .The use of a corps

HQ could result in key corps HQ elements becoming committed to long term operations at the expense of their tactical missions."

80. U. S. Department of the Army, Field Manual 100-15 Corps Operations, (Washington, D. C.: Department of the Army, September 1989), 2-3.

81. U. S. Department of the Army, Field Manual 100-15 Corps Operations, (Washington, D. C.: Department of the Army, initial draft 15 July 1994), 1-4.

82. U. S. Department of the Army, Field Manual 100-15 Corps Operations, (Washington, D. C.: Department of the Army, initial draft 15 July 1994), 1-4 - 1-5.

83. Army Battle Command Master Plan 1994, (Ft. Monroe, VA: Training and Doctrine Command, 19 Sep 94) A-7.

84. Army Battle Command Master Plan 1994, (Ft. Monroe, VA: Training and Doctrine Command, 19 Sep 94). This is a synthesis of this document's depiction of present systems as well as how they are to evolve from present time to 2010.

85. U. S. Department of the Army, Field Manual 24-1 Signal Support in the Airland Battle, (Washington, D. C.: Government Printing Office, October 1990), 2-12.

86. Center for Army Lessons Learned On-line Database, (Ft. Gordon, GA: 1995). The entry titled, "Communications Support for the JTF Headquarters," was a Desert Storm entry which speaks to deficiencies in numbers of equipment necessary for ARFOR and service component functions and the need to get augmentation up front for future contingencies. Another entry titled, "JTF J6/SYSCON/BATCON" was a disaster relief mission which also talks about the undermanning for dual hat missions. Finally, another Desert Storm entry titled, "Standardization of System/Circuit Designator," outlines the difficulty connecting into other services's systems and the reliance on liaison communications teams to achieve interoperability.

87. AFM 1-1 Basic Aerospace Doctrine of the United States Air Force Volume I, (Washington, DC: Department of the Air Force, March 1992), 8.

88. JFACC Primer, (Washington, DC: Department of the Air Force, February 1994), 12. While this publication acknowledges that the JFC designates who is to be the JFACC, the discussion on this page is how Army, Navy, and Marine aviation is incorporated into the JFACC and ATO process. This implies that the JFACC is provided by the Air Force via its component command. Much of the same types of discussion is also found in AFM 1-1 volumes one and two.

89. JCS Pub 1 Joint Warfare of the US Armed Forces, (Washington, DC: Joint Chiefs of Staff, 11 November 1991), 37.

90. AFM 1-1 Basic Aerospace Doctrine of the United States Air Force Volume I, (Washington, DC: Department of the Air Force, March 1992), 5. This paragraph is a synthesis of this portion of this doctrinal manual.

91. AFM 1-1 Basic Aerospace Doctrine of the United States Air Force Volume I, (Washington, DC: Department of the Air Force, March 1992), 6.

92. James A. Winnefeld and Dana J. Johnson, Joint Air Operations Pursuit of Unity in Command and Control 1942-1991, (Annapolis, MD: Naval Institute Press, 1993 by RAND), 106.

93. James A. Winnefeld and Dana J. Johnson, Joint Air Operations Pursuit of Unity in Command and Control 1942-1991, (Annapolis, MD: Naval Institute Press, 1993 by RAND), 106.

94. Center for Army Lessons Learned On-line Database, Ft. Gordon, GA: 1995. There are multiple entries which call attention to joint interoperability problems and stovepiping with component reliant on liaison communications teams. One excellent example is titled, "Joint Communications Control Center (JCCC) Organization," which states, "Inter-component systems were controlled as case by case problem resolution...[and] was managed by each component's impression of its own priorities. The JTF was very concerned with the "push to talk" nets, but showed little interest in inter-component multi-channel systems and circuits. . ." Since the multi-channel systems are the major telephone networks for tactical forces, liaison teams (called LNOs) were the predominate fix.

95. James A. Winnefeld and Dana J. Johnson, Joint Air Operations Pursuit of Unity in Command and Control 1942-1991, (Annapolis, MD: Naval Institute Press, 1993 by RAND), 170.

96. JFACC Primer, (Washington, DC: Department of the Air Force, February 1994), 51 - 52.

97. James A. Winnefeld, James A. and Dana J. Johnson, Joint Air Operations Pursuit of Unity in Command and Control 1942-1991, (Annapolis, MD: Naval Institute Press, 1993 by RAND), 130.

98. John Williamson, ed., Jane's Military Communications 1991 - 1992 (London: Butler and Tanner LTD, December 19910, 346.

99. John Williamson, ed., Jane's Military Communications 1991 - 1992, (London: Butler and Tanner LTD, December 1991), 781.

100. United States Marine Corps Concepts and Issues 1994: Taking the Corps Into the 21st Century, (Washington, DC: Headquarters Marine Corps Programs and Resources Department, 1994), vi.

101. United States Marine Corps Concepts and Issues 1994: Taking the Corps Into the 21st Century, (Washington, DC: Headquarters Marine Corps Programs and Resources Department, 1994), A-6.

102. B. S. Blankenship, K. R. Chambers, D. M. Ross, and D. S. Rowe, "Can the Marine Corps Support the Marine Component Command and Commander of a Joint Task Force?" (Paper submitted at the Communications Officer School, Quantico, VA: April 8, 1991), 7-15.

103. FMFM 1-2 The Role of the Marine Corps in the National Defense, (Washington, DC: Department of the Navy, 21 June 1991), 3-11.

104. FMFM 1-2 The Role of the Marine Corps in the National Defense, (Washington, DC: Department of the Navy, 21 June 1991), 3-11.

105. AFSC Pub 2 Service Warfighting Philosophy and Synchronization of Joint Forces, (Norfolk, VA: Armed Forces Staff College,
August 1992), I-2-7.

106. Interview by author with Major Daniel J. Schuster, USMC, on February 27, 1995.

107. United States Marine Corps Concepts and Issues 1994: Taking the Corps Into the 21st Century, (Washington, DC: Headquarters Marine Corps Programs and Resources Department, 1994), A-4.

108. FMFM 1-2 The Role of the Marine Corps in the National Defense, (Washington, DC: Department of the Navy, 21 June 1991), 3-18.

109. AFSC Pub 2 Service Warfighting Philosophy and Synchronization of Joint Forces, (Norfolk, VA: Armed Forces Staff College,
August 1992), I-2-7.

110. Blankenship, B. S., K. R. Chambers, D. M. Ross, and D. S. Rowe, "Can the Marine Corps Support the Marine Component and Commander of the Joint Task Force?" paper submitted at the Communications Officers School, (Quantico, VA: April 8, 1991), 7-8.

111. Peter Rackham, ed., Jane's C3I Systems 1991 - 1992, (London: Butler and Tanner LTD, December 1991), 750.

112. Force 2001 A Program Guide to the United States Navy, (Washington, DC: Deputy Chief of Naval Operations/ Resources, Warfare Requirements and Assessment (N8), 1994), 104.

113. United States Marine Corps Concepts and Issues 1994: Taking the Corps Into the 21st Century, (Washington, DC: Headquarters Marine Corps Programs and Resources Department, 1994), 4-3.

114. AFSC Pub 2 Service Warfighting Philosophy and Synchronization of Joint Forces, (Norfolk, VA: Armed Forces Staff College, August 1992), I-1-10.

115. AFSC Pub 2 Service Warfighting Philosophy and Synchronization of Joint Forces, (Norfolk, VA: Armed Forces Staff College, August 1992), I-1-11. The depiction and explanation within this paragraph is a synthesis of this chapter with specific information on each major subordinate command on the page listed above.

116. Williamson, John, ed., Jane's Military Communications 1991 - 1992, (London: Butler and Tanner LTD, December 19910, 759.

117. Williamson, John, ed., Jane's Military Communications 1991 - 1992, (London: Butler and Tanner LTD, December 1991), 759.

118. Force 2001 A Program Guide to the United States Navy, (Washington, DC: Deputy Chief of Naval Operations/ Resources, Warfare Requirements and Assessment (N8), 1994), 105.

119. Peter Rackham, Jane's C3I Systems 1991 - 1992, (London: Butler and Tanner LTD, December 1991), 82 -109 and 245 - 282.

120. Jeffrey McManus, "Develop a Joint Data Link," Proceedings vol. 121 (January 1995): 65. The author writes, "Navy systems integrate well when operating with other Navy units, but the Navy has had little operating experience in a joint, integrated. . .network."

121. Kevin E. Pollock, "Desert Storm Taught Us Something," Proceedings vol. 121 (January 1995): 69.

122. W. Gordon Welchman, "Ideas on the Future of JTIDS," 1980; quoted in John H. Cushman, Thoughts for Joint Commanders, (Annapolis, MD: Whitmore Printing, April 1993), 41.

123. JCS Pub 5-00.2 Joint Task Force Planning Guidance and Procedures, (Washington, DC: Joint Chiefs of Staff, September 1991), II-6.

124. JCS Pub 5-00.2 Joint Task Force Planning Guidance and Procedures, (Washington, DC: Joint Chiefs of Staff, September 1991), IV-2.

125. John H. Cushman, Thoughts for a Joint Commander, (Annapolis, MD: Whitmore Printing, August 1993), 42.

BIBLIOGRAPHY:

Books

Adkin, Mark. Urgent Fury. Lexington, MA: Lexington Books, 1989.

Allard, C. Kenneth. Command and Control and the Common Defense. New Haven, CN: Yale University, 1990.

Barnaby, Frank. The Automated Battlefield. London: Sidgwick and Jackson, 1986.

Beaumont, Roger. The Nerves of War. Washington, DC: AFCEA International Press, 1986.

Blair, John D. and James G. Hunt, ed. Leadership on the Future Battlefield. Washington, DC: Pergamon-Brassey's International Defence Publishers, 1985.

Boyes, Jon L. and Stephan J. Andriole, ed. Principles of Command and Control. Washington, DC: AFCEA International Press, 1987.

Campen, Alan D. ed. The First Information War: The Story of Communications, Computers, and Intelligence Systems in the Persian Gulf War. Fairfax, Va: AFCEA International Press, 1992.

Cardwell, Thomas A. Command Structure for Theater Warfare. Maxwell AFB: Air University Press, 1984.

Cimbala, Stephan J., ed. Soviet C3. Washington, DC: AFCEA International Press, 1987.

Coakley, Thomas P. Command and Control for War and Peace. Washington, DC: National Defense University, 1992.

C3I Handbook, Edition Three. Paolo Alto: Defense Electronics, 1988.

Cooper, Matthew. The German Army 1933-1945. Chelsea, MI: Scarborough House Publishers, 1978.

Cunningham, Ann Marie and Mariana Fitzpatrick. Future Fire: Weapons for the Apocalypse. New York: Warner Books, 1983.

Cushman, John H. Command and Control of Theater Forces: Adequacy. Washington, DC: AFCEA International Press, 1991.

Cushman, John H. Command and Control of Theater Forces: The Korea Command and Other Cases. Cambridge: Harvard University Program on Information Resources Policy, 1986.

Dixon, James H. Military Planning and Operations: The Joint Perspective. Washington, DC: National Defense University, 1985.

Gabriel, Richard A. Military Incompetence. New York: Hill and Wang, 1985.

Gilmore, William C. The Grenada Intervention. New York: Facts on File Publications, 1984.

Johnson, Stuart and Alexander Levis, ed. Science of Command and Control: Coping with Complexity. Washington, DC: AFCEA International Press, 1989.

Johnson, Stuart and Alexander Levis, ed. Science of Command and Control: Coping with Uncertainty. Washington, DC: AFCEA International Press, 1988.

Keegan, John. Mask of Command. New York: Penguin Books, 1987.

Luttwak, Edward N. The Pentagon and the Art of War: A Question of Military Reform. New York: Simon and Schuster, 1984.

Macksey, Kenneth. For Want of a Nail. London: Brassey's, 1990.

Macksey, Kenneth. Technology in War. New York: Prentice Hall Press, 1986.

March, James G., ed. Ambiguity and Command. New York: Harper Collins Publisher, 1986.

Maurer, Martha. Coalition Command and Control. Washington, DC: National Defense University, 1994.

McKnight, Clarence, ed. Control of Joint Forces: A New Perspective. Fairfax: AFCEA International Press, 1989.

Phillips, Thomas R., Roots of Strategy. Vol. 1, The Art of War, by Sun Tzu, trans Lionel Giles. Harrisburg, PA: Stackpole Books, 1985.

Rackham, Peter, ed. Jane's C3I Systems 1991 - 1992. London: Butler and Tanner LTD., 1991.

Raines, Edgar F. Jr. and David R. Campbell. The Army and the Joint Chiefs of Staff: Evolution of Army Ideas on the Command, Control, and Coordination of the US Armed Forces, 1942 - 1985. Washington, DC: Government Printing Office, 1985.

Rice, M. A. and A. J. Sammes. Communications and Information Systems for Battlefield Command and Control. New York: Maxwell-Pergamon Publishing, 1989.

Scales, Robert H. Certain Victory: The U. S. Army in the Gulf War. Leavenworth, KS: Selected Reprint, U. S. Army Command and General Staff College Press, 1994.

Toffler, Alvin and Heidi. War and Anti-War. New York: Little, Brown, and Company, 1993.

Von Clausewitz, Carl. On War. Ed. and trans. Michael Howard and Peter Paret, Princeton, N.J.: Princeton University Press, 1976.

Van Creveld, Martin. Command in War. Cambridge: Harvard University Press, 1985.

Van Creveld, Martin. Technology and War. New York: Macmillan, 1989.

Williamson, John, ed. Jane's Military Communications 1991 - 1992. London: Butler and Tanner LTD, December 1991.

Winnefeld, James A. and Dana Johnson. Joint Air Operations. Annapolis, MD: Naval Institute Press, 1993.

Manuals

U. S. Armed Forces Staff College Publication 1. The Joint Staff Officer's Guide 1993. Washington, DC: Government Printing Office, 1993.

U. S. Armed Forces Staff College Publication 2. Service Warfighting Philosophy and Synchronization of Joint Forces. Washington, DC: Government Printing Office, August 1992.

U. S. Department of the Air Force. AFM 1-1 Basic Aerospace Doctrine of the United States Air Force Volume I. Washington, DC: Government Printing Office, March 1992.

U. S. Department of the Army. Field Manual 11-38 MSE System Management and Control. Washington, DC: Government Printing Office, 4 April 1991.

U. S. Department of the Army. Field Manual 11-45 Signal Support: Echelons Above Corps. Washington, DC: Government Printing Office, September 1992.

U. S. Department of the Army. Field Manual 24-1 Signal Support in the Airland Battle. Washington, D. C.: Government Printing Office, October 1990.

U. S. Department of the Army. Field Manual 24-12 Communications in a "Come-As-You-Are" War. Washington, DC: Government Printing Office, 17 July 1990.

U. S. Department of the Army. Field Manual 24-24 Communications-Electronics Management System. Washington, DC: Government Printing Office, 30 June 1977.

U. S. Department of the Army. Field Manual 100-5 Operations. Washington, D. C.: Government Printing Office, June 1993.

U. S. Department of the Army. Field Manual 100-15 Corps Operations. Washington, D. C.: Department of the Army, September 1989.

U. S. Department of the Army. Field Manual 101-5 Staff Organization and Operations. Washington, D. C.: Governement Printing Office, 25 May 1984.

U. S. Department of Defense. Joint Publication 1 Joint Warfare of the US Armed Forces. Washington, DC: Government Printing Office, 11 November 1991.

U. S. Department of Defense. Joint Pub 0-2 Unified Action Armed Forces (UNAAF). Washington, DC: Government Printing Office, 11 August 1994.

U. S. Department of Defense. JCS Pub 3-0 Doctrine for Joint Operations. Washington, DC: Government Printing Office, 9 September 1993.

U. S. Department of Defense. JCS Pub 3-56 Command and Control Doctrine for Joint Operations. Washington, DC: Government Printing Office, September 1992.

U. S. Department of Defense. Joint Publication 5-00.2 Joint Task Force Planning Guidance and Procedures. Washington, DC: Government Printing Office, 3 September 1991.

U. S. Department of Defense. JCS Pub 6 Doctrine for Command, Control, Communications and Computer (C4) Systems Support to Joint Operations. Washington, DC: Government Printing Office, 3 June 1992.

U. S. Department of Defense. JCS Pub 6-05.1 Employment of Joint Tactical Communications Systems. Washington, DC: Government Printing Office, 24 April 1992.

U. S. Department of the Navy. Fleet Marine Force Manual 1-2 The Role of the Marine Corps in the National Defense. Washington, DC: Government Printing Office, 21 June 1991.

Articles, Memorandums, and Pamphlets

Ackerman, Robert K., "Bytes Transform Army, Turn Service Roles Upside Down," Signal, vol 48, no. 9, (May 1994): 21-20.

Battle Command. Ft. Leavenworth, KS: Battle Command Battle Labs, 22 April 1994.

Binder, L. James. "Grenada Post-Mortem: A 'Report' That Wasn't." In Army Magazine, June 1984, pp. 12-16.

Bolger, Daniel P. "Operation Urgent Fury and Its Crtics." In Military Review, July 1986, pp. 57-69.

Bolger, Daniel P. "Special Operations and the Grenada Campaign." In Parameters, December 1988, pp. 49-61.

Boyd, Morris J. and Michael Woodgerd. "Force XXI Operations." In Military Review, November 1994, pp. 17-28.

C4I for the Warrior, Washington, DC: Government Printing Office, June 12, 1993.

Cushman, John H. Thoughts for Joint Commanders. Annapolis, MD: Whitmore Printing, April 1993.

Decisive Victory: America's Power Projection Army, Washington, DC: Government Printing Office, October 1994.

Force 2001 A Program Guide to the United States Navy. Washington, DC: Deputy Chief of Naval Operations/ Resources,Warfare Requirements and Assessment (N8), 1994.

Franks, Fredrick M. Jr., Battle Labs, Fort Monroe: Training and Doctrine Command Publication, 1994.

Jaffe, Lorna. The Development of the Base Force 1989 - 1992. Washingon, DC: The Joint History Office, July 1993.

JFACC Primer. Washington, DC: Department of the Air Force, February 1994.

Joint Military Operations: DOD's Renewed Emphasis on Interoperability Is Important but Not Adequate. Washington, DC: General Accounting Office, October 21, 1993.

Kahan, James p., Cathleen Stasz, and D. Robert Worley. Understanding Commanders' Information Needs. Santa Monica, CA: RAND, June 1989.

Madigan, James C. and George E. Dodge. "Battle Command: A Force XXI Imperative," in Military Review, November 1994, pp. 29-39.

Memorandum of Policy (MOP) Number 30 Command and Control Warfare. Washington, DC: Joint Chiefs of Staff, 8 March 1993.

Memorandum of Policy (MOP) Number 37 Military Satellite Communications Systems. Washington, DC: Joint Chiefs of Staff, 14 May 1992.

Spector, Ronald H. US Marines in Grenada 1983. Washington, DC: History and Museams Division, HQ US Marine Corps, 1987.

Sullivan, Gordon R., and James M. Dubik, "Land Warfare in the 21st Century," Military Review, (September 1993): 13-32.

Sullivan, Gordon R., "America's Army-Focusing on the Future," Army: The Green Book 1994-5, vol. 44, no. 10 (October 1994): 19-29.

TRADOC Pamphlet 525-5 Force XXI Operations, Ft. Monroe, VA: Training and Doctrine Command, 1 August 1994.

United States Marine Corps Concepts and Issues 1994: Taking the Corps Into the 21st Century. Washington, DC: Headquarters Marine Corps Programs and Resources Department, 1994.

Wilson, George C. and Michael Weisskopf. "Pentagon, Congress seek Cure to Shortcomings Exposed in Grenada Invasion." In Washington Post, 20 February 1984, p. A24.

Databases, Dissertations, Interviews, Lectures, Papers, and Reports

Army Battle Command Master Plan 1994. Ft. Monroe, VA: Training and Doctrine Command, 19 Sep 94.

Battlefield Architectures 1994-1999-2010 (Brigade-Corps). Ft. Leavenworth, KS: Combined Arms Command, 1 May 1994.

Army Battle Command Master Plan 1994. Ft. Monroe, VA: Training and Doctrine Command, 19 Sep 94.

Bingham, Richard. CECOM and the War For Kuwait: August 1990 - March 1991. Ft. Monmouth, NJ: U. S. Army Communications-Electronics Command, May 1994.

Blank, Stephan J. The Soviet Military Views Operation Desert Storm: A Preliminary Assessment. Carlisle: Strategic Studies Institute U. S. Army War College, 23 September 1991.

Blankenship, B. S., K. R. Chambers, D. M. Ross, and D. S. Rowe. "Can the Marine Corps Support the Marine Component and Commander of the Joint Task Force?" Paper submitted at the Communications Officers School, Quantico, VA: April 8, 1991.

Bradley, Thomas. The Use of Air Power in Joint Maritime Operations. Maxwell AFB, Air University Press, August 1985.

United States Army Center for Lessons Learned (CALL). Fort Gordon: GA, retrieved 11 February 1995.

United States Army Center for Lessons Learned (CALL). Fort Leavenworth: KS, retrieved 18 February 1995.

CSA Message: Building the Force for the 21st Century, Force XXI. 081145z Mar 94.

Communications Acquisition Army Still Needs to Determine Battlefield Communications Capability. Washington, D.C.: General Accounting Office, November 1992.

Cushman, John H. Organization and Operational Employment of Air/Land Forces. Carlisle Barracks, PA: US Army War College, 1984.

Daniels, Gerald. Lecture and unclassified briefing slides provided by Major Gerald Daniels, United States Army Signal Corps Officer and former operations officer for the JCSE, February 1994.

Davis, Richard. "Battlefield Automation. Army Command and Control Systems Acquisition Cost and Schedule Changes," Fact Sheet for the Chairman, Subcommittee on Defense, Committee on Appropriations, House of Representatives. Washington, DC: General Accounting Office, December 9, 1987.

Grenada Documents: An Overview and Selection. Washington, DC: Releases of Department of State and Department of Defense, 1984.

Howard, Micheal. Chesney Memorial Gold Medal Lecture. Given on 3rd October 1973.

Interoperability DOD's Efforts to Achieve Interoperability Among C3 Systems. Washington, D.C.: General Accounting Office, 1987.

Joint Military Operations DOD's Renewed Emphasis on Interoperability Is Important but Not Adequate. Washington, DC: General Accounting Office, October 1993.

Joint Tactical Command, Control, and Communications Agency Desert Shield Desert Storm Lessons Learned Report. Ft. Huachucha: Joint Interoperability Test Center, March 1991.

McKiernan, David D. Command, Control, and Communications at the VII Corps Tactical Command Post: Operation Desert Shield/Desert Storm. Carlisle: Army War College, 1992.

Military Satellite Communications Opportunity to Save Billions of Dollars. Washington, D.C.: General Accounting Office, July 1993.

Schuster, Daniel. Interview by author with Major Daniel J. Schuster, USMC, on February 27, 1995.

Sessions, Sterling D. and Carl R. Jones. "Interoperability: A Desert Storm Case Study," McNair Paper Eighteen. Washington, DC: National Defense University, August 4, 1993.

TRADOC Pamphlet 525-5 Force XXI Operations. Ft. Monroe, VA: Training and Doctrine Command, 1 August 1994.