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AN INDEPENDENT EVALUATION OF
INFORMATION SYSTEMS SUPPORT OF THE
JOINT FORCES AIR COMPONENT COMMANDER
CONCEPT OF OPERATIONS

THESIS

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AFIT/GSM/LAR/93S-12

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**AN INDEPENDENT EVALUATION OF INFORMATION SYSTEMS
SUPPORT OF THE
JOINT FORCES AIR COMPONENT COMMANDER CONCEPT OF OPERATIONS
THESIS**

**Presented to the Faculty of the School of Logistics and Acquisition Management
of the Air Force Institute of Technology
Air University
In Partial Fulfillment of the
Requirements for the Degree of
Master of Science in Systems Management**

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September 1993

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Preface

Information systems have become an essential part of most military missions, particularly those involving planning or command and control. In his book *Twilight of Sovereignty*, former Citicorp chairman Walter Wriston argues that we have entered a new revolution, one as powerful as the industrial revolution of the turn of the century: the information revolution. Wriston describes the transformation of modern society as a result of global communication and the increases in computing power experienced in the last 40 years. This transformation has occurred within the military as well, and has not gone unnoticed: "As the sun of the Information Age moves steadily toward apogee, new information-technology applications will spin off to ensure that America's fighting forces maintain the edge so proudly demonstrated in Desert Storm (Powell, 1992:370)." In the Overview section of the Department of Defense Conduct of the Persian Gulf War Report, then Secretary of Defense Dick Cheney made the following observations concerning this revolution: "In a large part this revolution tracks the development of new technologies such as the microprocessing of information that has become familiar in our daily lives. The exploitation of these and still emerging technologies promises to change the nature of warfare significantly, as did the earlier advent of tanks, airplanes, and aircraft carriers (Department of Defense, 1992:xii)."

This thesis focuses on a small, specific portion of this revolution: the use of information systems to support command and control of tactical air assets in joint warfighting environments. This environment has recently changed with the creation of a Joint Forces Air Component Commander, or JFACC, who is responsible for the control and coordination of combat air power. The JFACC concept, as it is called, is designed to eliminate the historical problem of fragmented air operations, which

reduce the effectiveness of airpower. The JFACC concept was first implemented in Operation Desert Storm, and information systems support proved to be a problem area. This qualitative thesis reviews those problems and plans to overcome them and makes specific recommendations on how to improve the support the JFACC receives through use of information systems.

In undertaking this effort, we had the extreme good fortune of having Captains Michael Shoukat and Michael Morabito as our thesis advisors. Their steadfast commitment to quality and completeness guided our efforts and ensured we obtained the most from the thesis and, more importantly, the research process. Several agencies provided information essential to our review. Specifically, we would like to thank Lieutenant Colonel Al Whitley from the Joint Chiefs of Staff/J6J office, Major John Jernovics from the Defense Information Systems Agency, and the Air Combat Command/DRCF office for their invaluable assistance.

A special acknowledgement belongs to my wife, Holly, whom I love dearly. She spent endless hours editing, proofreading, and formatting this thesis, becoming a third member of our team. Her professionalism and dedication are an essential part of our work.

Finally, Rick and I want to thank our families for all their help, support, and patience. We couldn't have done it without them.

Gregory R. Kincaid

Richard A. Poligala

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ABSTRACT

This study examines automated Air Tasking Order (ATO) generation and dissemination under the Joint Forces Air Component Commander (JFACC) concept, focusing on an evaluation of information systems support given the differing service philosophies concerning control of tactical air assets. Current Department of Defense doctrine identifies the Contingency Tactical Air Control System Automated Planning System (CTAPS) as the standard automated system to execute Theater Battle Management (TBM) planning, intelligence, and other operational functions to support the JFACC. To achieve service interoperability, the doctrine requires the use of CTAPS for ATO generation and dissemination when joint operations are conducted under the JFACC concept. A problem arises in that CTAPS is developed under the Air Force's philosophy of centralized control and decentralized execution, a philosophy very different from the Navy's decentralized management concept. The study evaluates the current CTAPS development principles in light of the differing Service philosophies. The results of this research indicate that in order to improve information systems support for the JFACC, efforts should be made to increase joint involvement in CTAPS configuration management, increase Army, Navy, and Marine Corp exposure to the automated ATO process during training and exercises, and streamline the user feedback process as a mechanism to incorporate lessons learned from joint CTAPS utilization.

AN INDEPENDENT EVALUATION OF INFORMATION SYSTEMS
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I. Introduction

General Issue

The Persian Gulf War was the first conflict to address the historic problem of fragmented air operations through use of the Joint Forces Air Component Command (JFACC) concept:

Although this concept had been used as early as World War II, Operation Desert Storm was the first regional conflict in which the JFACC was established formally. The concept proved its value; JFACC planned, coordinated, and based on CINCCENT's [Commander in Chief, Central Command] apportionment decision, allocated, and tasked the efforts of more than 2,700 Coalition aircraft, representing 14 separate national and Service components. He integrated operations into a unified and focused 43-day campaign using the master attack plan (MAP) and the air tasking order (ATO) process, which provided the necessary details to execute the attack. (Department of Defense, 1992:136)

In Desert Storm, the CINCCENT assigned the CENTAF (Central Command Air Forces) commander as the JFACC, thus making him responsible for planning and coordinating the air campaign.

In establishing the Operation Desert Shield command structure, joint procedures and doctrine provided a basis for integration of US forces. While each service provided forces to CENTCOM [Central Command], CINCCENT commanded and decided how to organize them. He organized US forces using both Service components (similar to the peacetime organizational structure) and a Joint Force Air Component Commander (JFACC) to integrate and coordinate combat power. (Department of Defense, 1992:K-5)

The JFACC concept was developed following the Goldwater-Nichols Act of 1986 to provide a joint command and control structure to facilitate joint air operations. The

official definition of the JFACC concept is found in JCS Publication 1-02, The Dictionary of Military and Associated Terms, which describes the JFACC as follows:

The Joint Forces Air Component Commander derives his authority from the Joint Force Commander who has authority to exercise operational control, assign missions, direct coordination among his subordinate commanders, redirect and organize his forces to ensure unity of effort in the accomplishment of his overall mission. The Joint Force Commander will normally designate a Joint Force Air Component Commander. The Joint Force Air Component Commander's responsibilities will be assigned by the Joint Force Commander (normally these would include, but not be limited to, planning, coordination, allocation, and tasking based on the Joint Forces Commander's apportionment decision). Using the Joint Force Commander's guidance and authority, and in coordination with other service component commanders and other assigned or supporting commanders, the Joint Force Air Component Commander will recommend to the Joint Force Commander apportionment of air sorties to various missions or geographic areas. (Joint Chiefs of Staff, 1989:197)

Key Points of the JFACC Concept

According to Lobdell, four key points are derived from the JFACC definition:

1. The JFACC derives his authority from the Joint Forces Commander.
2. The Joint Forces Commander should provide guidance for force apportionment to the JFACC.
3. The JFACC will normally conduct planning, coordination, allocation, and tasking.
4. The JFACC is required to coordinate with other component, service, and supporting commanders (Lobdell, 1992:5).

While the first two key points address the authority base of the JFACC, key points 3 and 4 are more operational in nature. Currently, a great portion of the planning, allocation, tasking, and coordinating functions associated with air combat mission planning are accomplished with the assistance of automated systems designed

for these purposes. During Operation Desert Storm, the chief air war planner, Major General Buster Glosson, highlighted this trend towards automation: "...without the air of computer mission planning, you won't have the capacity to take advantage of the capabilities the taxpayer paid for. You must have the aid of computer mission planning (Capaccio, 1991:3)."

In addition to the trend towards automation, there is a reliance on automation to meet heavy planning workloads which occur when exploiting an air advantage: "In Desert Storm, because we had air supremacy, mission planners wanted to exploit our air capability. This translated into a high sortie generation rate. (We) turned to automation to meet this planning workload (Whitley, 1993)." Additionally, because of the complexity and scope of planning and coordinating an air campaign, the military has naturally pursued automation to improve the process: "Management systems, such as those which support deployment and logistics, must be automated with this need for flexibility in mind (Department of Defense, 1992:xiii)." Finally, there is increasing support to expand the role automation plays in mission planning.

The money invested in advanced intelligence and mission-planning systems is proving to be well spent. The growth potential in the systems for intelligence data management, threat and target analysis, mission planning, and campaign planning will keep operational intelligence people busy for some time to come. We must continue to stay on the edge of this exciting technology. (Brigadier General Downer, 1991:21)

Specific Problem

It cannot be assumed that increasing the use of information systems is inherently compatible with joint mission planning or execution. As identified in the Department of Defense Report on the conduct of the Persian Gulf War: "There is a need for a comprehensive joint architecture from which supporting communications

architecture can be built and interoperability issues resolved (Department of Defense, 1992:K50)." The system designated to automate the ATO generation and dissemination process under the JFACC concept is CTAPS, as outlined in the following extract from the Joint Chiefs of Staff (JCS) J6J office to the Chairman, JCS, issued on 15 April 1992:

Both Ocean Venture and Tandem Thrust will exercise the JFACC concept. In both exercises, CTAPS is reported to be the JFACC planning and distribution system. I fully agree and have been pushing to have CTAPS accepted as the JFACC system regardless of which component is assigned as JFACC. TAC [Tactical Air Command] is working diligently to get interoperability of CTAPS with Service unique command and control systems such as the Army's ATACCS and the Navy's Navy Tactical Command System - Afloat (NCTS-A). (Joint Chiefs of Staff/J6, 1992:1)

A problem arises in that CTAPS has been designed for the Air Force's centralized management philosophy of tactical air assets, while the JFACC can be designated from any of the Services, which have very different management philosophies. The purpose of this research is to assess strategic plans for information systems support necessary to effectively manage air assets under the JFACC concept. As part of this assessment, the Services' differing philosophies regarding command and control of tactical air assets and their impact on the JFACC concept and supporting information system design are addressed. Four specific assumptions will be made as part of this evaluation. First, there will be a situation or campaign in which the Joint Forces Commander (JFC) will employ the JFACC concept to manage air assets. This was the case in Operation Desert Storm. Second, the JFACC can be designated from any branch of service and can employ that branch's management philosophy for command and control of tactical air assets. Third, if the requirement arises for a large number of sorties, planning and execution will be achieved through the use of automated mission

planning systems. Finally, there is only one information system currently capable of generating and disseminating ATOs under the JFACC concept, the Air Force's Contingency Tactical Air Control System Automated Planning System (CTAPS).

Scope

The specific focus of the research is on the force management aspect of air asset mission planning--the Air Tasking Order process. While the JFACC concept involves the full spectrum of theater battle management, this thesis concentrates on the use of automated planning systems for force management of air assets as they support the JFACC and joint doctrine in a wartime environment. The specific scope of the research is the use of information systems at the JFACC level for force management. Other related areas are not excluded but are discussed in context with force management. The scope does not include mission planning at wing or unit level. Likewise, force management of Allied units under the JFACC concept is not addressed.

Definition of Terms

In this research, information systems are defined to include computer hardware and software used by the Department of Defense to support theater battle management (TBM) planning, intelligence, and operational functions. One of the more broadly used terms relating to the JFACC concept is that of interoperability. Interoperability is defined to be the ability to function effectively with dissimilar entities or segregated units (McConnell, 1988:10). Within the JFACC concept, it is the extent to which Army, Navy, Air Force, and Marine Corps air assets can be coordinated, scheduled,

allocated, and employed in a joint air campaign. Interoperability can also be defined at the hardware and software level as the ability of different communications and computer platforms and programs to exchange data. Computer hardware interoperability is achieved through the use of standard, mandated protocols, such as the Government Open Systems Interconnection Protocol (GOSIP) and standard operating systems like the Portable Operation System for Computer Environment (POSIX). The focus of this thesis is interoperability at the process level as opposed to hardware level. Because planning, scheduling, coordinating, and allocating air assets are performed through use of a management information system (MIS), review of interoperability focuses on the ability of an MIS to generate and transfer the necessary information to dissimilar organizations in the context of the JFACC mission.

Within the JFACC concept, two primary planning documents are used to execute the air campaign. They are the Master Attack Plan (MAP) and the Air Tasking Order (ATO). Definitions of these documents and the management information systems used to generate and disseminate them as they were used in the Persian Gulf conflict are provided below:

Master Attack Plan (MAP). The JFACC's intent for the air campaign was set forth in the MAP and the more detailed document derived from it, the ATO [Air Tasking Order]. The MAP was the key JFACC internal planning document which consolidated all inputs into a single, concise plan...MAP preparation reflected a dynamic JFACC process in which strategic decision making was based on objectives, CINCCENT guidance, target priorities, the desired effect on each target, a synthesis of the latest multisource intelligence and analysis, operational factors such as weather, the threat, and the availability and suitability of [air] strike assets...The result was a

relatively compact document (the first day's MAP was only 21 pages) that integrated all attacking elements into force packages and provided strategic coherency and timing to the day's operations. It consisted of the sequence of attacks for a 24-hour period and included the time on target, target number, target description, number and type of weapon systems and supporting systems for each attack package. The MAP drove the process (Department of Defense, 1992:137-138).

Air Tasking Order (ATO). The ATO was the daily schedule that provided the details and guidance aircrews needed to execute the MAP...The ATO was a two part document. The first focused on targeting and mission data and EW/SEAD [Electronic Warfare/Suppression of Enemy Air Defenses] support. The second contained the special instructions on topics such as communications frequencies, tanker and reconnaissance support, Airborne Warning and Control System (AWACS) coverage, combat search and rescue (CSAR) resources, routes into and out of enemy airspace, and many other details (Department of Defense, 1992:138).

Computer Assisted Force Management System (CAFMS). Software which provides planning and mission monitoring assistance for the construction and review of ATO mission schedule generation. CAFMS is the application module within the CTAPS which is used for constructing and reviewing mission schedules, resource monitoring, and summary/status reports generation.

Contingency Theater Air Control System Automated Planning System. The Air Force program to modernize the Tactical Air Control Center through upgraded computer hardware and software. CTAPS consists of several software modules including CAFMS, Airspace Deconfliction System (ADS), Route Evaluation Module (REM), etc., running on high-speed computer workstations and peripherals.

Objectives

There are four main objectives of this research effort:

Research Objective 1: To derive from historical experience, particularly the Persian Gulf War, an evaluation of baseline information systems support of the JFACC and lessons learned as a result.

Research Objective 2: To investigate the differing tactical air asset command and control doctrines found in the U.S. Armed Forces and briefly describe information systems used to support these doctrines.

Research Objective 3: To assess current and conceptual strategic plans for providing information systems support to the JFACC and the JFACC concept of operations in a wartime environment.

Research Objective 4: To provide recommendations to help reduce the impact of differences in philosophies on information systems support for the JFACC and improve overall effectiveness.

Overview of Thesis

The literature review, Chapter II, introduces the reader to the growing importance of information systems support in a wartime environment, primarily as it was experienced in the Persian Gulf War. Additionally, a discussion of joint air employment doctrine and the evolution of the JFACC concept are discussed. Because each Service's command and control doctrine is different, a discussion of the doctrine and methods of air asset planning used by the four Services is also introduced. This is followed by a brief history of CTAPS development. Chapter III describes the qualitative design methodology used for this research.

Chapter IV discusses the results of the research in the context of the research objectives. Finally, Chapter V presents conclusions and recommendations to improve information support of the JFACC concept.

II. Literature Review

Introduction of Topics

This chapter reviews several key philosophies, concepts, and processes essential to the research. The literature review begins with an exploration of the increased use of automation in wartime. Because the differing Service philosophies on air asset control play such a pivotal role to the analysis of Joint Forces Air Component Commander (JFACC) automation support, a historical background on the evolution of these philosophies and the birth of the JFACC concept is provided. Following this analysis, the literature review focuses on the usage of the JFACC concept during the Persian Gulf War. Next, the current air asset command and control doctrines of the Air Force, Navy, Marine Corps, and Army and their supporting command and control automated systems are discussed. Throughout the literature review, the focus will be on the use of information systems to support the JFACC's generation and dissemination of Air Tasking Orders and the impact of the Services' differing command and control doctrines on this support.

Increased Use of Automation in Wartime

The Persian Gulf War was the first major conflict following the end of the Cold War and the first to make extensive use of high-technology weapons. A description of the importance of high-technology weapons was provided by Secretary of Defense Richard Cheney as follows:

A second general lesson of the war is that high-technology systems vastly increased the effectiveness of our forces. This war demonstrated dramatically the new possibilities of what has been called the "military-technological revolution in warfare."...In large part this revolution tracks the development of

new technologies such as the microprocessing of information that has become familiar in our daily lives. The exploitation of these and still emerging technologies promises to change the nature of warfare significantly, as did the earlier advent of tanks, airplanes, and aircraft carriers. (Department of Defense, 1992:xii)

Some of the weapons were being used for the first time (i.e., the Sea Launched Cruise Missile), while for some of the older high-technology weapons (such as precision guided munitions) the war represented their first usage in large quantities.

The majority of pertinent literature focuses on the technology being employed, while the information processing necessary to use the technology was treated as a separate concern, with a recurring theme of lack of information support. In most cases, necessary information was either late, inaccurate, or not properly sized (too little or too much).

When Operation Desert Shield began in early August 1990, communications personnel immediately began to install a complete communications network. The scope of this effort was described in the Department of Defense Gulf War Report:

At the beginning of Operation Desert Shield force deployment, there was essentially no existing US Military command, control, communications, and computer (C4) infrastructure in the region. By mid-January, the Coalition had established the largest tactical C4 network ever assembled. (Department of Defense, 1992:140)

Lieutenant General James S. Cassity, Director of Command, Control, and Computers for the Joint Chiefs of Staff, summed the installation effort succinctly: "The services put more electronic communications connectivity into the Gulf in 90 days than we put in Europe in 40 years (Grier, 1992:20)." It should be noted that the luxury of time enjoyed by Coalition forces while the infrastructure was installed may not be available in future conflicts. This point did not go unnoticed by senior U.S. leaders: "A large part of the effectiveness was due to the luxury of five month's worth

of work-around and training to minimize inherent shortcomings (McPeak, Defense Week, 27 Jan 92)."

In the Persian Gulf War, information technology took on the role of increasing capability, becoming a so-called *force multiplier*.

Battlefield information systems became the ally of the warrior. They did much more than simply provide a service. Personal computers were *force multipliers*. Efficient management of information increased the pace of combat operations, improved decision making, and improved coordination among military units. (Powell, 1992:370)

"The volume of information passed during the height of the conflict exceeded 700,000 phone calls and 152,000 electronic messages per day (Grier, 1992:20)." This provided an unprecedented capability to obtain and utilize important information as quickly as possible. Additionally, it helped reduce the uncertainty normally found in the military planning process. "Automated planning systems were able to significantly reduce the planner's workload and increase tactics development time (Permenter, 1991:12)." Advanced weapons, when combined with appropriate intelligence information, provided a level of accuracy never before available:

Extensive use of precision munitions created a requirement for much more detailed intelligence than had ever existed before. It is no longer enough for intelligence to report that a certain complex of buildings housed parts of the Iraqi nuclear program; targeteers now want to know which part of the building, since they have the capability to strike with great accuracy. (Department of Defense, 1992:xvi)

A good portion of the synergy between information technology and the soldier was not positive in nature, however. In almost every section in the DOD's Gulf War Report where shortcomings were listed, a reference was made to an information processing- related problem. These problems ranged from lack of interoperability between the services to software glitches in the communications equipment. The

normal assumption one would make is that an electronic infrastructure as large as the one installed in the Persian Gulf would be capable of meeting the needs placed upon it. However, this was not the case.

Despite this effort, the start of Operation Desert Storm made it clear the requirement for communications outstripped the capacity. This was especially true for the large amounts of imagery and intelligence data bases that needed to be transmitted throughout the theater. (Department of Defense, 1992:140)

Grier makes the argument that this increase in demand for communications connectivity could be partly attributed to the use of personal computers within the military:

It turned out that many military people had grown accustomed--some would say almost addicted--to their personal computers as a work tool...The theater's logistics report, for example, was a 50-Kilobyte Lotus 1-2-3 spreadsheet drawn up at 22nd Support Command headquarters in Dhahran. The report was zapped electronically to Riyadh for review by top Army commanders. Then it would end its day thousands of miles away in the United States. (Grier, 1992:21)

It is clear that top military officers feel that the use of information technology by the military will increase, particularly in light of decreasing defense budgets:

The sight of a soldier going to war with a rifle in one hand and a laptop computer in the other would have been shocking only a few years ago. Yet that is exactly what was seen in the sands of Saudi Arabia in 1990 and 1991. (Powell, 1992:370)

A downsized force and a shrinking defense budget result in an increased reliance on technology, which must provide the force multiplier required to ensure a viable military deterrent. Increasingly, military requirements are being met by off-the-shelf hardware and software. (Powell, 1992:370)

History of the JFACC Concept and Tactical Aviation Employment Doctrine

Serious consideration of air power employment doctrines and strategies dates back to the end of the World War I when debates concerning centralized or decentralized command structures were argued by Brigadier General Billy Mitchell and

Rear Admiral William A. Moffett:

Famed Army aviator Billy Mitchell insisted on a single air commander to assure unity and concentration of effort. By 1924, the controversy reached a fever pitch as Rear Admiral Moffett presented the Naval Service's argument to the Naval Affairs Committee arguing that "the air personnel of the aircraft and planes should be under the control of the Naval commander at all times to insure their preparation, efficiency, and readiness". (Williams, 1991:3)"

The sinking of the ex-German battleship Ostfriesland by a bomber in a test of aviation power increased the Navy's involvement in aviation; they had three aircraft carriers within a year. While the service's believed in the unity of command, there were very differing positions on how command should be executed. "The Army, and later the Air Force, believed in functional component commanders - air assets under the Air Component Commander, ground forces under the Land Component Commander, and Naval forces under the Naval Component Commander. The Navy felt the division of components should be structured by service type, not function" (Williams, 1991:3).

World War II marked one of the first attempts to integrate air power. General Eisenhower, then Commander-in-Chief Allied Forces Northwest Africa, perceived the need for centralized control to eliminate the Luftwaffe's exploitation of Tunisian airspace; exploitation which was unable to be stopped by independent Royal Air Force and U.S. Army Air Corp operations. In January of 1943, centralized control was established when General Eisenhower ordered all air elements in theater under the command of Air Marshall Tedder--including Naval aviation when operating in the AOR (area of operations). In the Pacific theater, the Navy took the lead and

¹From a statement made by Rear Admiral Moffett before the House Naval Affairs committee, April 8, 1924, p. 8.

functioned mostly as an autonomous force. At the end of World War II, the importance of common direction and unity of air employment was realized:

The unity of airpower was not only sound in theory, but the theory stood the test of battle and proved to be the most effective method for the command and control of airpower in a theater of operations. (Momyer, 1978:44-45)

World War II provided the doctrine for a unified command structure, and it laid the groundwork for a separate air force and the component command structure. (Cardwell, 1984:10)

After World War II came a period of heavy debate over air power and carrier aviation control:

Post World War II saw the enactment of the National Security Act of 1947 and the establishment of the new Department of the Air Force. It was also a time of bitter interservice debate concerning air power and carrier aviation control resulting in the "Revolt of the Admirals." By 1950, divergent paths in the Air Force and navy produced very different patterns in training, equipment, and centralized control mechanisms. (Donovan, 1992:6)

The newly organized Air Force, as a result of previous lessons learned, felt it should control all aviation assets including Naval aviation. The Navy, just as it had done years prior, emphatically refused to accept this concept. (Williams, 1991:4)

The Korean conflict again saw the Commander-in-Chief, General Douglas MacArthur, assigning all air assets under one commander--Far East Air Forces' Lieutenant General George E. Stratemeyer. Command and control problems quickly surfaced:

The Navy kept its small Task Force 77 staff aboard the USS Valley Forge limiting inter-service coordination. Navy Skyraiders and Corsairs launched from the carrier deck to the skies overhead South Korea with little prior coordination between the Air Force and Army operated Joint Operations Center (JOC) and the carrier. The Navy aircraft had to jettison their ordinance wastefully without attacking targets. Messages flew from the JOC to TF77 as the Air Force perceived the Navy had a "go-it-alone" attitude. (Williams, 1991:4)

Lack of coordinated effort between the Navy command and the Air Force and Army Joint Operations Center (JOC) proved costly in terms of men, territory, and supplies. (Donovan, 1992:7)

Incompatibility of communications was vividly demonstrated by an extreme example where a radio message received in 1950 by Task Force 77 took 8000 encrypted groups and over 30 manhours to process for the air plan for one day. (Donovan, 1992:7)

Throughout the Korean conflict, command and control of air assets continued to be a problem. Confusing terms such as coordinated control, which were interpreted differently by the Services (the Navy felt it meant they should coordinate with the Air Force, while the Air Force felt it meant control of all air assets in theater), added to the command and control problem.

The air war in Vietnam had problems similar to the Korean conflict; primarily lack of unity of effort and command and control problems. Four differing air components were operating under two operating command structures. The Air Force, Strategic Air Command (SAC), the U.S. Navy air and the Marine Corp air units conducted independent air operations inside South Vietnam under the control of the Military Assistance Command Vietnam's (MACV's) air component commander, while operations outside South Vietnam were conducted under control of CINCPAC between PACAF and Task Force 77. Geographic areas of responsibility were established as a means of coordinating air power:

Faced with determining coordination or control between the two services, a coordinating committee proposed dividing the country into a series of route packages or geographic areas of responsibility. These geographic boundaries remained in effect until the end of the conflict. This system served to further divide the services as, unlike Korea, now very minimal cooperation between the services was required. (Williams, 1991:5-6)

Late in the war, the Linebacker air operations were executed under the control of a single air component commander with the express goal of improving coordination and control:

During Linebacker operations, Admiral Noel P. Gaylor, Commander-in-Chief

Pacific, agreed that the eventual integration of Navy and Air Force strikes was necessary to improve efficient use of resources and to attain mass application of force. (Williams, 1991:6)

It wasn't until "Linebacker" operations that the Navy agreed in spirit to function under a single air component commander to improve coordination and control of U.S. airpower but by then the war was winding down. (Momyer, 1978:90)

At the end of Vietnam, it was felt that the air war was characterized by "disjointed and inefficient air operations in which the Air Force, Navy, Marine Corps, and the Strategic Air Command conducted four separate wars (Record, 1991:45)."

Between Vietnam and Desert Storm, the U.S. Armed Forces were involved in a series of short-lived operations, such as Urgent Fury in 1983, El Dorado Canyon in 1986, and Just Cause in 1989. During this time, the carrier became the primary instrument of quick military response. Reliance on projection of power from the carrier caused the development of even more autonomous command and control doctrine on the part of the Navy:

Carrier air power became the instrument of choice by every President as the means to show resolve around the globe. As a result, the carrier battle group developed an even more autonomous doctrine which could allow limited power projection ashore while simultaneously defending the force. (Williams, 1991:6)

Naval power and carrier air have been the U.S.'s primary military instrument of response in the last two decades further engraining the autonomous nature of the Navy. (Donovan, 1992:8)

Operation Urgent Fury (the operation to rescue students in Granada) illustrated plainly the lack of ability to conduct joint operations or provide coordinated air support.

Operation Urgent Fury was a success but illustrated that multi-service air coordination was insufficient. Staffs did not have adequate service representation. Communications between Army Forces ashore and Navy Air assets were nonexistent from the start. Preplanning actions were not attended by both Services on either side. The Navy felt the Rangers did not understand Navy tactical air operations. Air Force A-10's with the capability of communicating with the Rangers on the ground were not utilized, though available. (Donovan, 1992:9)

Senator Sam Nunn, chairman of the Senate Armed Services Committee, concluded that "a close look at the Granada operation can only lead to the conclusion that, despite our victory and success, despite the performance of the individuals who fought bravely, the U.S. armed forces have serious problems conducting joint operations (Williams, 1991:7)." As a result, the U.S. Congress emphasized the importance of joint operations and joint doctrine through the Goldwater-Nichols Department of Defense Reorganization Act of 1986 (GNA). The objectives of the GNA were outlined in the Persian Gulf War Report:

The Goldwater-Nichols Department of Defense Reorganization Act of 1986 (GNA) sought to strengthen civilian control and oversight of military operations; improve the military advice provided to civilian authority; establish the Chairman, Joint Chiefs of Staff (CJCS) as the principal military advisor to the National Command Authorities; and place clear responsibility on combatant commanders while ensuring the Commanders-in-Chief's (CINC) authority was commensurate with their responsibilities...GNA clarified the chain of command and the lines of communication, from the President and Secretary of Defense, through the CJCS, to CINCCENT [Commander in Chief, Central Command]. (Department of Defense, 1992:K-4)

This act led to the development of a series of joint publications emphasizing unity of operations and joint command and control and the organization of the command structure along functional lines (Donovan, 1992:10). Command and control of airpower assets under a unified commander was specified in Joint Chiefs of Staff (JCS) Publication 3-01.2, which created the JFACC concept.

The JFACC Concept

The first test of the JFACC concept occurred during the Persian Gulf War. "While the JFACC concept had been discussed for several years, this [Operation Desert Shield/Desert Storm] was the first time it was used in a major regional conflict

(Department of Defense, 1992:K-13)." The CINCCENT designated the Central Command Air Forces Commander (CENTAF) as the JFACC. As such, the JFACC was assigned the responsibility for coordinating all Coalition air forces and obtaining unity of air operations. To do this, the JFACC relied on the Master Attack Plan (MAP), which was the key internal planning document, and its detailed execution order, the Air Tasking Order (Department of Defense, 1992: 136).

CINCCENT also designated CENTAF as the JFACC, with responsibility for coordinating all Coalition air forces to ensure focus of effort in the air campaign. The JFACC planned, coordinated, allocated, and tasked apportioned air sorties in coordination with other Service component commanders. The JFACC integrated area air defenses as the Area Air Defense Commander. The commander, CENTAF, also designated as the Airspace Control Authority, managed theater airspace requirements. The JFACC, in Riyadh, used a daily Master Attack Plan and Air Tasking order (ATO) to carry out his responsibilities. The same mechanism served as the basis for the JFACC's pre-offensive air campaign planning. Normally transmitted at immediate precedence, the daily ATO still required hours to arrive at the hundreds of addressees. As a result, couriers often were used to deliver the ATO on diskettes. (Department of Defense, 1992:K-13)

In Operation Desert Storm, the JFACC relied on CAFMS to generate and disseminate ATOs. "In the conduct of JFACC operations, Lieutenant General Horner utilized the joint ATO system to centrally control and integrate the air operations of seven different countries with over 2500 fixed and rotary wing aircraft (Lobdell, 1992:18)." This caused some much publicized problems in tasking Navy air assets, since the Navy did not possess the necessary communications or hardware components to receive the ATO.

The lateness of ATO arrival had a definite negative impact on Naval air operations: "Strike leaders were getting the verified tanker tracks, times, and frequency plans only a few hours before having to brief the pilots (Donovan, 1992:17). " Additionally, once the ATO was received, Navy units had difficulty interpreting the

information and operating instructions:

The ATO format was also a difficult translating process because the Navy rarely practiced it. The proficiency of the Red Sea Battle Force at reading the ATO was a direct result of the time we had to study the format and develop a team that could quickly glean the necessary information from the hundreds of pages. (Donovan, 1992:17)

The Red Sea battle force, consisting exclusively of Atlantic fleet carriers, initially had difficulty with ATO interpretation; however, in a short period of time, they became proficient at it. The Persian Gulf battle force, on the other hand, experienced difficulty reading the ATO throughout the conflict and eventually began working outside the JFACC system. (Williams, 1991:14)

The consequences of these shortcomings are that the JFACC did not have an optimal method for tasking Naval air assets, and as a result, carrier-based aviation was not able to contribute fully to mission objectives of the operation. In the final report to Congress on the conduct of the Persian Gulf War, the Department of Defense's assessment of the JFACC and associated command and control procedures included the following observations:

After the MAP was written, planners rarely changed Navy sorties because of planning and communications concerns. Initially, this limited the flexible use of Navy air assets and resulted in USAF and USMC land-based air assigned to most short-notice changes.

The ATO reflects the USAF philosophy and practice for attack planning. The USAF focused on the potential for large-scale theater war and developed a system that allowed an orderly management of large numbers of aircraft. Because USAF doctrine separates intelligence, targeting, and flying functions, the ATO was designed to provide mission commanders with detailed direction about many aspects of the mission (including the target, weapon type, and strike composition, but not tactics).

There were acknowledged difficulties with the mechanics of disseminating the ATO because of the lack of interoperability between the carriers' data systems and CAFMS. Nevertheless, it would have been impossible to achieve the air campaign's success and conduct combat operations as they were fought without the MAP and the ATO. (Department of Defense, 1992:139)

In Operation Desert Shield/Desert Storm, the JFACC was an Air Force commander. The JFACC does not have to be an Air Force commander, however, and can, in fact, be a component commander from any of the four Services. JCS publication 3-01.2, Joint Doctrine for Theater Counterair Operations, specifies the principles which apply to JFACC designation:

The joint force commander will normally designate a joint force air component commander [JFACC]. The joint force air component commander's responsibilities will be assigned by the joint force commander (normally these would include, but not be limited to, planning, coordination, allocation, and tasking based on the joint force commander's apportionment decision). Normally, the joint force air component commander will be the Service component commander who has the preponderance of air assets to be used and the ability to assume that responsibility. (Joint Chiefs of Staff, 1986:III-4)

JCS Publication 3-01.2 does not specify a command and control doctrine or philosophy for execution of JFACC duties; these decisions are left to the JFACC and the JFC. "There is no suggested structure for operating a JFACC's staff, which results in an ad hoc arrangement for each operation (Craig, 1991:8)." Because any of the Services can assume JFACC responsibility, it is important to review the current command and doctrines of the Services which could be used in a JFACC role.

Air Force Command and Control Doctrine

As was outlined in the history section of the literature review, the Air Force practices centralized control with decentralized execution within a centralized command structure for all aviation assets. Air Force Manual 1-1, which describes the basic aerospace doctrine of the Air Force, defines this doctrine as follows:

Full use of aerospace forces' advantages in flexibility and versatility is possible only when all aerospace forces within a theater are centrally controlled. Exploiting these characteristics is essential in creating the maximum amount of fog and friction for the enemy while reducing their effect on friendly forces. In

addition, centralized control is necessary so aerospace forces held in reserve can realize their tremendous potential, compared to surface forces, for influencing the outcome of a campaign by quickly concentrating massive force whenever and wherever in the theater the reserve will have the greatest impact. (Department of the Air Force, 1992:130-131)

The Air Force believes this positive control philosophy best supports a unified strategic plan in complex, fast changing air campaigns. Under positive control, operations are designed to leave little to chance, which lends familiarity to each operation and provides aircrew and commanders with confidence in the overall battle strategy and the ability of each component to accomplish its mission (Palzkill, 1991:50-52). The Air Force believes its philosophy should extend to the JFACC concept.

The arrangement that recent experience in Desert Storm clearly shows has the best chance of achieving success is one in which a single airman acts as the joint force air component commander [JFACC] to integrate employment of aerospace forces. The joint force air component commander should control all aerospace forces employed in the campaign and delegate authority for tactical execution to subordinates. The reason this arrangement has been so successful is that it is best suited to the natures of both war and aerospace power. (Department of the Air Force, 1992:130)

The Air Force believes a JFACC exercising centralized control offers many advantages:

Exercising centralized control through a joint force air component commander also can improve friendly performance by allowing a theater commander to devote more time and attention to the design, organization, and conduct of the campaign. If this improvement is to be realized, the joint force air component commander should be an airman because an airman is most likely to understand the actual capabilities and limitations of aerospace forces. Even more importantly, an airman has the knowledge required to maintain aerospace capabilities in the midst of war's dangers and exertions. (Department of the Air Force, 1992:130)

The result of the Air Force's centralized management concept is very detailed planning and tasking of tactical air assets, with control of air operations being accomplished at a very high level within the command structure (Washburn, 1992:5)

Navy Command and Control Doctrine

The Navy's war fighting doctrine is based on a decentralized approach to command and control which extends back throughout Naval history. "The Navy practices control by negation. Tactical decisions are made at the lowest appropriate level. This philosophy is a natural consequence of the Navy's tradition of reposing special trust in officers in command at sea, whose great distance from shore-based admiralty makes centralized command impractical (Palzkill, 1991:51)." The Navy's war fighting structure is currently based on the Composite Warfare Commander (CWC) concept, outlined in Naval Publication NWP 10-1, which enables the Officer in Tactical Command (OTC) to effectively employ his forces against air, surface, and subsurface threats while coordinating the overall mission of his force (Department of the Navy, 1985:2-1). The CWC concept is tied to decentralized control of forces for maintaining maximum flexibility and independence of operations at large distances from the battle group (Lobdell, 1992:7). Additionally, the Navy feels that this command structure provides its forces with the flexibility and autonomy required to prevail in a high-jamming environment, in which peacetime command-and-control nets may be degraded or lost (Palzkill, 1991:51). As a result, procedures for tactical control of Naval air assets differ greatly from those of the Air Force and even from those of other Naval air units:

The Navy...allows its battlegroup and carrier air wing commanders considerable latitude in executing doctrine. This long-standing practice is based on differences between one battle group or air wing and another in terms of composition, geographic location, weapons loadout, and other factors. Carrier air wing tactical notes, for example, are written by and for each air wing--and they are periodically re-written to reflect changes in squadron composition, operating areas, and tactical preferences. Because these tactical notes vary so much from air wing to air wing, some fleet replacement squadrons refrain from

teaching any specific tactics at all, for fear of young aviators becoming confused and frustrated when they check into fleet squadrons. (Palzkill, 1991:52)

Additionally, these differences contribute to friction between the Services, primarily the Air Force and the Navy, during joint air operations:

Most Air Force pilots who have flown joint exercises with Navy squadrons and air wings have horror stories of last-minute, unannounced changes in flight schedules, controlling agencies, frequencies, operating areas, and even missions. Many Naval aviators, on the other [sic], believe that the Air Force's rigid adherence to maintenance, operations, and crew rest requirements undercuts its ability to complete both training and wartime missions. (Palzkill, 1991:51)

With regard to the JFACC concept, the Navy advocates command relations along the lines of service components so its primary mission of sea control can be fulfilled.

This differs from the Air Force preference of functional command and requires entirely different command relations. In the Air Force case the JFACC would possibly have command authority over the other Services' assets, whereas in the Navy case the JFACC would be concerned with coordination among the air asset commanders from the differing Services (Craig, 1991:20).

The Navy almost invariably prefers to provide its forces in support of an operation as opposed to being placed under the operational control of a unified commander. The obvious problem with this arrangement is that it is always difficult for a unified commander to develop a coherent strategy when one of his forces reserves veto power over its contribution to the operation. (Palzkill, 1991:52)

The reluctance of the Navy to provide operational control to a non-Naval JFACC as opposed to the Naval CWC can be primarily related to the need for Fleet defense:

One of the axioms of Naval warfare continues to be that Naval forces take longer to replace than army forces. That fact and the predominance of the offense at sea have led to greater reluctance to risk Naval than military forces. In the unlikely event a carrier were sunk, the costs would be high-both in dollars and lives. The Nation would lose an asset whose combined cost of aircraft and ship would be \$6.6 billion and approximately 6000 lives. More importantly, with a planned 30-year-life cycle the carrier is not easily

reconstitutable. Thus, it is inherently difficult for a battle force commander to trust this valuable asset to anyone but a Naval officer. (Williams, 1991:12)

This reluctance has been recognized by Air Force headquarters:

JFACC has the power to create the Navy's worst nightmare: a non-Naval commander without a full appreciation of fleet defense who unknowingly restricts or limits a carrier's options or siphons sorties to other missions which results in unnecessary damage to or sinking of ships. (HQ USAF/XP, 1988)

Yet by definition, the JFACC does exercise operational control over air assets (including Naval air) based on the apportionment decision from the JFC. In response to these concerns, Joint Chiefs of Staff Publication 5-00.2, Joint Task Force (JTF) Planning Guidance and Procedures, outlines the relationship between the Navy's CWC concept and the JFACC concept: "The JFC [Joint Forces Commander] must completely define the command and coordination relationship between the JFACC and the OTC-CWC in order to encourage maximum coordination of air assets (Joint Chiefs of Staff, 1986:II-8)."

The Navy does see itself as being capable of assuming JFACC functions afloat. The 1993 Department of the Navy Posture Statement described current Navy efforts in this area:

Fully recognizing that joint operations are the venue of the future, the Navy has developed a focused strategy to support optimum, affordable flagship C4I [command, control, communications, computers, and intelligence] configurations that both complement and become integrated with expeditionary requirements...a quantum increase in C4I capability has recently been achieved and fully demonstrated during the joint exercise Tandem Thrust 92. In that exercise, the Navy demonstrated the ability to conduct Commander Joint Task Force (CJTF) as well as Joint Force Air Component Commander (JFACC) functions afloat. (Department of the Navy, 1993:3)

It is easy to foresee a scenario that the United States Navy will have to assume JFACC simply by geographic location and lack of friendly neighboring countries in which to base USAF air assets. Quite possibly USAF assets will scatter throughout a theater in friendly countries or islands and will have to fly

considerable distances each sortie to support the joint war effort. In this scenario, the U.S. Navy would have the preponderance of air assets (afloat)... (Moore, 1992:8)

Because of the Navy's decentralized doctrine, it has not pursued the development of its own ATO generation and dissemination system. "The Navy currently does not have a system on which to build an ATO. [The] USAF currently uses a system called Computer Assisted Force Management System (CAFMS) to build ATOs. The main problem with this system is that it is organic to the USAF only (Moore, 1992:11). "The Navy's lack of an operational force management system such as the Air Force CAFMS has been cited as the key element of connectivity lacking in order for the Navy to conduct a theater level air campaign (Lobdell, 1992:28)." This was evidenced in Operation Desert Storm, as highlighted by the Naval Historical Center:

The Navy did not bring to Desert Storm any system for planning and directing air campaigns because the Navy does not even possess a system to plan the integrated employment of aircraft from more than a single carrier, let alone plan and execute an air campaign involving several carriers. (Ramsdell, 1991:3)

Thus current Naval thinking requires the use of the Air Force CAFMS system to handle ATO creation and dissemination when the JFACC is a Naval officer:

CAFMS cannot be considered a cure-all for the Air Tasking Order, but it is currently the only system which can attempt to tackle this part of the planning problem which faces the JFACC. (Moore, 1992:11)

The Navy is, however, actively developing its own command and control system--the Navy Tactical Command System Afloat (NTCS-A). A requirement of this system is that it be interoperable with CTAPS and the CAFMS subsystem (Cox, 1993:1).

Marine Corps Command and Control Doctrine

Marine Corps aviation doctrine centers around support of the Marine Air-Ground Task Force (MAGTF) (Washburn, 1992:5). Marine Corps doctrine is thought of in terms of operational rather than theater-level warfare (Scott, 1991:17). The primary purpose of Marine Corps air assets is to provide tailored support to the MAGTF ground elements. Thus the Marine Corp feels it is essential for the MAGTF commander to retain organic control of his air assets at all times, making excess air sorties available to the JFACC (Donovan, 1992:11). The Marine Corps felt so strongly about this concept that it was incorporated into the Joint Doctrine for Theater Counterair Operations in the form of an omnibus agreement, which details Marine Corp Air command and control doctrine and the relationship between the MAGTF commander and the JFACC:

The Marine Air-Ground Task Force (MAGTF) Commander will retain operational control of his organic air assets. The primary mission of the MAGTF air combat element is the support of the MAGTF ground element. During joint operations, the MAGTF air assets will normally be in support of the MAGTF mission. The MAGTF commander will make sorties available to the Joint Force Commander, for tasking through his air component commander for air defense, long-range interdiction, and long-range reconnaissance. Sorties in excess of MAGTF direct support requirements will be provided to the Joint Force Commander for tasking through the air component commander for the support of other components of the joint force or the joint force as a whole. (Joint Chiefs of Staff, 1986:III-4)

The Joint Doctrine goes on to say, however, that the JFC has the final authority in the tasking of Marine Corps Air Assets:

Nothing herein shall infringe on the authority of the Theater or Joint Force Commander in the exercise of operational control, to assign missions, redirect efforts (e.g., the reapportionment and/or reallocation of any MAGTF TACAIR sorties when it has been determined by the joint force commander that they are required for higher priority missions), and direct coordination among his subordinate commanders to insure unity of effort in accomplishment of his

overall mission, or to maintain integrity of the force, as prescribed in JCS Pub 2. (Joint Chiefs of Staff, 1986:III-4,5)

The Marine Corps has stated that while it supports joint operations and the JFACC concept, it feels the best way to attain the joint force objectives is by employing the Service components in a manner consistent with their design and warfighting capabilities (Helleln, 1990:18) and that centralized command of air assets is too inflexible for a fluid battlefield and totally inadequate with respect to mobile targets (Coble, 1992:23).

The Marine Corps has also identified the need for a command and control system, and has initiated development of the Advanced Tactical Air Control Center (ATACC) system to its their air asset management needs. ATACC is the only other command and control system under development other than CTAPS which will have the capability to build ATOs (Whitley, 1993:4). Current efforts towards the Marine Corps exercising a JFACC role have been limited to using CTAPS terminals to coordinate flying activities (as in the Ocean Venture exercises) and limited testing of computer connectivity between CTAPS and a personal computer simulating the ATACC system. (Cox, 1993:3)

Army Command and Control Doctrine

Army command and control doctrine for air assets is, like that of the Marine Corps, based on the principle of providing support to ground forces:

Army aviation doctrine today is almost totally a reflection of Army ground forces terminology (Maneuver, Fire Support, Attack, etc.) instead of including some of the more common aviation terminology already developed (close air support, deep air support, interdiction, etc.). To preclude conflict with the Air Force, the Army has maintained its aviation as a tactical asset which is an integral part of the combined arms team. (Noble, 1989:28)

The Army doctrine is in reference to the JFACC concept in its Large Unit Operations Manual, Army Field Manual 100-6, which states that while ground commanders must have the freedom to use the airspace over their forces, coordination with other component commanders, including the Joint Forces Air Component Commander, in the

communications zone for all air defense, air based defense, and airspace control is essential (Craig, 1991:20).

With this said, historically the Air Force has established a horizontal division of the battlefield, concerning themselves with airspace above fifty feet. Helicopter operations have traditionally been separated from the fixed wing operations with the JFACC concerning himself with the latter. This has left the Army supporting the JFACC doctrine but along more of a service component command structure. Ultimately, the Army supports any doctrine which allows corps control of air resources that are delegated by the theater JFC which is in line with their Air-Land Battle Doctrine. (Craig, 1991:21)

The command and control systems used by the Army include the Maneuver Control System (MCS) and the Standard Theater Army Command and Control System (STACCS). Neither of these systems is capable of building an ATO (Whitley, 1993:4), and current integration efforts with the Air Force concentrate on integrating the CTAPS ATO software into MCS and STACCS for ATO reception and parsing only (Whitley, 1993:3). In a scenario in which an Army officer was assigned JFACC responsibility, CTAPS would be the only system currently available which could fully automate the ATO process (Whitley, 1993:5).

Because CTAPS has been designated by the Joint Chiefs of Staff as the objective system to be used by the JFACC, it is important to review its development. The next section examines the history of CTAPS, its goals, and specific design efforts initiated to allow the system to operate under the differing command and control doctrines which may be found during JFACC usage.

Development of CTAPS

The Contingency Theater Air Control System Automated Planning System (CTAPS) is an Air Force program which was established in 1987 as the latest in a

series of efforts to provide a modern, fully automated and rapidly responsive C3I system for Combat Air Forces as a replacement for the aging AN/TSQ-92 TACCs.

The original TACCs, also known as "rubber ducks", were based on 1970's technology and had a number of deficiencies. They were housed in large inflatable shelters which were extremely difficult to maintain and to move, requiring 35 trucks and 33 C-141 aircraft. They were very slow to set up, requiring on average 14 people nearly 15 hours. They were not designed for flexible configurations based on the size of the contingency, therefore, the entire shelter had to be used for small or large contingencies. Automation was provided by a series of stand-alone systems. This lack of integration required vast amounts of manual data entry and re-entry. Automation was so limited, in fact, that clear Plexiglass plotting boards were still used for posting data. (HQ ACC/DRCF, 1992:15)

Over the past 20 years prior to CTAPS, there have been three attempts to modernize the TACC. The first attempt was called TACC Automation (TACC Auto). This program ran from 1971 to 1979, experiencing numerous technical problems, delays and program restructures. According to HQ ACC/DRC: The program tended to chase the latest technology and consequently fell victim to the "hotter biscuit" syndrome-- the tendency to demand emerging or promised "hot" technology. After 8 years, an \$80M investment, and negligible results, TACC Auto was terminated (HQ ACC/DRCF, 1992:17).

The next TACC modernization effort was known as the Computer Assisted Force Management System (CAFMS). This was an in-house program which was begun in 1979 by TAC. CAFMS was a software solution only, and did not address the deficiencies inherent in the old shelter design. The primary product of the initial

CAFMS was the ATO, which, after substantial labor-intensive manual data entry, was generated on paper tape and had to be hand-delivered to the communications center for transmission to using organizations. Over the years, however, CAFMS has improved substantially and has been incorporated as one of several CTAPS applications.

Because the CAFMS project failed to address TACC shelter improvement, TAC initiated a new program in 1985 which was known as TACC Reshelterization. The purpose of this program was to provide upgraded shelters and, in addition, some improvements in automation and communications. Unfortunately, the program was pursued as a Class IV Modification under the Sacramento Air Logistics Center (SM-ALC), thereby incurring restrictions against the inclusion of new communications and environmental control equipment. TAC's objective was to completely replace the AN/TSQ-92, however, under a Class IV Modification, this could not be accomplished. Consequently, the TACC Reshelterization program was terminated in 1987.

CTAPS development spawned from the frustration of the three earlier failures to modernize the TACC. In 1985, Air Force Systems Command (AFSC) commissioned the Air Force Studies Board (AFSB) to conduct an independent analysis of theater battle management (TBM). The AFSB study resulted in the following findings:

- a. Previous C3 acquisitions were plagued by requirements creep, weak specifications, budget overruns, long acquisition cycles and planned obsolescence.
- b. The resulting "stovepipe" C3 systems were non-standard, non-interoperable, unsupportable and proprietary.
- c. The theater-unique systems and lack of standards resulted in no trained operator cadre for contingency augmentation.

- d. There has been a proliferation of stand-alone C3 systems with no defined standards to allow interoperability.

The AFSB also made the following recommendations:

- a. Improve TBM capabilities quickly by using current technology.
- b. Follow a systems engineering approach with heavy user involvement.
- c. Pursue rapid prototyping with evolutionary improvement.

The TAC Commander accepted these findings and recommendations, and in 1987, the CTAPS program was established as an innovative approach to C3 acquisition which would break from traditional acquisition strategies and focus on user/developer interaction in an evolutionary acquisition process using rapid prototyping.

DODI 5000.2 defines evolutionary acquisition as:

... an approach in which a core capability is fielded, and the system design has a modular structure and provisions for future upgrades and changes as requirements are refined. An evolutionary acquisition strategy is well suited to high technology and software intensive programs where requirements beyond a core capability can generally, but not specifically, be defined. (Department of Defense, 1991:5-A-5)

Using this approach along with rapid prototyping, the Air Force formed a program team using the Department of Energy's (DOE) Idaho National Engineering Laboratory (INEL), an experienced prototyper, as the system integrator.

The overall CTAPS program objective is to rapidly field an initial '80 percent solution,' or system core, as opposed to the immediate solution of total operational requirements. Following fielding, the core capability is upgraded through incremental enhancements. These improvements are based on user feedback and made possible by

the system's architectural flexibility and its ability to absorb new technology (HQ ACC/DRCF, 1992:16).

Table 2-1, from the Air Force Studies Board, provides an excellent framework from which to compare the CTAPS program's very flexible development approach to the classic "waterfall" approach to systems development. It lists several types of systems based on key characteristics and provides recommendations for the most appropriate development process to use. There are five basic questions:

1. Are the system requirements well understood?
2. Is applicable commercial software available?
3. Is the system architecture well understood?
4. What is the level of criticality and risk in the application?
5. Is the future evolution of the system well understood?

| EXAMPLES | UNDERSTANDING OF REQUIREMENTS | APPLICABLE COMMERCIAL SOFTWARE | SYSTEM ARCHITECTURE UNDERSTOOD? | APPLICATION CRITICALITY & RISK | FUTURE EVOLUTION UNDERSTOOD? | CANDIDATE PROCESS MODEL |
|---|-------------------------------------|--|---------------------------------------|--------------------------------------|------------------------------------|---|
| Inventory control resource monitor | Well understood | Complete application packages | Yes | Low | Yes | Acquire COTS |
| Updating of fielded system | Well understood | Probably none | Well understood | Low to moderate | Reasonably well | Waterfall (with Ada) |
| MIS portion of command and control system | Still converging | DBMS, prototyping tools, screen gen. | Usually not | Low to moderate | Generally but not in detail | Evolutionary development (build, rebuild) |
| Expert system, intel. analysis tool | Still converging | AI shells | Yes, but with limited coupling | Moderate | Not at all | Exploratory, for limited field use |
| Most C-cubed, avionics | Still converging | Prototyping tools, VHLLs (for evolution) | In part | Moderate to high | Generally but not in detail | Prototype, followed by waterfall |
| Large distributed real-time display- oriented systems | Only near-term understood | No | No | Moderate to high | Poorly | Incremental development |

TABLE 2-1 SOME SYSTEM SITUATIONS AND SUGGESTED PROCESSES FOR DEVELOPMENT

(Air Force Studies Board, 1989:24)

According to Table 2-1, the most basic, well understood system requirement, such as an inventory control system, can be acquired simply by purchasing commercial off-the-shelf (COTS) software and hardware. However, at the other end of the spectrum, when large distributed, real-time, display-oriented systems are required and only the very near-term requirements are understood, then an incremental development process should be used.

Historically, the Air Force has imposed the "waterfall model" for both hardware and software development. This classical, highly structured approach, depicted in Figure 2-1, is characterized by two basic features: a strong tendency toward bottom-up implementation of the system and an insistence on linear, sequential progression from one phase to the next (Yourdon, 1988: 46). It is because of this rigid structure that the Air Force has historically used this approach for both hardware and software development (Air Force Studies Board, 1989: 22). According to the AFSB, those programs for which this method is successful are considered precededented systems and are characterized by three significant elements:

1. A stable set of system and software development requirements that is not significantly different from that for a previously developed system or systems;
2. A digital system architecture and a software design that will satisfy the requirement;
3. Contractor's systems engineering teams and software teams communicate effectively with each other and have had previous application experience in developing a similar system or systems.

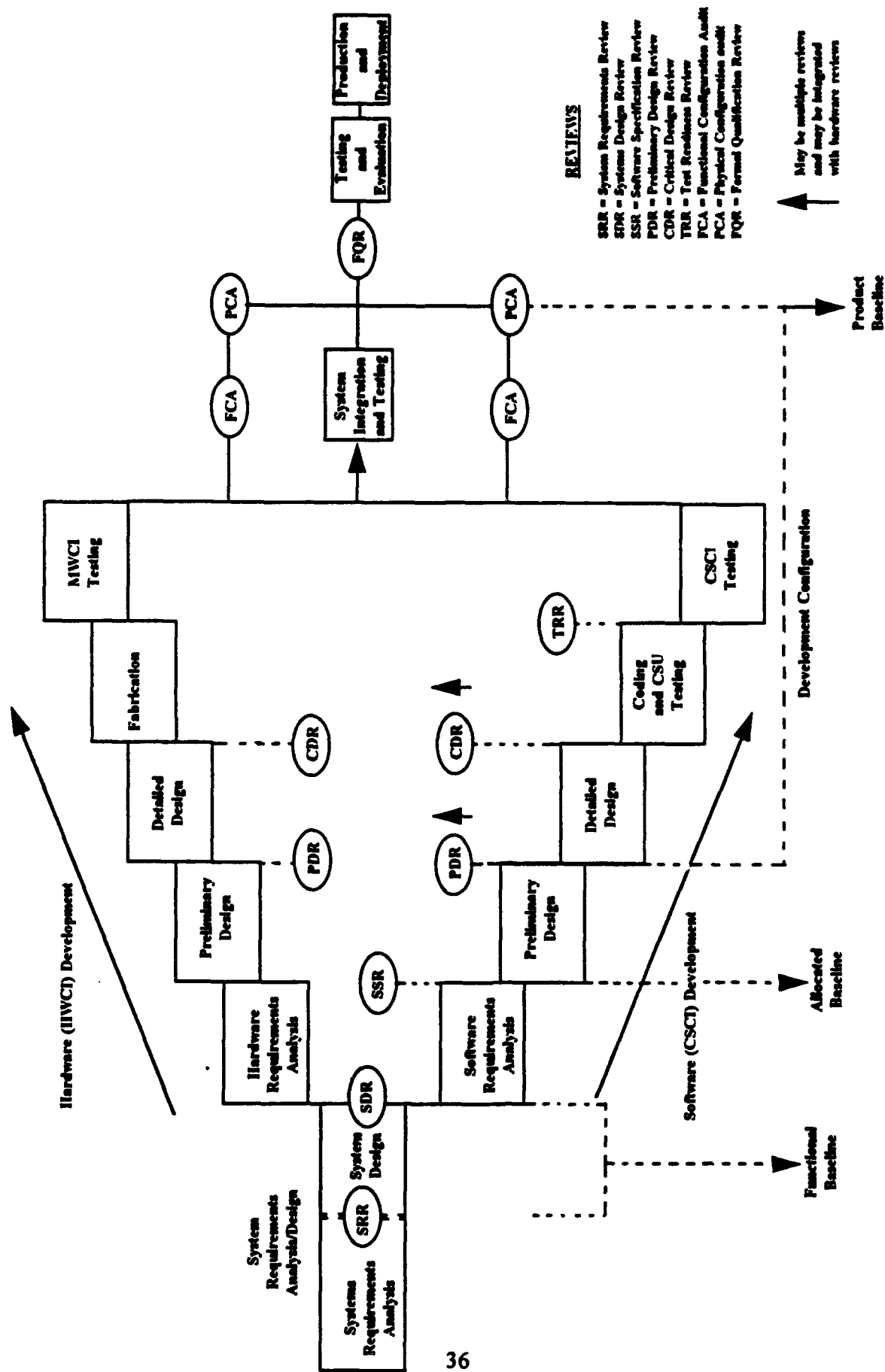


FIGURE 2-1 THE WATERFALL MODEL OF SOFTWARE DEVELOPMENT

Based on these characteristics, CTAPS could not be classified as a precedented system. Only the core requirements were clearly defined, as was the initial system architecture. Consequently, the traditional waterfall approach would have been far too slow, rigid, and ineffective.

Under the CTAPS evolutionary acquisition strategy, there was no lengthy, up-front requirements definition phase which would attempt to field the final solution immediately. Instead, a "core" capability was fielded based on a representative description of the overall capability needed. After the core capability was fielded, upgrades could be based on user feedback, evaluation of adequacy, and application of emerging technology.

The core was based on current open system standard hardware and software. The core itself provided no mission-oriented applications; however, it did provide mechanisms for the integration of mission-oriented functions. As a result, the system could evolve as new applications and technologies became available or as user requirements changed.

The first capability which was added to the core was a rehosted CAFMS application used as the ATO generator. The time line for the prototype systems spanned approximately 31 months. Initial up-front analysis began in 1987, with fielding of the TACC shelters and commencement of pre-production activities in June 1990. On 17 December 1991, the TAC/CC designated the CTAPS program as the CAF standard for Air Tasking Order software and protocols. In April 1992, the JCS/J6 identified CTAPS as the objective system for the Joint Forces Air Component Commander (JFACC) headquarters.

Literature Review Analysis

The review of pertinent operational and military literature revealed the increasing importance of information systems within the military environment. As evidenced in Operation Desert Shield/Desert Storm, it has become almost impossible for even the most basic military functions to be performed without some sort of automation support. Top military leaders, including the Secretary of Defense, the Chairman of the Joint Chiefs of Staff, and the Chief of Staff of the Air Force have recognized the importance of these systems as force multipliers, particularly when used for planning, decision making, and unit-to-unit coordination (Powell, 1992:370). The importance of information systems support was found to be crucial to the success of the air campaign in the Persian Gulf War. In a thesis evaluating unit-level air combat mission planning, Captains Sowell and Gaylord found that:

The increasing complexity of unit-level decision making and the compression of decision time drives the need to provide increasing amounts of automated decision-aiding. Improvements in computer technology provide the Air Force the capability to provide the needed support. However, one of the few areas of consensus in the research is that it can not be assumed that providing automated decision-aiding will yield the best possible or most effective AMP [Air Combat Mission Planning] process. (Gaylord and Sowell, 1991:2-41)

The review of pertinent documents conducted in this chapter supported this finding. The literature review also explored the evolution and current status of air asset command and control doctrine found in the four branches of the Armed Services. It was found that two differing doctrines have emerged; one advocating centralized control and decentralized execution, the other advocating decentralized control and execution of air assets. These differences in doctrine concerning air asset command and control become important in light of the JFACC concept because the concept allows for the employment of either (or even none) of these doctrines to control air

assets. Any information system designated to support the JFACC must be able to support the differing doctrines which might be employed. Review of the history of CTAPS revealed that it is an Air Force system selected for the JFACC role because of its ability to automate the ATO generation and dissemination process, particularly during high sortie generation periods.

The next chapter describes the methodology used to conduct this research effort, focusing on the requirements and designs necessary in a qualitative analysis such as this one.

III. Methodology

Overview

The purpose of this chapter is to describe the research methods chosen to conduct this study and the rationale used in selecting these methods. As stated in Chapter I, the purpose of this research is to assess strategic plans for information systems support necessary to effectively manage air assets under the Joint Forces Air Component Command (JFACC) concept. This thesis is, therefore, a qualitative policy research and comparison effort.

Because policy research operates at the boundaries of research methodology, there is no single, comprehensive method for doing the technical analysis of policy research (Coleman, 1975). Consequently, researchers must know a variety of different methods in order to apply them selectively to particular research questions (Majchrzak, 1984).

... an ideal policy research study is one that combines a number of different methods, such as survey with focused synthesis, or case study with secondary analysis... such a combination provides several advantages by (a) increasing the perceived validity of the study when the two methods yield corroborating results and (b) providing additional insight that one method alone could not provide. (Majchrzak, 1984)

Based on a review of the policy research literature, it was decided to use a combination of two methods. Each was selected based on its applicability to a specific investigative question.

Specific Methodology

In order to meet the research objectives outlined in Chapter I, the following investigative questions were developed:

1. What was the state of the informations systems support for the JFACC concept during the Gulf War?
2. How do the air combat mission planning philosophies differ between the United States Air Force, Navy, Army, and Marine Corps?
3. Do differing mission planning philosophies impact the effectiveness of the automated systems supporting the JFACC concept?
4. Do current or proposed strategic plans for providing information systems support to the JFACC in a joint wartime environment address philosophical differences in mission planning between the services?

To begin to answer each of these investigative questions, a method known as "focused synthesis" was used. Focused synthesis is related to the traditional literature review, but it goes beyond just-published articles into a variety of other sources such as, congressional hearings, personal experience, anecdotal evidence, memoranda, and letters. Unlike the traditional literature review, information sources are used only to the extent to which they directly contribute to the overall synthesis (Majchrzak, 1984).

In addition to the focused synthesis method, a case study was performed to gather in-depth knowledge and to emphasize many of the details related to the first investigative question. In the focused synthesis, it was evident that there was an ATO dissemination problem between the JFACC and the Navy. The case study was the most appropriate tool for describing an ex post facto event, in which there was no control over the subjects or variables.

A case study examines a phenomenon in its natural setting, employing multiple methods of data collection to gather information from one or a few entities (people, groups, or organizations). The boundaries of the phenomenon are not clearly evident at the outset of the research, and no experimental control or manipulation is used. (Benbaset and others, 1987:370)

Of course, the researchers had to be aware of the limitations of a case study. First, causation could not be shown. Only a description of what occurred , not why it occurred, could be provided. Second, this research team could not make any broad generalizations based on a single case over a limited time (Emory and Cooper, 1991).

Summary

This thesis effort is qualitative in nature. However, rather than simply performing an exhaustive literature review, an appropriate combination of focused synthesis and case study was used based on the nature of the investigative questions. Research literature supports this type of methodology.

IV. Analysis

Overview

The results from each of the four research objectives outlined in chapter 1 are presented separately. Results for research objectives 1 and 2 were obtained through the literature review, while results for research objective 3 were obtained through the review of the CTAPS development effort and associated documentation. The final research objective is presented in Chapter 5.

Objective 1 - Lessons Learned

The first objective of this research effort was to derive from historical experience an evaluation of information systems support of the JFACC. Lessons learned during the Persian Gulf War were also to be explored. The intent of this objective was to identify some of the problems and difficulties encountered during use of information systems to execute JFACC functions. Because the first usage of the JFACC concept as it is defined today came during the Persian Gulf War, the scope of past experience is very narrow; i.e. a sample size of one. Certainly unique aspects of the Persian Gulf War, such as the long lead time to deploy forces, the complete absence of opposition from the air, the lack of electronic jamming, etc., must be considered when evaluating how JFACC information systems performance. With this in mind, the following observations were made concerning information systems support for the JFACC:

One of the most publicized shortcomings of the Persian Gulf War was that of ATO transmission. ATO transmission was slow and cumbersome because of

inadequate interoperability (Department of Defense, 1992:K-49). This was due to lack of SHF communications and Computer Assisted Force Management System (CAFMS) terminals, particularly on the aircraft carriers (although some remote air bases experienced this problem as well). In many cases, courier aircraft were used to deliver the ATO on diskette. As a result, the JFACC lost valuable flexibility with regard to Naval air assets, since their missions could not be easily changed. Flying units were impacted because late ATO arrival had an adverse impact on mission planning. Almost immediately after the war, the Navy began installing SHF communications equipment and CTAPS terminals aboard their carriers to obtain access to ATO's through CAFMS. The Marine Corps requested three CTAPS terminals, while the Army made a decision to co-locate their command and control centers with the Air Force's Air Support Operations Center (Whitley, 1992:5). Clearly, access to CTAPS terminals and the CAFMS software is seen as the solution to the ATO transmission problem encountered in the Persian Gulf War. In all of the after action reports we reviewed and documentation we read, there was direct reference to fixing the ATO transmission problem by gaining high-speed access to CAFMS through the CTAPS system.

Another problem concerning the ATO during the Persian Gulf War was its long planning cycle. While the ATO was effective for the initial, preplanned stages of the strategic air campaign, it did not respond as rapidly when air operations progressed and emphasis shifted to more mobile targets. This was due the ATO's size and complexity, the lengthy planning cycle, and the previously mentioned transmission problems. Additionally, the ATO planning cycle became out of phase with bomb damage assessments - target selections and planning were often nearly complete before

the results of previous missions were available (Department of Defense, 1992:138).

Although references have been made to developmental efforts to reduce the ATO planning cycle from 72 hours to 3 hours (Williams, 1991:24), the current CTAPS documentation does not address an increase in performance of this magnitude (reducing the planning cycle is one of the development goals, however).

ATO interpretation and familiarization also were concerns. Many Navy units had difficulty understanding the ATO when they received it, particularly those in the Persian Gulf battle force (Williams, 1991:14). There were several reasons for the difficulty: while there were standard ATO formats designated in JCS Publication 3-56.23, many units were not familiar with the new standards having previously used common language ATOs. The tactical implications of these difficulties included aircraft using improper tactical frequencies, attacking different targets or at times other than specified in the ATO, using incorrect call signs, etc. An Air Force air weapons controller assessed the impact by stating "we knew they were Navy airplanes, but in many cases couldn't figure out which target they were attacking and had difficulty communicating with them - even on guard [emergency frequencies] (Williams, 1991:15)."

Although not directly a lesson learned in the Persian Gulf War, but during the same time period, was the related problem of regionally unique ATO generation and dissemination systems used by Air Force commands in Alaska, Korea, and Europe which did not interoperate with each other or CAFMS. This not only caused problems within the Air Force, but had an impact on the other Services as well, since they were trying to obtain ATO access and did not wish to become familiar with differing systems used in each operating location. This problem was addressed in a series of

messages generated from the Chief of Naval Operations (CNO), the J6 office of the Joint Chiefs of Staff, and the TAC Commander, discussing and clarifying the problem.

The CNO's message succinctly describes the problem as follows:

2. Recently acquired information indicates the goal of ATO interoperability may be hampered by theater unique stovepipe systems . 11th AF in Alaska uses the Command Tactical Information System (CTIS) for ATO generation and distribution. 7th AF in Korea uses the FRAGWORKS/CONSTANT WATCH C2 system for dissemination to PACAF and tactical units. AF in Europe uses a system called EIFEL for its ATO generation and distribution. Apparently, these systems are not interoperable with CAFMS or each other. While similar in functionality each system uses different formats and protocols. This will require Navy units to host and train to all software systems in order to ensure that we can deploy to any theater in response to a given crisis.
3. Request support for near term development of a standard Air Force ATO system output (format and comms protocol). Navy will implement ATO standard ASAP to achieve interoperability worldwide. (Chief of Naval Operations, 1991:1)

Shortly thereafter, a message was sent from the TAC Commander (electronic message 132330Z Dec 91) designating CTAPS as the Air Force standard theater command and control system which provides ATO planning and dissemination. As a result of the lesson learned in the Persian Gulf War, CTAPS and the CAFMS software became the JFACC standard for ATO generation and dissemination.

Objective 2 - Contrast Differing Tactical Air Asset Command and Control Doctrines

Review of the differing command and control philosophies or doctrines was accomplished as part of the literature review, in which basic policy manuals such as Air Force Manual 1-1, Basic Aerospace Doctrine of the United States Air Force; Army Field Manual 100-6, Large Unit Operations Manual, and Navy Publication 10-1, The Composite Warfare Commanders Manual, were studied. Additionally, current thinking on policy and doctrine was obtained through individual publications and papers written

by military personnel close to the issue. The results indicate that command and control doctrine for tactical air assets has developed into two distinctive philosophies; the centralized control and decentralized execution philosophy practiced by the Air Force and Army and the decentralized control and execution philosophy practiced by the Navy and Marine Corps. Both philosophies have their roots in history and are based on the mission and needs of that particular Service. Indeed, the roots of the Navy's philosophy date back to the Service's inception, when it was essential to have autonomous command because of the difficult task of communicating with ships at sea. Both the Navy and Marine Corps feel it is essential to maintain control of their air assets to provide for Fleet defense and close air support respectively. Navy and Marine Corps aircraft exist for these purposes. Both Services have created command and control structures which place control of air assets under the operational commander; in the Navy's case the Composite Warfare commander, in the Marine Corp's case the Marine Air-Ground Task Force commander. Removing control from these commanders and placing it at joint level under the JFACC is a highly disputed idea to say the least. As pointed out in the literature review, these doctrinal differences and the biases against one or the other have the effect of making Air Force - Navy operations much more difficult to control than Army - Air Force or Navy - Marine Corps operations (Palzkill, 1991:52).

The Army's command and control doctrine is similar to the Air Force's, but the Army does not operate many fixed wing tactical air assets, and helicopter operations have been historically separated by a horizontal division of the battlefield at 50 feet (Craig, 1991:20). Thus Army doctrine is not in conflict with the JFACC concept: "Ultimately, the Army supports any doctrine which allows corps control of air

resources that are delineated by the theater or JFC [Joint Force Commander] which is in line with their Air-Land battle doctrine (Craig, 1991:20)." However there is a feeling within the Army that the Air Force places their needs for air support behind the more glamorous Air Force missions involving control of airspace. As a consequence, Army aviation doctrine today is a reflection of Army ground force terminology (maneuver, fire support, attack, etc)... (Noble, 1989:28).

Each of the Services are pursuing their own command and control systems. These systems include the Maneuver Control System (MCS) and the Standard Theater Army Command and Control System (STACCS) for the Army, the Naval Tactical Command System Afloat (NTCS-A) for the Navy, and the Marine Corp's Advanced Tactical Air Control Center (ATACC). All of these systems are currently being fielded with the exception of ATACC, which is still in the test and evaluation stage of its development. None of these systems, again with the exception of ATACC, are capable of generating an ATO. The only system currently fielded which can generate and disseminate ATO's is CTAPS, a primary reason this system was selected to support the JFACC. This leads to the third objective of this research effort, to assess current and conceptual plans for providing information systems support to the JFACC.

Objective 3 - Assessment of Plans for Information Systems Support for the JFACC

Our assessment of plans to provide information systems support for the JFACC centered around a review of pertinent design and program management documentation for CTAPS. Specifically, we were interested in modifications and new directions taken by the program as a result of its additional mission of providing automation support to the JFACC. An analysis of changes to underlying products of that support,

such as the CAFMS software for the generation of ATOs was also to be conducted. Because the Services have differing philosophies for managing their tactical air assets, we expected to find a broad range of changes and an increased level of input to CTAPS development from the Navy, Marine Corps, and Army. However, this was not the case. Surprisingly, we found that while integration between CTAPS and the other command and control systems has become a high priority (Cox, 1992:1), very few changes have been proposed to modify the CTAPS software to accommodate the new JFACC support role it has been assigned.

The focus on integration within the CTAPS programs currently takes two forms. The first concentrates on providing the necessary communications interfaces to allow the exchange of data between CTAPS and the other Service's command and control systems. Army efforts at integrating their MCS command and control system with CTAPS were described in the MCS-CTAPS User Interface Requirements (UIR) document released on 15 May 1992. The MCS-CTAPS UIR document clearly outlined the scope and objectives of this effort:

The MCS to CTAPS automated interface will occur at the Army corps echelon for the purpose of passing maneuver C2 [command and control] planning and execution information to the Air Force ASOC [Air Support Operations Center] director and staff, and air support planning and execution information to the maneuver force-level commander and staff. (United States Combined Arms Command, 1992:1-5)

The thrust of the MCS-CTAPS integration effort is to provide communications connectivity without modifications to the CTAPS data structure. A CTAPS mission package has been developed to allow Army Battlefield Coordination Elements to sort the ATO, thus altering its presentation so Army units can reference air support missions tasked in the ATO. While communications architectures and network

topologies are discussed, the issue of possible modifications due to Army unique command and control doctrine is not addressed. As a result, the information support for the JFACC does not change from Air Force development standards due to Army-Air Force integration efforts. A JFACC from the Army would rely on CTAPS in its pure form to manage air assets and mission taskings.

The Navy's efforts at integrating CTAPS with their command and control system, the Naval Tactical Command System Afloat (NTCS-A), also concentrate on communications connectivity. After Operation Desert Storm, the Navy made upgrades to its communication and shipboard computer systems to accommodate CTAPS software and correct past deficiencies in ATO reception and transmission. Since then, the CTAPS software (primarily CAFMS) was used by the Navy during the July 1992 Tandem Thrust exercise. In this exercise, the ATO was disseminated to the Fleet via Super High Frequency (SHF) satellite communications links. As with Army integration efforts, the CTAPS software modules remain unchanged except for the computer hardware platform on which they are executed.

Integration with the Marine Corps command and control system, the Advanced Tactical Air Control Center (ATACC), has been limited due to the newness of the ATACC development effort. Like the Navy, the Marines have used CTAPS during exercises (Ocean Venture - May 92) to coordinate flying activities. Additionally, preliminary data exchange testing has been accomplished between CTAPS and a personal computer simulating the ATACC system (Cox, 1992:3).

The second focus on integration is an effort to provide a CTAPS developer's tool kit. The goal of this focus is to allow development agencies to create their own theater battle management applications in such a way as to be completely integratable

into CTAPS. Its goal is to allow agencies to make full use of CTAPS core services and reusable software code. While we were unable to determine the current status of the CTAPS developer's tool kit, the idea has much merit and should be an invaluable integration tool.

Summary

As a result of this research effort, the following observations are presented regarding information systems support of the JFACC concept:

1. There is an increasing reliance on the use of information systems within the military as a force multiplier; particularly for planning functions. Because of the growing complexity and scope of planning an air campaign, information systems have been developed to support the air planning function. These systems have become indispensable in the air campaign, particularly when mission planners want to exploit air supremacy through high sortie generation rates. These high sortie rates cannot be achieved without the support of an automated mission planning system to assist in the generation and dissemination of the necessary mission plans and schedules (the Air Tasking Orders), as well as other planning functions such as airspace deconfliction, route evaluation, intelligence analysis and dissemination, and battlefield coordination.

2. Each of the Services has developed different command and control doctrines for their tactical air assets. This is due to the different missions of the Services, their heritage, and the missions of the air assets themselves. Each is currently pursuing development of information systems to support command and control of their tactical air assets, and these systems are being designed to meet the unique needs of that particular Service.

3. As a result of the Goldwater-Nichols Department of Defense Reorganization Act of 1986, procedures for unity of operations and joint command and control structures were developed to increase the effectiveness of the Armed Forces during joint operations. The JFACC concept was developed to ensure unity of air operations. The JFACC can be designated from any branch of the Armed Forces (normally the branch with the most air assets in theater), and, as a result, command and control doctrine exercised by the JFACC is not standardized and can reflect that of the Service picking up the responsibility of JFACC.

4. The Air Force's theater command and control program, CTAPS, reflects the Air Force philosophy of centralized control and decentralized execution. Because this information system was the most advanced and had been previously selected as the Air Force standard, it was identified by the Joint Chiefs of Staff as the objective system for the JFACC in April 1992.

5. CTAPS is an Air Force program, consequently, integration with the command and control systems of the other Services was identified as a top priority by the Air Force's Theater Battle Management General Officer Steering Group. Efforts at integration to date have focused on establishing the necessary communications links and fielding the necessary hardware to allow the CTAPS system to transmit data (primarily ATOs) to other command and control information systems (such as MCS, STACCS, NTCS-A, and ATACC). Modification of the CTAPS software to reflect differing command and control doctrines has not been identified as an initiative in the CTAPS development documentation, and we were unable to identify strategic plans considering this requirement.

Selecting an information system for a joint mission which does not account for

doctrinal differences may create a shortfall in mission support for the JFACC:

While it is possible for either the Air Force or the Navy to function as JFACC, it is clear that this task can not be effectively managed in an ad hoc manner. Communications systems support requirements are based on doctrine. The absence of definitive joint doctrine regarding theater air operations and the latitude afforded the service components produced interoperability problems. (Washburn, 1992:19)

The application of a centralized management information system into a decentralized environment is bound to be problematic at best. In their book, *Management Systems*, authors Cavaleri and Obloj discuss the impact of environment on systems and how they behave:

While a system's environment undoubtedly contributes to its behavior, structure plays a key role in determining how a system will act. Internal structural factors such as feedback loops, complexity, coupling, and linearity all interact to generate system behavior. (Cavaleri and Obloj, 1993: 73)

Figure 4-1, which depicts the fundamental steps used by the Boeing Company to develop their information technology plan (called Boeing 2010), illustrates the impact and importance of business processes on information systems development. Careful consideration of the differing methods for controlling tactical air assets under the JFACC concept should be included in the design effort of any supporting information system.

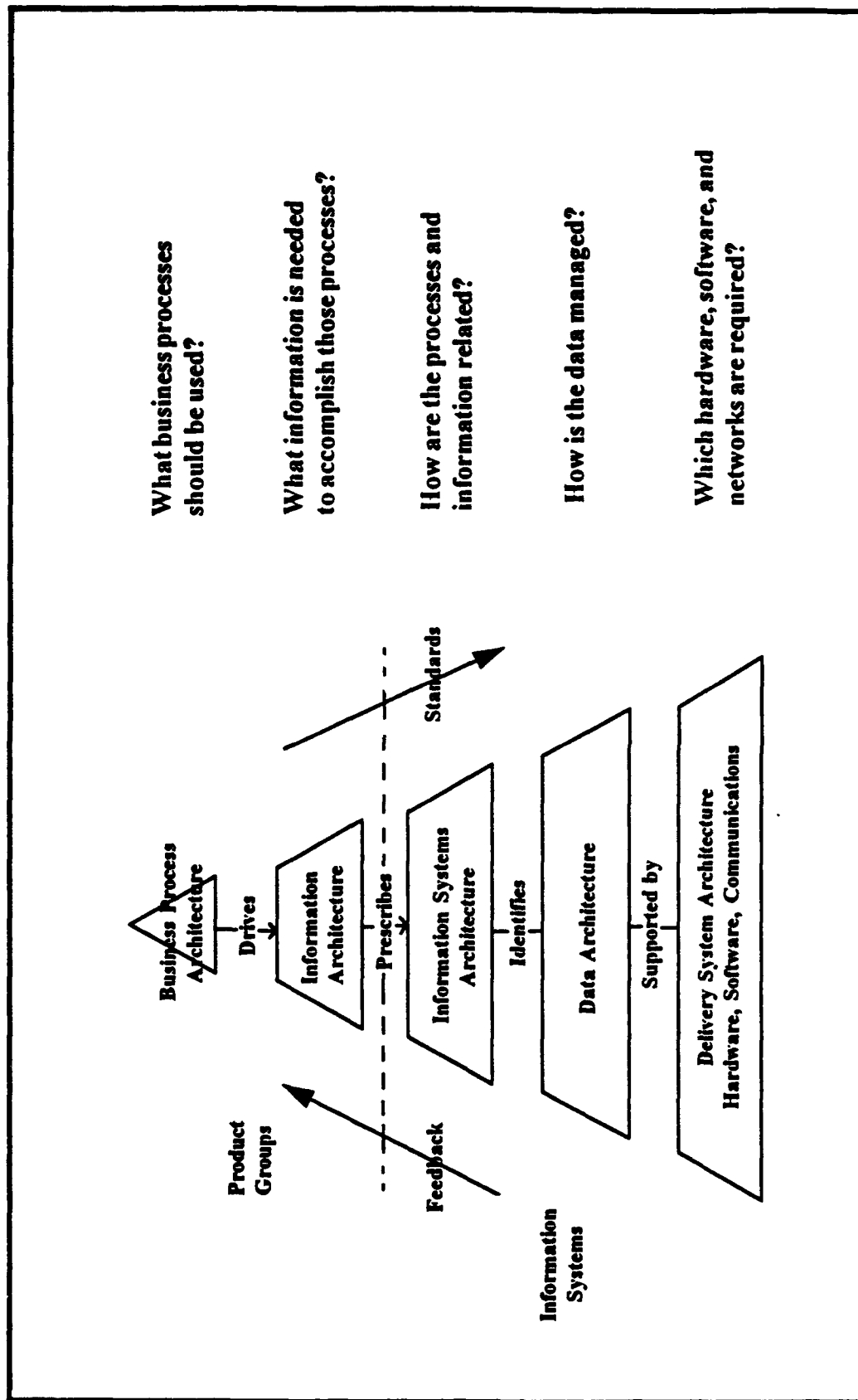


FIGURE 4-1 BOEING 2010 INFORMATION TECHNOLOGY PLAN

(Sprague, 1993:51)

V. Recommendations

Overview

This chapter fulfills the final research objective--to provide recommendations on steps which could be taken to enhance or improve the information systems support for the JFACC. These enhancements or improvements would presumably improve the overall usage or effectiveness of CTAPS for the JFACC. Our intent at the start of this research was to identify specific actions which could be taken in this regard. We have strived to make our recommendations as exacting as possible, avoiding generalization or inference wherever possible.

Joint Representation in CTAPS Software Configuration Management

The Air Force addresses joint interoperability and command, control, communications, and intelligence (C³I) computer systems standards for CTAPS through a Theater Battle Management (TBM) General Officer Steering Group. This steering group is composed of representatives from the user and development communities and is chaired by the Air Combat Command Director for Requirements (ACC/DR). Joint representation includes the JCS/J6J, Navy OP94, and 3rd US Army. The steering group sets priorities and establishes standards for the development of TBM systems, including CTAPS. At this level, the steering group has set the direction for increasingly unified and coordinated joint air component C³I systems. It identifies common operating systems, programming languages, and networking standards. In this regard, the steering group has specified CTAPS as the operable systems architecture for the JFACC.

At the system development level, software configuration and management

control procedures for CTAPS are defined in Air Combat Command Regulation 171-5, which specifies use of a Software Configuration Control Sub-Board (SCCSB) for management of CTAPS software changes. A summary of the process is defined as follows:

1. CTAPS users and developers suggest system changes by generating a Computer Software Change Proposal (CSCP). The CSSPs fall into three categories - Software Problem Reports, Baseline Change Requests, and Documentation Deficiency Reports.

2. The CSCPs are received and tracked by the configuration management division of the CTAPS development agency, the 1912CSGP.

3. A technical assessment and cost analysis is performed for each CSCP, and the results are provided to the SCCSB for consideration.

4. The SCCSB validates, prioritizes, and schedules CSCPs for implementation. The SCCSB consists of three voting members: ACC/DRCF, 9th Air Force (9AF), and 12th Air Force (12AF). Plans are currently being developed to adjust the board membership to include Pacific Air Forces (PACAF), since CTAPS will soon be available in this theater.

Recommendation 1: Adjust voting membership of the SCCSB to include Army, Navy, Marine Corps, and Joint Chiefs of Staff representation. Because CTAPS is the objective system for the JFACC, joint representation and involvement in the software configuration control process is essential. The priorities of the other Services must be evaluated and considered in the configuration process. Additionally, this provides the other Services with a vital insight to CTAPS developmental issues which may effect their own information systems development. Through SCCSB

membership, coordination and prioritization can take place before configuration decisions are made, hopefully eliminating surprises and problems down the road. This recommendation is a relatively simple and inexpensive one which can be easily implemented.

Incorporate a CTAPS course into Army and Naval Aviation Training

Since the introduction of the JFACC concept, there have been several calls to include JFACC and ATO training into the curriculums of the advanced military aviation schools:

Naval aviators, in general, are accustomed to receiving their asking (sic) from the commander of the air wing and only during joint operations such as Team Spirit are they exposed to outside tasking orders. I strongly recommend that a course be instituted to familiarize mid to senior grade naval officers in the creation and translation of Air Tasking Orders. This course could easily be incorporated into established naval aviation schools such as Navy Fighter Weapons School (Top Gun), Naval Strike Warfare Center (Strike U), and medium/light attack weapons schools (East/West). The benefit of instituting such a course would allow the U.S. Navy a wide spectrum of tactical pilots to choose from for the staffing of a Naval JFACC or other joint aviation staffs. The course would also increase, at all levels of naval aviation, the ability to comprehend Air Tasking Orders. (Moore, 1992:20)

The NSWC (Naval Strike Warfare Center) conducts a Strike Leader Attack Training Syllabus (SLATS) course for air wing strike leaders. The emphasis on this course has been air wing tactics, intelligence, enemy order of battle, and contingency planning. An introductory course in the JFACC concept with table top exercises in the ATO process would provide unit level exposure for future integration into joint operations. (Lobdell, 1992:26)

During the advanced phase of an Air Wing training cycle, a major weapons deployment occurs which exercises coordinated wing procedures tailored to existing Operational Plan requirements as well as specific requirements of the operational commander. This normally consists of three weeks of training executing all primary mission areas from deep strike interdiction to close air support. Yet, no joint training is conducted or required. Although joint training is infeasible during the first two weeks, it could easily be incorporated as a part of the graduate level training now executed during the last week of operations. Incorporated as a part of, and not in addition to, current air wing

turn-around training, joint training would enhance the Air Force and Navy interoperability at little extra cost to the services. (Williams, 1991:19-20)

The value of joint training is widely recognized, and as a result of recommendations like those just presented there is an increase in joint training and joint exercises.

While joint exercises such as Tandem Thrust and Ocean Venture do incorporate CTAPS as an integral component, this is not the case for aviation training.

Recommendation 2: Modify the curriculums of the Army and Navy advanced aviation schools to include a CTAPS course. By including CTAPS training into the curriculums, system familiarization and proficiency can be increased. Those units not familiar with the ATO or CTAPS can gain valuable exposure to it and how it will be used within the JFACC concept. Inexperience with the ATO process was an identified shortcoming of the Persian Gulf War (Donovan, 1992:17) and (Williams, 1991:14).

As will be discussed shortly, including CTAPS as part of the curriculum also provides an excellent opportunity for user feedback and recommendations for system improvement. This recommendation need not be expensive and, as suggested by Williams, does not necessarily require an increase in the number of training days or school length.

Mandate Feedback be Provided to the CTAPS Development Organization after Joint Exercises and Training

Joint exercises such as Tandem Thrust and Ocean Venture provide unique opportunities to evaluate CTAPS support for the JFACC in action. They can be used to test new concepts in systems operation or for comparing differing ideologies while providing the full spectrum of user perspectives, from General Officers on down.

Recommendation 3: Mandate the providing of feedback from Joint Exercises and the modified advanced aviation courses to the CTAPS development office for consideration and comment. Some of the most valuable inputs to the design and development of CTAPS are lost because the users in the other branches of the military are not able to address their concerns or make recommendations on the system's development. By mandating feedback, these inputs can be considered. Additionally, feedback can promote a sense of system loyalty and ownership if the users feel their comments are valued and important. Within this recommendation we also feel it is important to automate the feedback process. CTAPS has an outstanding electronic mail system as part of the core software. Using the e-mail system to handle Computer Software Change Proposals (CSCPs) could increase the timeliness of the process. It is important that the development agency respond to all CSCPs in a timely fashion. To be sure, many of the proposals may be redundant or already acted upon, but providing even a "canned" response improves the relationship between the user and developer. While this recommendation may involve an increase in developer workload, it is much better to address it up front than to wait until the system is in use during a conflict and find that it does not meet the users needs.

Summary

The recommendations provided in this research have suggested that enhancement of the information systems support for the JFACC can be obtained by increasing the level of joint involvement with the system designated to provide this support, CTAPS. The study recommended increasing joint involvement in CTAPS configuration management and increasing joint usage of the system during training and

exercises. Valuable recommendations and system improvements can be obtained by requiring user feedback at all levels. Through these steps future commanders assuming the responsibility of JFACC will have a familiar and proven information system capable of meeting their support needs.

Recommendations for Future Research

Because of the limited scope of our research, several opportunities exist to explore other facets of JFACC information systems support. We did not address the issue of how this support would be impacted when the JFACC's relationship with allied forces is considered. Because the JFACC can exercise control over our allies air assets, a supporting information system should address this management problem. The extent to which CTAPS development does address it is open to investigation.

Another area of research concerns the pursuit of theater battle management systems by all of the Services. Efforts at eliminating duplication, standards for development, and integration aids (such as the CTAPS developer's tool kit) could be examined in the context of joint impacts. While our focus was tactical air asset mission planning through the JFACC concept, other concerns such as logistics support, intelligence support, battlefield situation displays, etc., could also be considered. The increased usage of automation to support military operations and planning opens up a world of management issues at the single service, joint , and even allied level.

The increasing complexity of the battlefield environment, combined with ongoing organizational and mission changes, emphasizes the need for successful information systems support and the importance of continued research in this area.

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| REPORT DOCUMENTATION PAGE | | | Form Approved OMB No. 0704-0188 | |
|--|---|--|--|--|
| <small>Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.</small> | | | | |
| 1. AGENCY USE ONLY (Leave blank) | | 2. REPORT DATE September 1993 | 3. REPORT TYPE AND DATES COVERED Master's Thesis | |
| 4. TITLE AND SUBTITLE AN INDEPENDENT EVALUATION OF INFORMATION SYSTEMS SUPPORT OF THE JOINT FORCES AIR COMPONENT COMMANDER CONCEPT OF OPERATIONS | | | 5. FUNDING NUMBERS | |
| 6. AUTHOR(S) Gregory R. Kincaid, Capt, USAF Richard A. Poligala, Capt, USAF | | | | |
| 7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Air Force Institute of Technology WPAFB OH 45433-6583 | | | 8. PERFORMING ORGANIZATION REPORT NUMBER AFTT/GSM/LAR/93S-12 | |
| 9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) N/A | | | 10. SPONSORING / MONITORING AGENCY REPORT NUMBER | |
| 11. SUPPLEMENTARY NOTES | | | | |
| 12a. DISTRIBUTION / AVAILABILITY STATEMENT Approved For Public Release; Distribution Unlimited | | | 12b. DISTRIBUTION CODE | |
| 13. ABSTRACT (Maximum 200 words) <p>This study examines automated Air Tasking Order (ATO) generation and dissemination under the Joint Forces Air Component Commander (JFACC) concept, focusing on an evaluation of information systems support given the differing service philosophies concerning control of tactical air assets. Current Department of Defense doctrine identifies the Contingency Tactical Air Control System Automated Planning System (CTAPS) as the standard automated system for Theater Battle Management planning for the JFACC. To achieve service interoperability, the doctrine requires the use of CTAPS for ATO generation and dissemination when joint operations are conducted under the JFACC concept. A problem arises in that CTAPS is developed under the Air Force's philosophy of centralized control and decentralized execution, a philosophy very different from the Navy's decentralized management concept. The study evaluates the current CTAPS development principles in light of the differing Service philosophies. The results of this research indicate that in order to improve information systems support for the JFACC, efforts should be made to increase joint involvement in CTAPS configuration management, increase Army, Navy, and Marine Corp exposure to the automated ATO process during training and exercises, and streamline the user feedback process as a mechanism to incorporate lessons learned from joint CTAPS utilization.</p> | | | | |
| 14. SUBJECT TERMS Control Systems, Tactical Data Systems, Tactical Air Control Systems, Military Tactics | | | 15. NUMBER OF PAGES 79 | |
| | | | 16. PRICE CODE | |
| 17. SECURITY CLASSIFICATION OF REPORT Unclassified | 18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified | 19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified | 20. LIMITATION OF ABSTRACT UL | |

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