TIMELY EFFECTS: ORGANIC SURFACE FIRES AND AIRSPACE DOCTRINE IN THE 21ST CENTURY JOINT FIGHT

A thesis presented to the Faculty of the U.S. Army
Command and General Staff College in partial
fulfillment of the requirements for the
degree

MASTER OF MILITARY ART AND SCIENCE
General Studies

by

JONATHAN L. HARVEY, MAJOR, ARMY
B.S., Eastern New Mexico University, Portales, New Mexico, 1998

Fort Leavenworth, Kansas
2011-01

REPORT DOCUMENTATION PAGE	*Form Approved OMB No. 0704-0188*

1. REPORT DATE *(DD-MM-YYYY)*	**2. REPORT TYPE**	**3. DATES COVERED** *(From - To)*
08-06-2011	Master's Thesis	AUG 2011 – JUN 2012

4. TITLE AND SUBTITLE

Timely Effects: Organic Surface Fires and Airspace Doctrine in the 21st Century Joint Fight

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)

Major Jonathan L. Harvey

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
U.S. Army Command and General Staff College
ATTN: ATZL-SWD-GD
Fort Leavenworth, KS 66027-2301

8. PERFORMING ORG REPORT NUMBER

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION / AVAILABILITY STATEMENT
Approved for Public Release; Distribution is Unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT
The last 10 years of conflict have seen a dramatic increase of airspace users above the battlefield providing both opportunities and challenges to maneuver commanders. Assets operating overhead assist the commander in mission command; however, the additional airspace users also pose challenges to the maneuver commander's ability to employ organic surface fires.
The primary research question this thesis seeks to answer is, "Does doctrine provide adequate guidance for maneuver brigade commanders to enter into the airspace discussion with the Joint Force Commander?" This study evaluates current joint and service airspace doctrine to assess information and procedural gaps that might limit the brigade commander's ability to effectively employ organic surface fires. Two findings are highlighted: at the brigade commander level there is a limited understanding of the airspace requirements needed to ensure effective employment of organic fire support assets; and joint and service airspace doctrine requires refinement. This thesis concludes that implementing a coordinating altitude between 10,000 and 12,500 feet above ground level gives the maneuver brigade commander maximum flexibility to employ organic surface fires.

15. SUBJECT TERMS
Airspace, Fires Integration, Joint Fires, Fires, Briagde Origanic Fire Support, Maxord, Coordinaing Altitude

16. SECURITY CLASSIFICATION OF:			**17. LIMITATION OF ABSTRACT**	**18. NUMBER OF PAGES**	**19a. NAME OF RESPONSIBLE PERSON**
a. REPORT	**b. ABSTRACT**	**c. THIS PAGE**			**19b. PHONE NUMBER** *(include area code)*
(U)	(U)	(U)	(U)	109	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std. Z39.18

MASTER OF MILITARY ART AND SCIENCE

THESIS APPROVAL PAGE

Name of Candidate: Major Jonathan L. Harvey

Thesis Title: Timely Effects: Organic Surface Fires and Airspace Doctrine in the 21st Century Joint Fight

Approved by:

____, Thesis Committee Chair
Herbert F. Merrick, Jr., M.A.

____, Member
Jeffrey J. Kubiak, Ph.D.

____, Member
LTC Jay A. Van Der Werff, M.A.

Accepted this 8th day of June 2012 by:

____, Director, Graduate Degree Programs
Robert F. Baumann, Ph.D.

The opinions and conclusions expressed herein are those of the student author and do not necessarily represent the views of the U.S. Army Command and General Staff College or any other governmental agency. (References to this study should include the foregoing statement.)

ABSTRACT

TIMELY EFFECTS: ORGANIC SURFACE FIRES AND AIRSPACE DOCTRINE IN THE 21ST CENTURY JOINT FIGHT, by Major Jonathan L. Harvey, 109 pages.

The last 10 years of conflict have seen a dramatic increase of airspace users above the battlefield providing both opportunities and challenges to maneuver commanders. Assets operating overhead assist the commander in mission command; however, the additional airspace users also pose challenges to the maneuver commander's ability to employ organic surface fires.

The primary research question this thesis seeks to answer is, "Does doctrine provide adequate guidance for maneuver brigade commanders to enter into the airspace discussion with the Joint Force Commander?" This study evaluates current joint and service airspace doctrine to assess information and procedural gaps that might limit the brigade commander's ability to effectively employ organic surface fires. Two findings are highlighted: at the brigade commander level there is a limited understanding of the airspace requirements needed to ensure effective employment of organic fire support assets; and joint and service airspace doctrine requires refinement. This thesis concludes that implementing a coordinating altitude between 10,000 and 12,500 feet above ground level gives the maneuver brigade commander maximum flexibility to employ organic surface fires.

ACKNOWLEDGMENTS

I give sincere thanks to those on my committee for the hard work they put into driving this paper from where it was in September, to the product you see today. Their input and feedback was critical to my growth during this process and I am confident, resulted in a better product.

I would also like to recognize two subject matter experts in the field of airspace I relied heavily on. Any future author looking to work on a project relating to airspace should seek out Mr. Christopher Boetig and Mr. Matt "El Cid" Neuenswander at Fort Leavenworth, Kansas. I have no doubt they have forgotten more about airspace than I was able to uncover in research. Two Army Officers that deserve a great deal of my thanks are COL Joseph Harrington and COL Mike Cabrey. COL Harrington provided me much needed motivation during this process and COL Cabrey provided unabated access to recourses at Fort Sill, Oklahoma to support this work.

Finally, I would like to thank my family. Notably, my parents for watching my son weekends upon weekends while I was locked away in the shed writing. Most of all, my wife, Lain, and my son, Fox, who deserve my unending gratitude and I know I owe a lot of family time back to. You both sacrificed most of the "greatest year of our life" for me to pursue this goal. Thank you.

TABLE OF CONTENTS

ACRONYMS

ACA	Airspace Coordination Area
ACM	Airspace Coordinating Measures
ACP	Airspace Control Plan
AFDD	Air Force Doctrine Document
AGL	Above Ground Level
AO	Area of Operations
ATO	Air Tasking Order
BCT	Brigade Combat Team
CA	Coordinating Altitude
CAS	Close Air Support
CFL	Coordinated Fire Line
FM	Field Manual
FSCL	Fire Support Coordination Line
FSCM	Fire Support Coordination Measures
JFACC	Joint Forces Air Component Commander
JFC	Joint Force Commander
JFLCC	Joint Forces Land Component Commander
JP	Joint Publication
MC	Mission Command
MO	Maximum Ordinate
ROA	Restricted Operations Area
ROZ	Restricted Operations Zone
TFT	Tabular Firing Table

TRADOC	Traning and Doctrine Command
UAV	Unmanned Aerial Vehicles

TABLES

CHAPTER 1

INTRODUCTION

> To provide fire support to joint, Army, SOF and multinational forces conducting decentralized full-spectrum operations over wide AOs, indirect fires must be immediately responsive and available at all echelons. Furthermore, indirect fires will be employed at increasing lower echelons in combined arms and joint maneuver and security operations.
>
> — Department of the Army, *Unites States Army Functional Concept for Fires 2016-2028*

Background

The last 10 years of persistent conflict has seen a dramatic increase of airspace users above the battlefield providing both opportunities and challenges to maneuver commanders like never before. However, those same systems that now provide advantages to the maneuver commander challenge the system in which they operate. “Lessons learned from every hostile encounter during the past 15 years have shown that airspace management, include the coordination, integration, and regulation of the use of airspace of defined dimensions, must be improved.”[1] Unfortunately, the addition of these assets in today’s airspace which benefit the commander pose additional challenges to the system in which they operate. Examples of opportunities the additional airspace users provide to the commander area; additional airborne battlefield visualization tools and airborne firepower. A Brigade Combat Team (BCT) Commander has unprecedented access to fixed-wing aircraft to both see the battlefield and engage the enemy. He also now has additional organic and higher echelon reconnaissance and surveillance platforms, coupled with access to national level intelligence collection to create situational awareness. These assets provide the conventional commander opportunities to see the battlefield and engage the enemy that was not available 10 years ago. Assets operating overhead assist the commander in mission command; however, the additional airspace users also pose challenges to the maneuver commander in his ability to employ his organic surface fires assets.

Although artillery rounds have always flown though the air, a 2011 update to service doctrine formally recognizes artillery as a user of airspace bringing them squarely into the issue of airspace management. Air Force Doctrine Document (AFDD) 3-52 dated 2 February 2011 states, "Complicating matters, indirect fires systems (e.g., artillery), are recognized airspace users and today range higher, farther, and with greater volume of fire than ever before. These increased user demands require an integrated airspace control system to enable flight safety and prevent fratricide while enabling mission accomplishment and minimizing risk."[2] Joint Publication (JP) 3-52 goes on to say "Indirect fires systems are airspace users; however, current airspace control TTP [tactics, techniques, and procedures] and FSCMs do not lend themselves to seamless integration."[3] The question that remains is what do airspace and fire support coordinating measures do?

Airspace is a resource in demand. Think of a bowl of mixed candy. If you want a specific piece of candy and the bowl only has a few pieces in it, then it is relatively easy to pick out what you want with little to no disruption to the rest of the bowl. If the bowl is full however, you must disturb the entire bowl to obtain the specific piece you want. Some pieces will be moved, others removed, but virtually all are affected. Airspace is no different. Any object that travels though airspace requires an unimpeded path to achieve its objective. The more users of airspace, the more complex it is to employ the systems that utilize it. This affects a maneuver commander's options under Mission Command (MC), as his options are reduced in many cases to employ air delivered fires, or navigate the system of airspace control to employ organic indirect fires. Although he has an Air Liaison Officer in many cases to assist him in navigating that process, Army modularity has provided challenges in the form of removing senior commanders of artillery at the Division and above level.

Army modularity places increased responsibilities on Brigade Commanders to consider and manage the battlefield in ways they were not accustomed to prior to the recent conflicts, three dimensionally. Major General Stricklin, in a recently published article in the magazine *Fires*, states "Army modularity force structure changes eliminated the brigade fire support element from the direct support artillery battalion and made it organic to the BCT. The Army's decision to inactivate its division and corps artilleries eliminated the fire support coordinator for divisions and corps that make up many joint task force organizations."[4] With the removal of higher echelon artillery headquarters, the artillery commanders at Division and Corps Artillery levels are gone. The role those commanders played was to advise, at a command level, the Division and Corps Commanders. Fire Support Coordinators, a staff position, have replaced them. The functions Division and Corps Artillery headquarters previously served in both the command channel communications and staff actions are now inherent on BCT. The "BCTs are the principle tactical echelon formations . . . BCTs conduct decentralized full-spectrum operations."[5] Essential to the BCT Commander conducting decisive action and unified land operations is the ability to employ the wide variety of assets at his disposal with minimal constraint. Organic indirect fires are one of those assets and one of the six war fighting functions according to Army doctrine.[6] Training and Doctrine Command (TRADOC) Pamphlet 525-3-4, *The United States Army Functional Concept for Fires: 2016-2028* states, "The authority to employ fires must also be decentralized to the lowest appropriate level according to METT-TC [Mission, Equipment, Time, Troops, Terrain, and Civil Considerations].[7] Commanders at the point of decision will require the capability to clear fires on the ground and through the airspace, enabled by situational awareness and understanding."[8]

The previous discussion regarding the loss of artillery force structure is to provide the reader the understanding that force structure once exsisted to focus on the airspace issue. With that structure now gone, it is the responsibility of the Brigade Commander and his staff. The logical question that now exsists is, is a brigade command and his staff versed in airspace management and prepared to execute the tasks required to utilize it to his advantage. The thesis question of this study is, "Does doctrine provide adequate guidance for maneuver Brigade commanders to enter into the airspace discussion with the Joint Force Commander (JFC)?" If joint doctrine expects a commander to "employ forces in the operational area through movement in combination with fires to achieve a position of advantage in respect to the enemy,"[9] the first step in this process is to understand the operating environment, by knowing how to communicate his airspace requirements to ensure he maintains freedom to employ his organic fires assets. Stricklin contends that the process does not facilitate them doing so. "The Army must develop a less cumbersome and more responsive airspace coordination process. When the process cannot support 'troops in contact' it is ineffective and must be fixed."[10] Although his comment uses fires during a troop-in-contact engagement to make his point, it should not be lost that his article's thesis is that the airspace process is cumbersome and requires simplification in order to facilitate fires.

Thesis Importance

This study will evaluate current joint and specific service airspace doctrine in order to establish if the Brigade Commander has sufficient ability under MC to employ organic surface fires. The importance of this study rests in the uncertainty of the future. The Joint Chiefs of Staff's document *Vision for 2020: America's Military-Preparing for Tomorrow* describes the future as unpredictable.

> In 2020, the Nation will face a wide range of interest, opportunities, and challenges and will require a military that can both win wars and contribute to the peace. The global interest and responsibilities of the Unites States will endure, and there is no indication that threats to those interest and responsibilities, or to our allies, will disappear. The strategic concepts of decisive force, power projection, overseas presence, and strategic agility will continue to govern our efforts to fulfill those responsibilities and meet the challenges of the future.[11]

It is essential that doctrine provide sufficient guidance to commanders in training that is both flexible and adaptable in the operational environment. JP 1-02 defines doctrine as "fundamental principles by which the military forces or elements thereof guide their actions in support of national objectives. It is authoritative but requires judgment in application."[12] Brigade Commanders must know and understand what doctrine provides in terms of both opportunities and restrictions so they can create realistic training as the Army exits this period of persistent conflict. The hypothesis of this study is, that by informing maneuver commanders of the limitations certain airspace coordination measures have on organic surface fires, they will be able to enter the discussion with the JFC by identifying the risk associated with losing the ability to employ fires, while conducting decentralized full-spectrum operations.

The author of this study is an artilleryman with 14 years of experience at the tactical level of artillery employment both in execution of fires and planning. In his experience, the author has seen two dynamics regarding the employment of fires that he views as detrimental to the Artillery Branch and has the potential to negatively impact the combined arms fight. The first, is that commanders are frustrated by airspace limiting their ability to employ fires. The second, is a willingness by commanders to choose fixed-wing support, over surface to surface fires to avoid the process. This study should not be perceived by the reader as an attempt to move BCT Commanders away from fixed or rotary-wing platform employment. Those systems provide lethality, flexibility, and responsiveness to the commander in MC. The importance of this study is to analyze the core components of these dynamics and attempt to discover a solution that would allow a BCT commander to employ his fires, while integrating those additional platforms to maximize battlefield affects. Although components of this study might be seen by the reader as viewed though the lens of the most recent conflict, the authors' intent is to generate discussion on an issue that will remain long after it is over, crowded airspace.

A widely circulated White Paper titled "The King and I," written by three former Infantry Brigade Commanders, documents their concern with what they coin as the "Impending crisis in the Field Artillery's ability to provide fire support to maneuver commanders."[13] Although this paper is not written specifically focused on airspace, it contains statements such as, "The once-mighty "King of Battle" has been described by one of its own officers as a "dead branch walking." Now the Army is beginning to see real consequences in our ability to integrate fires with maneuver . . . We can't afford to lose sight of the critical role artillerymen play in our ability to plan, coordinate, integrate and synchronize our combined arms operations. This is not an artillery branch issue, this is an Army issue."[14] At least in this documented case, by three former BCT commands from three different Army Divisions, there is a need to focus attention on the artillery and issues relating to the Artillery Branch's ability to support maneuver.

Thesis Intent

The intent of this thesis is to fill a gap in the body of knowledge that exists at the brigade level in the area of airspace. Stricklin also articulates a systems gap exists when he states, "This is not an indictment of the U.S. Army or our field artillery commanders. Instead, it points to a significant gap regarding support relationships between senior commanders and multiple organizations."[15] He contends that losing artillery structure during transformation led to the gaps of in-depth understanding of complicated issues such as airspace management. By removing the senior level Artillery Commanders and placing the onus now on Brigade Fire Support Offices as the subject matter experts to a maneuver Brigade Commander and Artillery Battalion Commanders as the only Artillery Commander in a Division. As his quote points out, he does not indict those commanders, but recognizes a gap now exists in what they are expected to know. They now fill the roll formerly filled by entire brigade level staffs.

The reality is unless a dramatic shift in direction away from modularity comes in a time of announced military drawdown, these lost formations will not be coming back. Therefore, airspace and the issues that surround it will continue to rest in the hands of the Brigade Commanders at the ground tactical level. There are Fires Brigades that can be task organized to support Division or Corps, however, the preponderance of fire support assets in the Army now reside within the BCTs, meaning they will be the ones primarily operating within airspace constraints. This thesis will answer the question, “Does doctrine provide adequate guidance for maneuver commanders to enter into airspace discussions up to and the through the chain of command to the JFC?” In an attempt to fill the gap in knowledge, the study will look to one primary and three secondary questions.

The primary question: “What does a maneuver commander need to know to employ his organic surface fires with minimal constraint during decentralized full-spectrum operations?” The secondary questions: “What do graphical control and Fire Support Coordination Measures (FSCM) facilitate in relation to the ground commander?” In order to provide an answer there will need to be a study of what graphical control and FSCM facilitate in relation to the ground commander. There are a limited number of FSCM that affect the maneuver commander’s ability to employ surface fires. These are Coordinated Fire Line (CFL), Fire Support Coordination Line (FSCL), Restricted Operations Zone (ROZ), Airspace Coordination Area (ACA), and Coordinating Altitude (CA). These have the greatest impact on the ground commander’s ability to fight with fires. It is important to recognize that some Airspace Coordinating and Fire Support Coordinating Measures are permissive and some are restrictive. There are inherent MC responsibilities in the planning for and employment of these measures to achieve the desired effects. Discussion of these considerations will facilitate a more sound assessment of when and where to employ Airspace Coordinating Measures (ACM) to best facilitate the ground commander, while simultaneously providing risk mitigation to airspace users. Also reviewed is the joint definition of Area of Operations (AO) as it frames the area in which a maneuver commander operates.

Understanding the capabilities of surface-to-surface fires is essential for properly planning the placement of coordinating measures that support the brigade commander's employment of organic surface fires. "In an airspace unconstrained environment, what altitudes would be required for surface-to-surface fires to achieve the commander's intent?" This will require a detailed analysis of the trajectory each system requires to fire munitions at various ranges, thus providing a visual picture to commanders when recommending to the JFC the placement of ACM such as the CA. Finally, empowered with that knowledge, "How does a maneuver commander establish his requirements within the airspace process?"

Even if this study finds that joint doctrine provides the breadth and depth of guidance regarding coordination measures, this study may discover refinements to joint doctrine to better support the ground commander in MC while still preserving the ability of the Joint Forces Air Component Commander (JFACC) to achieve the objectives assigned by him from the JFC. It is important to note that consideration must be given to the impact of both the Joint Forces Land Component Commander (JFLCC) and JFACC's ability to achieve the JFC's desired end state. Chapter 5 contains further exploration of this.

Assumptions

The primary assumption made in this work is that the maneuver commander actually would prefer to use his organic artillery if the process was less cumbersome. In a 2003 article, Field Artillerymen, Lieutenant Colonel Dennis Tewksbury, describes the tipping point in Iraq that caused maneuver commanders to shift from a cannons first mentality, to applying joint fires before organic surface fires. "Early in OEF III, indirect fire was shut down to execute an air assault or allow C2 [Command and Control] aircraft to land because we did not set up procedures to facilitate those joint operations."[16] Another article in the same journal more clearly identifies this same issue. "The . . . system is satisfactory for rapid management, planning, and deconfliction. However, it was not designed for real time (or near real time) coordination, deconfliction and control of all tactical air operations and fires,"[17] Omitted from the quote are the digital systems and processes used in airspace management. The author brings to light that no matter what tools exist to deconflict airspace, they are unsatisfactory for today's battlefield.

The current process, as well as fixed-wing availability, has allowed commanders to remove organic surface fires from their immediate MC considerations with little risk. Stricklin states "In the east,[18] Army units have close air support (CAS) only 10 minutes away which creates an over reliance of that asset. There is no guarantee our nation's next fight will readily have CAS only 10 minutes away. Organic delivery means must be available for Army/JTF commanders."[19] This paper will provide commanders with an understanding of what fire support and ACM facilitate so that they can use the appropriate tool in their MC tool bag and employ it effectively. The future force requires it. TRADOC Pamphlet 525-3-6, *The United States Functional Concept for Movement and Maneuver: 2016-2028* states, "Future Army forces require the capability to integrate mortars with other indirect fires systems through the network to provide offensive and defensive fires for decentralized full-spectrum operations across wide areas."[20]

There is no certainty in what the future holds. The force can not predict when or where the next major conflict will be or even whom we will fight. In an attempt to focus the force, Army Doctrine Publication 3-0, has directed a revision to our capstone doctrine defining it as “Decisive Action and Unified Land Operations.”[21] The purpose of the change is to encompass everything in the previous doctrine of Air Land Warfare with the lessons learned of the past 10 years of combat without losing the edge gained in the counter-insurgency fight. Units must rebuild their core skills as they return to Combined Arms Maneuver. This will prove to be a challenge for the force in and of itself and is outside the scope of this paper. Although no one knows who our next adversary will be or where we will fight, the Nation requires the force remain prepared for major large scale combat operations.

Scope

The scope of this thesis is the BCT and the commander’s ability to employ his organic surface fires. Therefore, it will evaluate particular fire support and ACM in order to ensure the maneuver commander is provided the maximum flexibility under MC to employ his organic surface fires. To achieve this, ranges of surface-to-surface fires will be used with the maximum ordinate (MO),[22] commonly referred to as maxord, as the benchmark for where airspace is affected. As the scope of this paper is brigade level maneuver commanders in major combat operations, the focus of MO comparison will be on those fires organic to a BCT. Although surface-to-surface fires such as Multiple Launch Rocket Systems are fires available to the Division and-or Corps commanders, they are outside the scope of this paper. The range, MO, and time of flight at which Multiple Launch Rocket System munitions are employed, typically require specific deconfliction and integration into the Airspace Control Order or on a case by case basis with the JFACC. The surface-to-surface systems in this thesis are 60mm, 81mm, and

120mm mortars and 105mm and 155mm howitzers, for both standard and extended range munitions.

Limitations

One limitation of this study is the classification of this paper. It will be unclassified to facilitate the broadest reader base. The audience for this paper is maneuver commanders, artillerymen, and Air Force airspace planners. The major limitation that will result from the classification of this paper is the ability to consider operational application of ACM during the most recent conflicts. Details such as the current CA in Afghanistan would be contained in the Airspace Control Plan (ACP) or Special Instructions and those documents are classified. To mitigate this, 3000 feet above ground level (AGL) will be the prescribed CA considered.[23] This serves as a starting point to compare possible restrictions to the ground commander's ability to employ surface-to-surface fires.

Another limitation is the fact the term CA and its associated definition has been fundamentally redefined with the publication of JP 3-52, in May 2010. Although the definition is reflected in Army and Air Force service publications, the author of this study has not discovered any professional writings on this topic to date.

A final limitation is the lack of professional writing by artillerymen on the issues surrounding airspace control. Stricklin is the first author of note to publish an article that identifies airspace as a limitation to artillery employment. Another source documenting the need for modification of the current ACM is in the summary notes and slide presentation of the Fires Center of Excellence discussion, November 2011.[24] These slides were produced by the Fires Capabilities Development Integration Directorate and were not disseminated through publication. Slide 4, titled “Gaps,” states, “Fires and ADA [Air Defense Artillery] Brigades, and their subordinate battalions, lack the ability to clear the airspace and gain authority to employ fires in JIIM [Joint, Interagency, Intergovernmental, and Multinational] and ROE [Rules of Engagement] restricted environments, adversely impacting the ability of FA [Field Artillery] and ADA [Air Defense Artillery] systems to conduct timely engagements of threat ground and air systems, respectively.”[25] Slide 9 lists the need for a solution to the above statement as an Operational Required Capability. “In order to maintain a permissive Joint Fires environment for air-to-surface and surface-to-surface fires, flexible coordination measures must be established.”[26] These slides were later consolidated into a For Official Use Only product called the *Army Functional Concept for Fires Capabilities-Based Assessment Functional Needs Analysis Report*, in November of 2009, to articulate the gap analysis to the authors of the *Functional Concept for Fires 2016–2028*.[27] This document is not included in this study due to its classification.

Delimitations

The fact that the air above the battlefield is extremely populated cannot be ignored. There are unmanned aerial vehicles (UAV), rotary-wing helicopters, and fixed-wing aircraft overhead. This paper does not address UAV or rotary-wing platforms. The issues surrounding deconfliction of these assets is outside the scope of this paper as the requirements for deconfliction is reciprocal between the Brigade Commander and the asset as they operate within a defined battle space. “The authority that a BCT controlling an AO has over Army airspace users is the same as the BCT’s authority over ground units transitioning its AO. . . . All Army airspace users transiting a BCT AO are expected to coordinate with the BCT responsible for the AO they are transiting."[28] Additionally, regarding unit level UAV assets, as well as assets tasked to support the brigade to include rotary-wing, the commanders employing these assets are the same commanders providing detailed integration of all assets above and in the area of operations.

Doctrine specifically addresses UAV and the risk of collision. The AFDD 3-52 categorizes the acceptable risk of an indirect fires and UAV collision, as high priority should be given to "mission accomplishment over the preservation of resources."[29] The financial cost of these is low enough that if one is lost by impact with surface-to-surface fires during the employment of fires, the loss is of much lower tactical risk than the necessity of the delivery of munitions. A Multi Service publication on Airspace Control further supports this by establishing the risk acceptance level for a surface-to-surface and UAV impact at the approval level of the BCT Commander.[30]

Rotary-wing deconfliction is also outside the scope of this paper. Like unit level UAV, the commanders employing these assets are the same commanders providing detailed integration of all assets above and in the objective area. Therefore, it is incumbent on that commander to deconflict those assets during employment. Although the risk is unacceptable in terms of loss of life and capability, rotary-wing employment falls under the control of the tactical ground commander, the same commander employing surface-to-surface fires. By removing these UAVs and rotary-wing assets from the problem, it allows for a more narrowly focused study of airspace doctrine affecting the application of fires.

Also not considered in this study is analysis of the force structure of the Artillery Branch. Although Division Artillery force structure once existed to serve as the Division

Commander's single point of contact for all issues relating to fires, this paper will not look at the impact of the loss of that organization as part of this problem. Discussion earlier in chapter 1 of the loss of Division Artillery units is only to frame for the reader why airspace is a relevant issue to the BCT commander.

Definitions

Several key definitions are necessary to afford the reader a common understanding of the thesis frame of reference.

Airspace Control. "A process used to increase operational effectiveness by promoting the safe, efficient, and flexible use of airspace."[31]

Airspace Control Authority. "The commander designated to assume overall responsibility for the operation of the airspace control system in the airspace control area. Also called ACA."[32]

Airspace Control Order. "An order implementing the Airspace Campaign Plan that provides the details of the approved requests for Airspace Coordinating Measure. It is published either as part of the Airspace Tasking Order or as a separate document. Also called ACO."[33]

Airspace Control Plan. "The document approved by the JFC that provides specific planning guidance and procedures for the airspace control system for the joint force operational area. Also called ACP."[34]

Airspace Control Procedures. "Rules, mechanisms, and directions that facilitate the control and use of airspace of specified dimensions."[35]

Airspace Coordinating Measures. "Measures employed to facilitate the efficient use of airspace to accomplish missions and simultaneously provide safeguards for friendly forces. Also called ACM."[36]

Airspace Coordination Area. "A three-dimensional block of airspace in a target area, established by the appropriate ground commander, in which friendly aircraft are reasonably safe from friendly surface fires. The Airspace Coordination Area may be formal or informal. Also called ACA."[37]

Airspace Management. "The coordination, integration, and regulation of the use of airspace of defined dimensions."[38]

Air Tasking Order. "A method used to task and disseminate to components, subordinate units, and command and control agencies projected sorties, capabilities, and-or forces to targets and specific missions. Normally provides specific instructions to include call signs, targets, controlling agencies, etc., as well as general instructions. Also called ATO."[39]

Area of Operations. "An operational area defined by the JFC for land and maritime forces. Areas of operations do not typically encompass the entire operational area of the JFC, but should be large enough for component commanders to accomplish their missions and protect their forces."[40]

Coordinating Altitude. "An airspace coordinating measure that uses altitude to separate users and as the transition between different airspace coordinating entities."[41]

Coordinating Authority**. "**A commander or individual assigned responsibility for coordinating specific functions or activities involving forces of two or more Military Departments, two or more joint force components, or two or more forces of the same

Service. The commander or individual has the authority to require consultation between the agencies involved, but does not have the authority to compel agreement. In the event that essential agreement cannot be obtained, the matter shall be referred to the appointing authority. Coordinating authority is a consultation relationship, not an authority through which command may be exercised. Coordinating authority is more applicable to planning and similar activities than to operations."[42]

Coordinated Fire Line. "A line beyond which conventional and indirect surface fire support means may fire at any time within the boundaries of the establishing headquarters without additional coordination. The purpose of the Coordinated Fire Line is to expedite the surface-to-surface attack of targets beyond the Coordinated Fire Line without coordination with the ground commander in whose area the targets are located. Also called CFL."[43]

Decentralized Execution. "Delegation of execution authority to subordinate commanders."[44]

Fire Support Coordination Line. "A fire support coordination measure that is established and adjusted by appropriate land or amphibious force commanders within their boundaries in consultation with superior, subordinate, supporting, and affected commanders. Fire Support Coordination Line facilitates the expeditious attack of surface targets of opportunity beyond the coordinating measure. A Fire Support Coordination Line does not divide an AO by defining a boundary between close and deep operations or a zone for CAS. The Fire Support Coordination Line applies to all fires of air, land, and sea-based weapon systems using any type of ammunition. Forces attacking targets beyond a Fire Support Coordination Line must inform all affected commanders in sufficient time to allow necessary reaction to avoid fratricide. Supporting elements attacking targets beyond the Fire Support Coordination Line must ensure that the attack will not produce adverse effects on, or to the rear of, the line. Short of a Fire Support Coordination Line, all air-to-ground and surface-to-surface attack operations are controlled by the appropriate land or amphibious force commander. The Fire Support Coordination Line should follow well defined terrain features. Coordination of attacks beyond the Fire Support Coordination Line is especially critical to commanders of air, land, and special operations forces. In exceptional circumstances, the inability to conduct this coordination will not preclude the attack of targets beyond the Fire Support Coordination Line. However, failure to do so may increase the risk of fratricide and could waste limited resources. Also called FSCL."[45]

Fire Support Coordination Measure. "A measure employed by land or amphibious commanders to facilitate the rapid engagement of targets and simultaneously provide safeguards for friendly forces. Also called FSCM."[46]

Joint Force Air Component Commander. "The commander within a unified command, subordinate unified command, or joint task force responsible to the establishing commander for making recommendations on the proper employment of assigned, attached, and-or made available for tasking Air Forces; planning and coordinating air operations; or accomplishing such operational missions as may be assigned. The joint force air component commander is given the authority necessary to accomplish missions and tasks assigned by the establishing commander. Also called JFACC."[47]

Joint Force Land Component Commander. "The commander within a unified command, subordinate unified command, or joint task force responsible to the establishing commander for making recommendations on the proper employment of assigned, attached, and-or made available for tasking land forces; planning and coordinating land operations; or accomplishing such operational missions as may be assigned. The joint force land component commander is given the authority necessary to accomplish missions and tasks assigned by the establishing commander. Also called JFLCC."[48]

Maximum Ordinate. "The maximum ordinate (MO) is the height of the summit above the origin in meters. This is the height of the trajectory above the howitzer expressed in meters under standard conditions."[49]

Mission Command. "The exercise of authority and direction by the commander and the commander's staff to integrate the war fighting functions using the operations process and mission orders to accomplish successful full-spectrum operations. MC enables agile and adaptive leaders and organizations to execute disciplined initiative within commander's intent as part of unified action in a complex and ambiguous environment."[50]

Restricted Operations Area. "Airspace of defined dimensions, designated by the airspace control authority, in response to specific operational situations-requirements within which the operation of one or more airspace users is restricted. Also called ROA."[51]

Restricted Operations Zone. "Airspace reserved for specific activities in which the operations of one or more airspace users is restricted. Also called ROZ."[52]

Summary

In summary, the ability to return surface-to-surface fires to the forefront of maneuver commander's considerations under MC lies within the maneuver commander's knowledge and understanding of fire support and ACM. If properly understood and utilized, the maneuver commander's ability to fight decentralized will be maximized. Consideration must be given to the impact of all users of airspace in order to preserve the supported and supporting command relationship, as well as sustain the gains the last 10 years of conflict have seen the joint force, particularly in the realm of joint fires integration. This thesis will look to the applicability and employment of ACM and FSCM on the battlefield. Consideration will be given to the MO required for the commander to employ his organic surface fires, in order to weigh the cost benefit of assuming control of that airspace.

---

[1]Michael Seifert, et al., "JASMAD–Meeting Current and Future Combat Airspace Requirements," *The Air Land Sea Bulletin* no. 2006-1 (January 2006): 15.

[2]Department of the Air Force, Air Force Doctrine Document 3-52, *Airspace Control* (Washington, DC: Government Printing Office, February 2011), 1.

[3]Chairman, Joint Chiefs of Staff, Joint Publication (JP) 3-52, *Joint Airspace Control* (Washington, DC: Government Printing Office, May 2010), IV-9.

[4]MG (Ret) Toney Stricklin, "Employment of the M982 in Afghanistan: US Army and Marine Corps Differences," *Fires* (January-February 2012): 17.

[5]U.S. Army Training and Doctrine Command, TRADOC Pamphlet 525-3-1, *United States Army Operating Concept: 2016-2028* (Fort Monroe, VA: Government Printing Office, 19 August 2010), 12.

[6]Department of the Army, Army Doctrine Reference Publication (ADRP) 3-0, *The Army in Unified Land Operations*, Final Draft (Washington, DC: Government Printing Office, September 2011), 3-4.

[7]METT-TC is defined as Mission, Enemy, Terrain and weather, Time and Civil considerations.

[8]U.S. Army Training and Doctrine Command, TRADOC Pamphlet 525-3-4, *The United States Army Functional Concept for Fires 2016-2028* (Fort Monroe, VA: Government Printing Office, October 2010), 19.

[9]Chairman, Joint Chiefs of Staff, Joint Publication (JP) 3-0, *Joint Operations* (Washington, DC: Government Printing Office, March 2010), III-28.

[10]Stricklin, "Employment of the M982 in Afghanistan," 19.

[11]Joint Chiefs of Staff, "CJCS Vision for 2020," *Joint Forces Quarterly* (Summer 2000): 57-76, ebscohost.com (accessed January 5, 2011).

[12]Chairman, Joint Chiefs of Staff, Joint Publication (JP) 1-02, *Department of Defense Dictionary of Military and Associated Terms* (Washington, DC: Government Printing Office, 2001 as amended 15 November 2011), 168-169.

[13]Sean MacFarland, Michael Shields, Jeffery Snow, "The King and I: The Impending Crisis in Field Artillery's ability to provide Fire Support to Maneuver Commanders" (White Paper), 1.

[14]Ibid., 2-3.

[15]Stricklin, "Employment of the M982 in Afghanistan," 17.

[16]LTC Dennis Tewksbury and Joel Hamby, "Decentralized Fires in Afghanistan: A Glimpse of the Future?" *FA Journal* (November-December 2003): 11.

[17]Curtis V. Neal, "JAGC2: A Concept for Future Battlefield Air-Ground Integration," *Field Artillery Magazine* (November-December 2006): 14; U.S. Army Training and Doctrine Command and the Curtis E. Lemay Center for Doctrine Development and Education, FM 3-52.1, AFTTP 3-2.78, 13.

[18]This is a reference to eastern Afghanistan.

[19]Stricklin, "Employment of the M982 in Afghanistan," 18.

[20]U.S. Army Training and Doctrine Command, TRADOC Pamphlet 525-3-6, *The United States Army Functional Concept for Movement and Maneuver 2016-2028* (Fort Monroe, VA: Government Printing Office, October 2010), 52.

[21]Department of the Army, ADP 3-0.

[22]Maximum Ordinate is the peak of the trajectory, in feet above ground level, of a surface-to-surface fired projectile.

[23]The author has over 10 years experience assigned to the 82d Airborne Division as both a company grade and field grade officer conducting an extensive amount of joint training exercises. In those exercises, 3000ft AGL was the Coordinating Altitude (formerly referred to as the CL). No reference beyond the authors experience is available.

[24]Slides were provided by Mr. John Folland, Integration Officer, US Field Artillery Commandant's Office, Fort Sill, Oklahoma, 23 January, 2012.

[25]FCoE Seminar Discussion Phase 0&I. 15-17 November 2011, 4. E-mail by Mr. John Folland, 23 January 2012.

[26]Ibid., 9.

[27]Capabilities Development Directorate, Fires Center of Excellence, Army Functional Fires Concept for Fires Capabilities-Based Assessment Function Needs Analysis Report, 9 November 2010. (FOUO)

[28]U.S. Army Training and Doctrine Command and the Curtis E. Lemay Center for Doctrine Development and Education,FM 3-52.1, AFTTP 3-2.78, 13.

[29]Department of the Air Force, AFDD 3-52, 55.

[30]U.S. Army Training and Doctrine Command and the Curtis E. Lemay Center for Doctrine Development and Education, FM 3-52.1, AFTTP 3-2.78, 40.

[31]Chairman, Joint Chiefs of Staff, JP 3-52, GL-4.

[32]Ibid.

[33]Ibid., GL-5.

[34]Ibid.

[35]Ibid.

[36]Ibid., 6.

[37]Chairman, Joint Chiefs of Staff, JP 3-09, GL-5.

[38]Chairman, Joint Chiefs of Staff, JP 3-52, GL-6.

[39]Chairman, Joint Chiefs of Staff, Joint Publication (JP) 3-30, *Command and Control of Joint Operations* (Washington, DC: Government Printing Office, June 2003), GL-3.

[40]Chairman, Joint Chiefs of Staff, Joint Publication (JP) 3-0, *Joint Operations* Change 2 (Washington, DC: Government Printing Office, March 2010), GL-6.

[41]Chairman, Joint Chiefs of Staff, JP 3-52, GL-8.

[42]Chairman, Joint Chiefs of Staff, JP 1-02, 77.

[43]Chairman, Joint Chiefs of Staff, JP 3-09, GL-6.

[44]Chairman, Joint Chiefs of Staff, JP 3-30, GL-8.

[45]Chairman, Joint Chiefs of Staff, JP 3-09, GL-7.

[46]Chairman, Joint Chiefs of Staff, JP 3-0, GL-13.

[47]Ibid., GL-17.

[48]Ibid., GL-17.

[49]Department of the Army, United States Marine Corps, Field Manual (FM) 6-40, MCWP 3-1.6.19, *Tactics, Techniques, and Procedures for Field Artillery Manual Cannon Gunnery* (Washington, DC: Government Printing Office, October 1999), 7-19.

[50]U.S. Army Training and Doctrine Command, TRADOC Pamphlet 525-3-1, 60.

[51]Chairman, Joint Chiefs of Staff, JP 3-52, GL-12.

[52]Ibid., B-B-1.

CHAPTER 2

LITERATURE REVIEW

This thesis will address the question of, "Does doctrine provide adequate guidance for maneuver commanders to enter into airspace discussions with the JFC." In an attempt to fill the gap in knowledge, the study will look to one primary and three secondary questions. The primary question is, "What does a maneuver commander need to know to employ the surface based fires at his disposal with minimal constraint during decentralized full-spectrum operations?" To answer the primary question the first secondary question is, "What do graphical control and FSCM facilitate in relation to the ground commander?" The next secondary question is, "In an airspace unconstrained environment, what altitudes would be required for surface-to-surface fires to achieve the commander's intent?" The final secondary question is, "How does a maneuver commander articulate his requirements within the airspace process?" This study adds to the overall body of knowledge on this topic by: reviewing joint and service airspace doctrine to identify if revisions are required to better facilitate a maneuver commander's understanding, providing a single source document to BCT commanders and staff indentifying the impacts a prescribed coordinating altitude has on their employment of organic indirect fires, and describing for commanders at what point they must communicate their airspace requirements up to the JFC.

Primary Question

Joint and service doctrine is readily available to the author to conduct this study. The three bodies of doctrine required are joint, Army, and Air Force Doctrine focused on fire support and air space coordinating measures. Although other services like the Navy and Marine Corps have airspace doctrine, the scope of this paper looks at enabling a BCT commander to employ fires and by narrowing the study to Air Force Doctrine, it allows a review of the Army and Joint Doctrine with at least one other service.

Doctrine such as JP 1 *Doctrine for the Armed Forces of the United States,* AFDD 1, *Air Force Base Doctrine*, and Field Manual(FM) 3-0, *Operations* lays the groundwork for what doctrine is and what it is supposed to do by providing definitions and context. These references have all be updated post 9-11. JP 3-52, *Doctrine for Airspace control in the Combat Zone*, AFDD 3-52, *Airspace Control* and FM 3-52 will further layout the doctrine as it relates to employment and deconfliction of fires in airspace.

First Secondary Question

In relation to this paper, six primary graphical control measures affect the problem. They are AO, CFL, FSCL, ROZ, ACA, and CA as they relate to the ground commanders ability to fight with fires. It is important to recognize that some ACM and FSCM are permissive and some are restrictive.

To manage the airspace the JFACC utilizes ACM. JP 3-52, *Joint Airspace Control* contains a 13-page glossary of them. The May 2010 publication of JP 3-52 introduced a significant revision of an airspace coordinating measure definition, the CA. The joint staff-working group and decision board notes will provide insight to the context, intent, and reasoning behind its revision.

Joint and service doctrine augmented with a body of professional writings will provide insight to the current fire support and ACM. This will bring to light the directed application by doctrine as well as interpretation of the capabilities and limitations they impose. However, what does the revised definition of the CA do to better facilitate the maneuver commander employing his organic surface fires support assets? With the revision of the CA, it clarifies the intent of an existing airspace coordinating measure, the Coordinating Level, to provide a "procedural method to separate fixed-and rotary-wing aircraft by determining an altitude below which fixed-wing aircraft normally will not fly."[1] The Coordinating Level is a coordinating measure to ensure safety between two classes of aircraft. In most cases fixed-wing will remain above and rotary-wing below the Coordinating Level; however, either can transition into the others airspace as long they follow prescribed procedures to alert the other class of aircraft as to the unexpected airspace user's presence. As noted in the definition, it is typically established at a level where fixed-wing typically will not be present. Two documents were provided to the author of this study from the joint staff, J 7 regarding the revision of JP 3-52. The first document was the consolidated comments from the staffing committee and the second is the decision comments from the approval board. Both documents provide a speaker, comment, recommendation, and rational. They provide insight into the discussion that led to the revisions and final decision of the definition of CA.

The CA is defined in JP 3-52 as, "An airspace coordinating measure that uses altitude to separate users as the transition between different airspace coordinating entities." Of notable difference from the Coordinating Line is that it is articulated in the JP that this measure depicts a requirement for designation of controlling agencies responsible for operations and deconfliction of a given piece of airspace. It is a measure to ensure coordination. The JP goes on to clarify that the CA should be published by the JFACC in the appropriate airspace control documents such as the Air Control Order and it is incumbent on the airspace user to coordinate with the other users of airspace if transition is required.

Both the Army FM 3-52 and the AFDD 3-52 recognize this additional coordination measure. However, only AFDD 3-52 provides clarity to the definition by providing guidance about the placement of the CA to Air Force airspace planners.

> Placement should strike a balance between maximizing the effectiveness of air component and organic forces while not unduly inhibiting those same operations. The optimum CA (specified as above ground level) varies with specific operational area circumstances but should address the following: the respective C2 agencies' ability to provide airspace C2 below the designated CA, the anticipated ground scheme of maneuver during the effective time period established for the CA, and affected indirect fire support systems' range and altitude limits.[2]

This guidance within the AFDD is the basis for this study. It establishes that there is a requirement to consider surface based fires employment when establishing this measure. However, maneuver commanders are not currently resourced with a single source document that addresses all of their organic surface fires assets capabilities in terms of ranges and MO requirements. A consolidated product such as this, would simply the process for commanders, by allowing them to quickly reference either the impact of a prescribed CA or communicate operational requirements for airspace, based on their organic surface fires support capabilities.

This thesis will attempt to fill that gap by conducting a comparative analysis of fires ranges, to altitude required, for MO of BCT organic surface fires. Careful examination of the CA through analysis of the considerations listed in the AFDD 3-52 could pose a solution to best maximize the delivery of organic surface fires in a maneuver commander's battle space, while still preserving airspace for fixed-wing freedom of flight.

Second Secondary Question

This will require a detailed analysis of the trajectory each system needs to fire munitions at various ranges. This analysis will provide a visual picture to commanders when recommending to the JFC the placement of ACM, such as the CA. To achieve this, ranges of surface-to-surface fires will be used with the MO as the benchmark for where airspace is affected. As the scope of this paper is support to the maneuver commander in major combat operations, Joint Phasing Models Phase III: Dominate and IV: Stabilize, the focus of MO comparison will be on those fires organic to a BCT. Those systems are mortars and howitzers.

Mortar and artillery firing data is contained in a tabular firing table (TFT). "These tables contain the fire control information (FCI) under standard conditions and data corrective for nonstandard conditions. These tables and equipment include the tabular firing tables, graphical firing tables, and graphical site tables. The tabular firing tables are the basic source of firing data. They present fire control information in a tabular format."[3] Because the TFT is the primary source for firing data, this study will rely on that information and will not review graphical firing tables or graphical site tables. These tools are simply a slide rule depiction of the TFT chart data[4] and meant for ease, speed, and convenience of use in a field environment.

Each table provides specific information relating to firing data such as table A, metrological message line numbers, table B complimentary range, table H correction to range to compensate for earth rotation etc. The table this study will focus on is table G, supplementary data. Table G is broken into 13 sub columns, each depicting a different data point corresponding to a given range. The entry argument used to extract a data point is range to target, column A in table G.[5] Once the desired range is found, by moving across the chart the reader discovers data relevant to the entry range such as elevation, probable errors in range, terminal velocity etc. This study is concerned with column 11, MO. This column provides the "maximum height above the gun of the trajectory fires, under standard conditions, to the range in column 1."[6] This provides the point at which the round stops rising and begins falling enroot to a target at a given range and is the essential data point for establishing what volume of airspace is required to employ surface based fires. This will allow the study to provide the highest point of trajectory as well as comparison benchmarks such as one third or two thirds of a weapons system range.

Third Secondary Question

If a commander is expected to clear fires, the first step in that process is to understand the operating environment and know how to communicate his requirements to ensure he has the freedom to employ his organic surface fires. The JFACC is responsible for developing the plan for air operations according to doctrine.

> The JFACC's responsibilities normally include, but are not limited to planning, coordinating, and monitoring joint air operations, and the allocation and tasking of joint air operations forces based on the Joint Forces Commander's CONOPs and air apportionment decision. . . .When the JFC designates a JFACC, the JFACC normally assumes the area air defense commander (AADC) and airspace control authority (ACA) responsibilities since air defense and airspace control are an integral part of joint air operations.

The Joint Air Component Commander uses the Air Tasking Order (ATO) to communicate this to airspace users. JP 3-30 defines the ATO as "A method used to task and disseminate to components, subordinate units, and command and control agencies projected sorties, capabilities, and-or forces to targets and specific munitions. Normally provides specific instructions to include call signs, targets, controlling agencies, etc., as well as general instructions."

The process to create an ATO is conducted in six phases beginning with receipt of guidance and ending with assessment of missions flow. Phase four of the process is the creation of the ATO. The ATO is supported by two supporting documents, the Airspace Coordinating Order and the Special Instructions.

JP 3-30 defines the Airspace Coordinating Order as "An order implementing the ACP that provides the details of the approved request for airspace requests and airspace coordinating measures. It is published either as part of the ATO or as a separate document."[7]

The following excerpt from JP 3-0 identifies the unique functions of the JFACC: oversight of joint air operations, resource allocation, and airspace control authority. The responsibility to serve as the Airspace Coordinating Area is of relevance to this study. "The Airspace Coordinating Authority coordinates and integrates the use of the airspace under the Joint Forces Commander's authority. The Airspace Coordinating Authority develops guidance, techniques, and procedures for airspace control and for the coordination required among units within the operational area."[8] This means that the JFC retains responsibility for the integration of all airspace above the operational area but delegates the authority to manage that airspace to the JFACC. Through products such as the Airspace Control Order, ATO, and Special Instructions the JFACC has the responsibility to create the rules by which all users of airspace must comply.

Summary

With an understanding of what graphical control and FSCM facilitate, what doctrine provides in terms of employment guidance, what surface fires require in terms of airspace, and how airspace is managed, a maneuver commander is prepared to enter into airspace discussions with the JFC. However, this occurs at the highest levels. In the lead up to the Gulf War, there was disagreement between the service component commanders on how best to apply air power. Settling the argument, General Schwarzkopf stated, "Guys, it is all mine, and I will put it where it needs to be put."[9] As the BCT continues to operate decentralized in accordance with TRADOC Pamphlet 525-3-1 and is employing his fires in accordance with TRADOC Pamphlet 525-3-4, those brigade commanders must insert themselves into the process but can only do so by communicating the risk of restrictive ACM.

---

[1]Chairman, Joint Chiefs of Staff, JP 3-52, B-B-12.

[2]Department of the Air Force, AFDD 3-52, 37.

[3]Department of the Army, United States Marine Corps, FM 6-40, MCWP 3-1.6.19, 7-1.

[4]Ibid.

[5]This data is found in table G, column 11 for 155mm and 105mm artillery and 120mm mortars. Table E, column 8 provides the same data for 81mm and 60mm mortars.

[6]U.S. Army ARDEC, *FT 105-AS-4* (Aberdeen Proving Ground, MD, 24 August 2005), XXI.

[7]Chairman, Joint Chiefs of Staff, JP 3-30, GL-3.

[8]Chairman, Joint Chiefs of Staff, JP 3-0, III-8.

[9]Thomas Keaney and Eliot Cohen, *Gulf War Airpower Survey Summary Report* (Washington, DC: US Government Printing Office, 1993), 391.

CHAPTER 3

METHODOLOGY

The study will answer the thesis question, “Does doctrine adequately prepare maneuver commanders to enter into airspace discussions with the JFC?” In an attempt to fill the gap in knowledge, this thesis will address one primary and three secondary questions. The primary question is, “What does a maneuver commander need to know to employ the surface based fires at his disposal with minimal constraint during decentralized full spectrum operations?” The secondary questions are, “What do graphical control and FSCM facilitate in relation to the ground commander?” In an airspace unconstrained environment, what altitudes would be required for surface-to-surface fires to achieve the commander’s intent?” Finally, “How does a maneuver commander articulate his requirements within the airspace process?”

Analysis of the primary question as well as the first and third secondary questions will be executed utilizing an exploratory research method. This will allow the study to look at the definitions and guidance provided in doctrine, to discover what information is provided to maneuver commanders to operate decentralized and manage their airspace and then evaluate the sufficiency of that guidance.

The second, secondary question, will require a cost benefit analysis comparing surface fired weapons system ranges point of maximum trajectory, versus the range at which those fires will achieve. This will be defined as the benefit, as it will display for the maneuver commander what he may gain in terms of unhindered employment of his organic surface fires. The cost, will be in terms of how much airspace is required to achieve given ranges.

The purpose of this research method is to compare desired range to target, with the MO required to achieve that range. To uncover that data point, the TFTs will be utilized for each munitions and weapon system organic to a BCT. These include 60mm, 81mm, and 120mm mortars, as well as 105mm and 155mm howitzers. These TFTs are broken down into various tables for each charge or munitions. For this study, the maximum allowable charge for each munition was selected as it provides the extreme MO required employing the system. That does mean that some ranges might be achievable under a given MO with a lower charge, but provides the reader with the most complete understanding of the problem by presenting the worst case that could be required in combat operations. A detailed discussion of how data was extracted for this study is contained in Appendix A.

In summary, by exploring the definitions and guidance provided in joint and service doctrine, it bridges the gap in knowledge BCT commanders have regarding airspace and fire support coordinating measures affecting their employment of organic surface fires. The cost benefit analysis will provide the maneuver commanders the information required to articulate to the JFC, their needs and associated risks if the airspace does not facilitate decentralized employment of organic surface fires. A secondary benefit of this study is, it will provide a body of work that BCT staff can use to communicate to the commander, what they can provide in terms of surface fired ranges based on published CAs. Currently a single source document does not exist to provide this information to them. A BCT staff could need to reference as many as 12 different TFTs to obtain the data required to answer a commander’s inquiry on what impact a prescribed coordinating altitude has on his fires.

CHAPTER 4

ANALYSIS

The study will answer the thesis question, "Does doctrine adequately prepare maneuver commanders to enter into airspace discussions with the JFC?" In an attempt to fill the gap in knowledge, this thesis will address one primary and three secondary questions. The primary question is, "What does a maneuver commander need to know to employ the surface based fires at his disposal with minimal constraint during decentralized full-spectrum operations?" The secondary questions are, "What do graphical control, and FSCM facilitate in relation to the ground commander?" In an airspace unconstrained environment, what altitudes would be required for surface-to-surface fires to achieve the commander's intent?" Finally, "How does a maneuver commander establish his requirements within the airspace process?"

This chapter will analyze six major airspace and fire support coordinating measures affecting a maneuver commander's utilization of airspace. Once that is framed, this chapter will compare the BCTs organic surface fires assets ranges to MO, to recommend an acceptable CA that supports maneuver while limiting the impact to fixed-wing freedom of maneuver. Finally a discussion on the doctrinal process for airspace management to establish how a commander would enter into the airspace discussion is provided.

Fire Support and Airspace Coordination Measures

JP 3-09, *Joint Fire Support* states, "FSCM enhance the expeditious engagement of targets, protect forces, populations, critical infrastructure, and sites of religious or cultural significance, and set the state for future operations. Commanders position and adjust FSCM consistent with the operational situation and in consultation with superior, subordinate, supporting, and affected commanders."[1] Of note is the requirement for the commander to manage these FSCM and utilize them to engage targets. It is worth noting there are many FSCM, however, for enabling fires there are two that affect fires the greatest; they are the FSCL and the CFL. Both of these FSCM are permissive, meaning they facilitate fires with minimal deconfliction thereby increasing responsiveness.

Fire Support Coordination Line

The FSCL is defined in JP 3-09 as,

> A fire support coordination measure that is established and adjusted by appropriate land or amphibious force commanders within their boundaries in consultation with superior, subordinate, supporting, and affected commanders. FSCLs facilitate the expeditious attack of surface targets of opportunity beyond the coordinating measure. A FSCL does not divide an AO by defining a boundary between close and deep operations or a zone for close air support. The FSCL applies to all fires of air, land, and sea-based weapon systems using any type of ammunition. Forces attacking targets beyond a FSCL must inform all affected commanders in sufficient time to allow necessary reaction to avoid fratricide. Supporting elements attacking targets beyond the FSCL must ensure that the attack will not produce adverse effects on, or to the rear of, the line. Short of a FSCL, all air-to-ground and surface-to-surface attack operations are controlled by the appropriate land or amphibious force commander. The FSCL should follow well-defined terrain features. Coordination of attacks beyond the FSCL is especially critical to commanders of air, land, and special operations forces. In exceptional circumstances, the inability to conduct this coordination will not preclude the attack of targets beyond the FSCL. However, failure to do so may increase the risk of fratricide and could waste limited resources.[2]

This definition provides a description, meaning, and context to the definition for the commander. Examining the parts of the definition allow a commander to understand who is affected, what the permission and restrictions are, as well as how to employ it. It clearly establishes that fires beyond the FSCL need not be approved by another authority, but that the affected authority must be informed. An example of this would be a Brigade Commander utilizing his UAV, locates a target beyond the FSCL. He deems his 155mm howitzers can effectively engage the target, however since it is beyond the FSCL, he must inform the JFACC he intends to do so. This is not to seek approval, but to inform the JFACC that munitions may affect his operations. Conversely, if the JFACC utilizing his UAV, locates a target short of the FSCL, he is required to request approval of the land commander to engage the target, due to its proximity to ground troops and affects it will have on a maneuver battle space. It is noteworthy, that if a JFLCC does not establish a FSCL, the JFACC does not have access to any part of the AO without coordination. By granting access to the JFACC, the JFLCC gives defacto permission for operations beyond the FSCL to the JFACC. That places the onus on the JFLCC to coordinate fires beyond the FSCL with the fixed-wing aircraft to achieve integration and deconfliction and more importantly, ensure safety to those elements operating beyond it.

The definition also gives guidance on placement of the FSCL by stating it should be on a definable terrain feature. This ensures that from the air it can be easily recognized. Appendix A, of JP 3-09 provides additional positioning guidance to commanders on the FSCL. "The FSCL is normally positioned closer to the forward line of own troops in the defense than in the offense; however, the exact positioning depends on the situation."[3] Additional discussion is found in professional writings that highlight the advantages and disadvantages of FSCL placement. "The resulting overlap of battle space and fires can potentially blur control and coordination authority measure in an LCC [Land Component Commander]AO. As a possible means to deal with this problem, the LCC can place the FSCL at the maximum range of organic fire support systems, ensuring these fires always occur inside the FSCL and, therefore, do not require coordination with the ACC [Air Component Commander]."[4] The author goes on to state "Conversely, the FSCL can be placed close to the friendly ground forces in the AO, maximizing the chances for Air Forces to conduct attacks uninhibited by extensive and detailed coordination measures. Obviously coordination restrictions on LCC fires long of this FSCL would place an undue and unacceptable burden on the LCC forces in the AO and limit joint employment and potential success."[5] This discussion on the FSCL is relevant to maneuver commanders in that it establishes in joint doctrine both a definition and discussion to maneuver commanders on its employment. Therefore, as the Brigade Commander develops the operational plan they must consider what organic assets they have at their disposal and communicate to the JFLCC where the FSCL should be placed, to provide them the greatest flexibility to employ those fires.

Coordinated Fire Line

The CFL is the other fire support coordination measure that affects fires. JP 3-09 defines it as "A line beyond which conventional and indirect surface fire support means may fire at any time within the boundaries of the establishing headquarters without additional coordination. The purpose of the CFL is to expedite the surface-to-surface attack of targets beyond the CFL without coordination with the ground commander in whose area the targets are located."[6] The CFL is a fire support coordination measure designed to facilitate fires inside a maneuver battle space without prior clearance of ground forces. Although it has minimal impact on air-to-surface fires, the establishment of a coordinate fire line does provide the fixed-wing aircraft relative assurance that fires delivered between the CFL and the FSCL are limited in risk to friendly ground forces.

JP 3-09 states in the definition it is designed to expedite surface based fires. Outside the definition, it expands to say "a line beyond which conventional indirect surface joint fire support means may fire at any time within the boundaries of the establishing HQ without additional coordination."[7] The Brigade Commander typically establishes the CFL.

By exploring these FSCM there are a two noteworthy items. Both are permissive measures meant to expedite joint fires. Both use terms such as "without additional coordination." To a maneuver commander, it can be inferred that he can employ his organic surface fires within his battle space relatively unhindered if these two FSCM are properly placed. This is in line with guidance provided in joint doctrine. "Use the lowest echelon capable of furnishing effective support. In order to keep joint fire support responsive, the lowest level having effective means available should deliver it."[8] Why then are commanders challenged with employing organic surface fires? One author contends integrating fires is just plain difficult. "Integrating fires is difficult because it couples critical effects with lethal consequences–we've got to do it, but we've got to do it right."[9] Recall from chapter 1 of this study, the recognition in Air Force Doctrine that artillery is an airspace user. That means that although a maneuver commander has control measures to facilitate organic surface fires, in order to employ them he must have control of the air, not just the land, to do so. These joint definitions all address the permissive or restrictive nature of employing fires short of, or long of, the control measure. Although joint doctrine addresses the airspace domain with mention that it belongs to the JFC, and he delegates management of it to the airspace coordinating authority, but neglecting to address how, or if it extends up from these FSCM, joint doctrine does not provide clarity to the maneuver command in regards to what is required for fires to travel from the gun to the target. One would assume that clarity on this would come in the form of joint definitions relating to battlefield ownership. Unfortunately, that is not so.

Ground Coordination Measures

Area of Operations is not a fire support or airspace coordinating measure but it does have relevance to the airspace discussion. JP 3-0, *Joint Operations,* provides the baseline for joint operations and establishes, through definition, certain terms to guide operations. This defines the workspace a unit has to operate. It defines AO as, "An operational area defined by the JFC for land and maritime forces. Areas of operations do not typically encompass the entire operational area of the JFC, but should be large enough for component commanders to accomplish their missions and protect their forces."[10] This states that the JFC has the authority to establish these areas and define them geographically. It leaves to question how an AO is defined in relation to airspace. Are boundaries merely on the surface or does that line extend into space? JP 3-52 states, "Airspace is a crucial part of the operating environment and is used by all components of the joint and multinational forces. A high concentration of friendly surface, subsurface, and air-launched weapon systems must share this airspace without unnecessarily hindering the application of combat power in accordance with the JFC's intent."[11] This begs the question, who controls the airspace?

Joint doctrine does not provide clarity in further discussion of the operational area. "Operational area is an overarching term encompassing more descriptive terms for geographic areas in which military operations are conducted. . . . JFCs define these areas with geographical boundaries, which facilitate the coordination, integration, and deconfliction of joint operations among joint force components and supporting commands."[12] Who then controls airspace? As discussed in chapter 2 of this thesis, the Airspace Coordinating Authority[13] develops the ACP and has the authority to "approve, amend, or disapprove airspace requests for the designated operational area in accordance with the JFC guidance and objectives."[14] This gap in doctrine creates an ambiguous environment, where maneuver commanders are directed to operate freely to achieve desired effects with minimal restraint, while simultaneously subjected to rules established by the Airspace Coordinating Authority, that affect their ability to employ fires above the surface level. How then are commanders able to employ fires? They must utilize ACM.

Airspace Coordinating Measures

A commander can reserve airspace by utilizing an airspace coordination measure. JP 3-52 defines these as, "Measures employed to facilitate the efficient use of airspace to accomplish missions and simultaneously provide safeguards for friendly forces."[15] The JP lists 111 ACM and FSCM and have broken these down into eight main categories: air defense area, air defense operations area, air traffic control, air corridor-route, procedural control, reference point, ROZ, and special use airspace.[16] The majority of these affect airspace related to air defense, air traffic control such as flight paths and patterns, reference points, or FSCM previously discussed. There are three primary procedural control ACM that affect a commander's ability to utilize airspace when employing organic surface fires. They are restricted operations zone (ROZ), ACA, and CA.

Restricted Operations Zone

A ROZ is "Airspace reserved for specific activities in which the operations of one or more airspace users is restricted."[17] A ROZ is often referred to as a restricted operations area (ROA), meaning airspace dedicated for a specific use, and is active until the mission is complete.[18] The Army and Air Force multi-service publication on airspace tactics, techniques, and procedures discussed in chapter 2 provides discussion on this airspace coordinating measure supplementing joint doctrine. “A ROZ or ROA is the prescribed ACM for airspace planners to facilitate operations. A ROZ or ROA is used for artillery, mortar, naval surface fire support, UA [Unmanned Aircraft] operating area, aerial refueling.”[19] It goes on to state “Ideally, all ROAs would be preplanned and included in the published ACO [Air Control Order]. However, during high intensity operations, there is often a requirement to establish immediate measures that restrict the use of airspace. The pace of operations could preclude the established procedures for requesting and or establishing an ROA for an immediate operation.”[20]

The establishment of a ROZ allows the maneuver commander to section off a piece of airspace to deconflict his organic surface fires assets, to fire unhindered by coordination with the airspace control authority. Basically, it keeps aircraft out of an area of airspace until they coordinate and are approved by the ground commander for entry. It is permissive for his surface fires assets, and restrictive for air assets. Although this does facilitate firing, it requires time and coordination to implement. An example of a ROA can be seen in a troops-in-contact situation. “Before the implementation of the TIC [troops-in-contact] ROZ, CAS, or fires in support of TIC were often delayed until the CRC [control and reporting center] could clear airspace needed for the mission.”[21] This reference is to a vignette discussing operations in Sadr City, Iraq and provides an example of a successful use of ACM to facilitate joint fires.

If a maneuver commander was to expand the use of the ROZ and plan these extending from his firing unit location to the anticipated target area for any given mission in his AO, he would accomplish the intent of joint doctrine as highlighted in the RAND study, *Beyond Close Support*. “Within the range of his organic weapons (normally 30 to 40 kilometers), the land-force commander rightly expects to control air attacks. Indeed, he must have such control in order to integrate direct fires, artillery, rockets, attack helicopters, and fixed-wing aviation.”[22] The RAND authors contend that if a maneuver commander has a method to control airspace he is better suited to integrate all aspects of fires in his operations. The ROZ meets that goal. However, if a maneuver commander establishes ROZs from each of his firing unit locations to their maximum range, the airspace becomes extremely crowded with coordination measures and they could lead to decreased CAS response times or impede the flow of air traffic. A ROZ is a permissive fire coordination measure. That means that the controlling authority grants users access to non-preapproved users of that volume of airspace. Consider a Light Infantry BCT employing the Artillery Battalion at the platoon level. If a BCT establishes a ROZ over ever artillery platoon, and all battalion mortars that result in seven circular ROZs requiring between 6,900 to 20,000 meters of surface space and up to a maximum of 45,000 feet in airspace. Any fixed-wing platform that requires access to that airspace must contact, coordinate with, and be granted permission by, the establishing headquarters, to enter each of those pieces of airspace prescribed within each ROZ before proceeding to the target or along their route.

Airspace Coordination Area

The second airspace coordination measure that affects a maneuver commander's ability to employ organic surface fires asset is ACA. JP 3-52 defines it as "A three-dimensional block of airspace in a target area, established by the appropriate ground commander, in which friendly aircraft are reasonably safe from friendly surface fires. The ACA may be formal or informal."[23] This is a permissive control measure established by maneuver to allow fixed-wing freedom of maneuver typically used during CAS missions in order to deconflict the firing of surface fires with the flight path of aircraft.[24] This allows a maneuver commander to employ both assets on a target by deconflicting them laterally or by time over a target area. This is not an enduring control measure, but rather a short-term method to minimize risk when integrating fires.

However, if a maneuver commander has operational control over the AO, why then does airspace matter? Why would he need to establish a ROZ or ACA to fire his organic surface fires assets? Should a maneuver commander not own the terrain on both the surface and airspace above it? Joint doctrine does not provide adequate guidance on this with the definition of operations area as defined above in JP 3-0. The airspace above an operations area is neither included nor excluded from the maneuver commander's control but the airspace control authority is granted the authority to approve and disapprove requests to use airspace. The answer is that to allow aircraft airspace to operate, a need exists to establish a line between the maneuver commander's airspace and the JFACCs airspace. This is called the coordinating altitude.

Coordinating Altitude

The definition of CA was revised in joint doctrine with the publication of the May 2010 update to JP 3-52, *Joint Airspace*. The JP definition is "An airspace coordinating measure that uses altitude to separate users and as the transition between different airspace coordinating entities." Prior to the most recent publication of JP 3-52, the services were using the CA outside the definition that existed at that time. "Operations Iraqi Freedom (OIF)/Operation Enduring Freedom (OEF) operations use the term CA as the vertical limit between airspace control agencies [i.e. the top of Army controlled airspace and the bottom of CRC controlled airspace]."[25] Although this is very similar to the current joint doctrine definition of CA, it is important to note that the application was occurring prior to the joint doctrine revision. FM 3-52.1 states, "Current theater usage is outside the JP 3-52 doctoral definition."[26] At that time, the definition of CA actually mirrored what is now defined as the coordinating level. The importance of this acknowledgment is to establish the background that led to the definitions revision.

Two documents were provided to the author of this study from the joint staff, J7, regarding the revision of JP 3-52. The first document was the consolidated comments from the staffing committee and the second is the decision comments from the approval board. Both documents provide a speaker, comment and recommendation, and rational. They provide insight into the discussion that led to final decision and revision of the definition of CA.

Discussions during the revision committee begin with the Army representative responding to the proposed refined definition of CA.

> A vertical boundary that delineates airspace for the purpose of facilitating, coordinating, and deconflicting operations between airspace control agencies. The

> CA is normally specified in the ACP and may include a buffer zone for small altitude deviations. All airspace users must coordinate with the airspace control agency when transitioning though or firing through (above or below) the CA.[27]

The Army representative further explains,

> The proposed re-definition of "CA" is unacceptable. It goes beyond a definition by specifying procedures. The definition would impinge upon commanders' authority/responsibility to manage risk, especially regarding surface-to-surface fires. As proposed, this definition would require coordination with an airspace control agency whenever indirect fires were applied. It takes from the commander the ability to plan fires and airspace in sufficient detail so as to minimize risk while preserving flexibility and responsiveness for fire support.[28]

This comment is supported by the Pacific Command representative whom states, "Operational use of the CA has changed from a measure to separate rotary wing from fixed wing aircraft to one which separates all airspace users. . . . Requiring firing batteries to contact controlling agencies above the CA hampers the timely prosecution of targets."[29]

In the approval committee, the first mention of revision comes from the Special Operations Command. The recommendation was "CA is a boundary that delineates airspace for the purpose of separating airspace users by altitude. The CA, measured above ground level (AGL), is normally specified in the ACP and may include a buffer zone for small altitude deviations."[30] The commenter goes onto state,

> The CA requires special consideration due to its impact on the integration of C2 agencies, fires, and maneuver. The decision on where to place (or even to use) a CA requires careful consideration. Placement of the CA should strike a balance so as not to unduly inhibit operations while maximizing the effectiveness of organic and joint fires. The optimum CA (again, specified as above ground level) varies with specific operational area circumstances to include: respective C2 agencies ability to provide airspace C2 below the CA, anticipated ground scheme of maneuver during an effective time period of the CA, and indirect fire support systems' range and altitude limits.[31]

The responding moderators comment was, “The proposed CA is in fact a horizontal control measure with no vertical boundaries. Any control measure for the purpose of control should be three dimensional in order to properly identify the volume of airspace. . . . The revised definition is better than the one originally proposed, but is still redundant and creates a shortfall for separating fixed and rotary wing aircraft procedurally.”[32]

In response to this recommendation, the United States Marine Corps representative recommended to retain the current definition with the addition of a requirement to publish it in the air control products.[33] The Special Operations Command representative then proposed an alternate definition. “A boundary that delineates airspace for the purpose of separating airspace uses by altitude facilitating, coordinating, and deconflicting operations between airspace control agencies. The CA, measured above ground level (AGL), is normally specified in the ACP and may include a buffer zone for small altitude deviations.”[34] The rational provided was to “separate the different types of airspace users. It is an airspace coordinating measure. The controlling agency for that airspace above and below the CA, would be disseminated in the ACP.”[35]

The Marine Corps representative disagreed and proposed the following change in response a separate term, “coordinating level”, to meet this purpose. “Coordinating level. A procedural method to separate fixed-and rotary-wing aircraft by determining an altitude below which fixed-wing aircraft normally will not fly.”[36] The Army representative proposes one final adjustment with the recommended modification of “A boundary that delineates airspace for the purpose of separating airspace users by altitude. The CA, AGL is normally specified in the ACP and may include a buffer zone for small altitude deviations."[37] Rational provided, supported the Special Operations Command representative, by contending the purpose was to "separate different types of airspace users."[38] They also asserted that there was no need to specify in the definition who controlled what airspace, but it should be placed in the airspace control order.[39] This discussion, led by the Special Operations Command and Army, resulted in the current joint definition.

The key component that survived the revision process puts the definition in line with the application in current operations. The CA serves as separation between airspace users and defined that the airspace above and below it would be controlled by separate coordinating entities. Control is not ownership. Airspace is controlled, meaning whoever is designated as the controlling agency, is responsible for the administration of operations within the area they are designated to control. That means not only integrating the assets they have at their disposal within the airspace they are designated, but also deconflicting that same airspace if another user is required to use it. For example if a BCT is designated as the controlling agency below the CA and an F-15 is engaged in an intercept mission and offensive counter air is a JFC priority, the Brigade Commander must clear the airspace to facilitate that mission even if it means cutting off fires. As stated, the definition of CA in joint doctrine grants control of airspace to the maneuver commander over his operations, but fails to address placement of the CA or considerations to do so, leaving ambiguity as to where maneuver commanders control of airspace ends and JFACC's control of airspace begins.

Joint doctrine does not provide any additional guidance on placement of the CA. This measure is discussed in JP 3-52, the discussion of who an airspace coordinating agency is, is in chapter 2. In that same paragraph, it states, “The coordinating altitude is an ACM. It uses altitude to separate users and as the transition between different airspace coordinating entities. . . . All airspace users should coordinate with the appropriate airspace coordinating entities when transitioning though or firing though the CA.”[40] Army doctrine provides no guidance for placement in the current draft of FM 3-52. Exclusive of the definition in the glossary, the only mention of the CA is in regards to the requirement to control the airspace below the CA.[41]

The only doctrine that provides guidance on the placement of the CA is an Air Force Doctrine.

> The coordinating altitude (CA) is a type of airspace coordinating measure. It represents a vertical boundary that delineates airspace to facilitate the coordination and deconfliction of operations between airspace users and controlling agencies. The decision on where to place (or even to use) a CA requires careful consideration due to its impact on the integration of C2 agencies, fires, and maneuver. Placement should strike a balance between maximizing the effectiveness of air components and organic forces while not unduly inhibiting those same operations. The optimum CA (specified as above ground level) varies with specific operational area circumstances but should address the following: the respective C2 agencies’ ability to provide airspace C2 below the designated CA, the anticipated ground scheme of maneuver during the effective time period established for the CA, and affected indirect fire support systems’ range an altitude limits.[42]

Although the joint definition uses the word separate and the Air Force definition uses the term boundary the stated intent of both is the same. The requirement to transition between coordinating authorities is to coordinate, not seek approval or clearance.

Reflecting on the three considerations listed in the Air Force Doctrine for CA placement: ability to control airspace, scheme of maneuver, and indirect fire systems capabilities, this paper does not address the technical aspects of a brigade’s ability to control airspace. Previously in chapter 1 the scope was narrowed to focus on phase three operations when the land component is the supported commander and the expectation for surface fires is highest. What results is a requirement to evaluate the organic fire support systems capabilities in terms of range, compared with altitudes required to achieve those ranges.

Cost Benefit Analysis

The purpose of the cost benefit analysis is to address the second secondary question, with a comparison of surface fired weapons system ranges point of maximum trajectory, against the range at which those fires will affect. The TFTs are the basic source of firing data. They present fire control information in a tabular format. The range listed in the TFT will be defined as the benefit, as it will display for the maneuver commander what he may gain in terms of unhindered employment of his organic surface fires. The cost will be in terms of how much airspace is required to achieve these ranges. To uncover that data point, the TFTs for each munitions and weapon system organic to a BCT were reviewed. These include 60mm, 81mm, and 120mm mortars as well as 105mm and 155mm howitzers. The entry argument used to extract a data point is range to target, column A in table G.[43] This study is concerned with column 11, MO. This column provides the "maximum height above the gun of the trajectory fires, under standard conditions, to the range in column 1."[44] This provides the point at which the round stops rising and begins falling enroot to a target at a given range and is the essential data point for establishing what volume of airspace is required to employ surface based fires.[45] Details relating to how data was extracted from the TFT are found in Appendix A and the maxord by weapon system is in Appendix B of this study.

Mortars

Company Mortars

The 60mm mortar is the basic organic indirect fire system for the Infantry Company. They are under the direct control of an Infantry Company Commander, a Captain. It provides immediate fire support at distances of up to 3,450 meters and fire the high explosive lethal munitions as well as illumination and concealment smoke. The 60mm mortars are not direct fire weapons. They fire with a lobbing trajectory towards a target. This system is assigned to an Infantry Company. A CA of 3,000 feet AGL would prevent any uncoordinated firing of 60mm mortars. A CA of 7,500 feet allows the Infantry Company to fire the complete span of ranges within the capabilities of the system. This is due to the trajectory the mortar fires. As range increases, maxord decreases. Annex B provides the detailed analysis of the range to maxord comparison. When considering airspace usage, an Infantry Company Commander would be best served to keep his mortars at maximum range to minimize maxord. Tactically however, this would mean a distance of over three kilometers between his indirect fire asset and his company.

Two issues are present with a CA below 7,500 feet for 60mm mortars. They are tactics and deconfliction. An Infantry Company is at a disadvantage if airspace drives their placement and employment of the mortar section. This is an organic system to the company meant to be integrated into operations and employed at the discretion of that commander. Placement of the section at up to one third maximum range, or 1,600 meters from the Infantry Company, causes challenges from logistics, to security, as well as maneuver flexibility.

The second issue is with deconfliction. The Company Commander is four levels of command below the Division. For him to coordinate with the controlling authority to fire above the CA, he would either require direct communication with the JFACC, or suffer the communications chain from him, to his Battalion, to the Brigade, then Division and up to the Combined Air Operations Center, to coordinate his fires. This issue is not that a system does not exist to execute this, but that it is time consuming. During that period where coordination is being sought with the controlling agency, the company commander's mortar system stands by waiting to fire on an identified enemy target. On its face, this requirement goes against the stated intent of TRADOC Pamphlet 525-3-6, *The United States Functional Concept for Movement and Maneuver: 2016-2028* to "integrate mortars with other indirect fires systems through the network to provide offensive and defensive fires for decentralized full-spectrum operations across wide areas."[46]

The risk to the maneuver commander is a complete loss of responsive fires that his infantry companies are organically resourced to execute. CAs below 7,500 feet also places an increased requirement on the battalion staff to seek coordination for each mission each of these company mortar systems attempt to fire sacrificing timeless of responsive fires. This undermines the principles of initiative, decisive action, and MC under the foundations of unified land operations.[47]

<u>Battalion Mortars</u>

The 81mm and 120mm mortars are the basic organic indirect fire system for the Infantry Battalion. They are under the direct control of an Infantry Battalion Commander. The 81mm mortar provides immediate fire support at distances of up to 5,792 meters and fires high explosive lethal munitions, as well as illumination and concealment smoke. The 120mm mortar is the Army's heavy mortar. It was designed to fill the gap between the 81mm mortar and the 105mm howitzer, with increased maneuverability and a decreased operational footprint.

The Battalion Commander has greater flexibility to employ this system than does an Infantry Company employing his mortars. However, he only has one firing element and must consider placement optimal to support his main effort or arrayed to support a majority of his force. A CA of 12,500 feet is required to allow the infantry battalion to fire the complete span of ranges within the capabilities of the system. A detailed analysis of the range to maxord comparison can be found in Appendix B. When considering airspace usage, due to the weapons trajectory, an Infantry Battalion Commander is best served by keeping his mortars at maximum range, but tactically this would mean a distance of over four kilometers between his indirect fire asset and his elements.

Two issues are presented with a CA below 12,500 feet for battalion mortars. Similar to the company mortars, they are tactics and deconfliction. This is an organic system to the battalion, meant to be integrated into operations and employed at the discretion of that commander. The Battalion Commander is able to overcome some of the issues presented to the Company Commander, in that he is able to employ assets from across his battalion to meet the challenges of logistics and security. However, in combined arms maneuver this responsibility is to "force the [enemy] commander to respond to friendly action. In the offense, it is about taking the fight to the enemy and never allowing enemy forces to recover from the initial shock of the attack."[48] If he is emplacing his mortars with consideration to airspace, he will be severely restricted in his ability to support the entirety of his force with his mortars, unless they are facing a linear enemy where positioning is simplified.

The second issue is with deconfliction. The Battalion Commander is three levels of command below the Division and the Division is responsible for taking the coordination request to the Combined Air Operations Center. Like the Company, for him to coordinate with the controlling authority to fire above the CA he would either require direct communication with the JFACC or suffer the communications chain from him, to the Brigade, then Division and up to the Combined Air Operations Center to coordinate his fires. During that period, his mortar system stands by waiting to fire on an identified enemy target. The risk to the maneuver commander is a loss of responsive fires that his Infantry Battalion is organically resourced to execute. A CA that restricts his battalion level mortar fires undermines the principles of initiative, decisive action, and MC under the foundations of unified land operations.

Artillery

The 105mm and 155mm howitzer are the basic organic indirect fire system for the Infantry Brigade. They are under the direct control of an Artillery Battalion Commander, but do not employ fires at his discretion. Fires are planned and directed by the Brigade Commander to support the brigade as a whole. They can be placed under the operational control of the main effort, arrayed on the battlefield to provide full coverage to the brigades units, or consolidated to mass fires on a particular enemy. They provide the Brigade Commander immediate, mobile, all weather fire support.

The 105mm howitzer provides immediate fire support at distances of up to 11,000 meters with conventional munitions and 20,000 meters with extended range munitions, to include high explosive lethal fires, illumination, and concealment smoke. At maximum range, the 105mm howitzer can fire 11,000 meters with conventional munitions with a maxord of only 2,346 meters. A CA of 3,000 feet would allow his 105mm howitzers to fire in the low angle standard ranges up to 8,000 meters. A detailed analysis of the range to maxord comparison can be found in Appendix B. High angle fires require a maxord of 4,373 to achieve the same maximum range. The lowest CA acceptable to introduce high angle fires with any significant range is 20,000 feet. To achieve the extended ranges the 105mm howitzer is capable of, 20,000 meters, a maxord of 7,399 meters is required. A CA of 12,500 feet is the point at which all munitions, less high angle extended range munitions, are able to extend the tactical advantage of the commander.

The 155mm howitzers are both towed and self-propelled, depending on the type of brigade they are assigned to. Regardless of the platform that holds the gun, the ranges and suite of munitions are the same. It provides immediate fire support at distances of up to 18,000 meters with conventional munitions and 29,000 meters with extended range munitions to include high explosive lethal fires, illumination, and concealment smoke. At maximum range, the 155mm howitzer can fire 18,000 meters with conventional munitions with a maxord of only 4,689 meters. A CA of 3,000 feet would allow a commander to fire his 155mm howitzers in the low angle ranges up to 11,000 meters. A detailed analysis of the range to maxord comparison can be found in Appendix B. Firing standard munitions, the same maximum range of 18,000 meters high angle requires a maxord of 7,844 meters. The lowest CA acceptable to introduce high angle fires with any significant range is 25,000 feet. With this CA, he can employ standard charges of high explosive munitions and rocket assisted projectile but only at the extreme maximum of their ranges. The most restrictive 155mm fires to employ under a directed CA, would be the base bleed and Extended Range Rocket Assisted Projectile, high angle. To fire the full range capabilities of base bleed, a CA of 55,000 feet is required and 65,000 feet for an Extended Range Rocket Assisted Projectile. That is 12.3 miles up, before the round begins to descend towards the target.

A unique benefit to the 155mm howitzer is the added capability of firing precision. The 155mm can fire the Excalibur, noted in the annex B 155mm tables as XCAL. This is currently the only artillery delivered precision munitions in the inventory. The Excalibur round provides the commander the ability to strike a target with accuracy that conventional munitions cannot provide. This is a significant tactical advantage to the commander, however employing this round comes at a significant cost in regards to airspace. The range of the Excalibur round has a minimum firing distance of 11,500 meters and a maximum range of 27,000 meters. To achieve the minimum range, a maxord of 6,543 meters is required. To achieve the maximum range 7,378 meters is required. The very narrow separation between the minimum and maximum ranges places this round in a very specific band of airspace. In terms of feet, this round would require a CA of a minimum of 20,000 feet and a maximum of 25,000 feet under standard conditions. Although Excalibur provides a unique capability to the commander, employment must be very closely planned and coordinated.

The same conclusion can be drawn for both systems firing all munitions low angle, a CA of up to 12,500 feet achieves a minimum of two thirds of their ranges, providing the commander the opportunity to extend his ability to influence the battlefield beyond that of his mortars.

When considering airspace usage, an Infantry Brigade Commander would be best served to keep his howitzers as close to his front line or at minimum range to the enemy, firing low angle. Tactically this may not be achievable due to terrain. If units were in a mountainous or urban terrain, then high angle would be required. In that case, if a commander were considering airspace, he would be served to keep them closer to maximum range from his expected targets to minimize airspace usage.

The howitzer gives the commander an array of opportunities in combined arms maneuver. With his artillery, he is able to meet the core tenants of combined arms maneuver laid out in the Army Doctrine Reference Publication 3-0. It states, "In combined arms maneuver, commanders force the enemy to respond to friendly action. In the offense, it is about taking the fight to the enemy and never allowing enemy forces to recover from the initial shock of the attack. In the defense, it is about preventing the enemy from achieving success and then counterattacking to seize the initiative."[49]

The fact that the Brigade Commander's artillery is contained in a self-supporting, independently commanded unit gives it a marked advantage over mortars. He can utilize the standoff the artillery provides and the low angle trajectory, to gain initiative in battle by influencing the enemy from afar. However, if he does not control airspace with a supporting CA he risks the ability to rapidly mass fires on the enemy at the time and place of his choosing. The artillery is his organic means to provide that.

Airspace Planning Process

Chapter 2 establishes the responsibilities and authorities granted to the JFACC by the JFC as the Airspace Coordinating Authority. Although an Airspace Coordinating Authority can be designated separate from the JFACC,[50] for the purpose of this paper it is assumed that future operations are conducted similar to Iraq and Afghanistan where the JFACC served both rolls. The overarching plan that governs air operations is the Joint Air Operations Plan. This guides air operations to mission accomplishment within the JFCs intent.[51] JP 3-30, *Command and Control for Joint Air Operations* states, “The JFACC must ensure that planning occurs in a collaborative manner with other components. Joint air planners should meet on a regular basis with planners form the other components to support integration of operations across the joint force.”[52] Joint doctrine recognizes that for integration to occur there is a need for input from all components.

The airspace planning process provides two entry points for a maneuver commander to have input. Initial planning for airspace occurs during the writing of the Joint Air Operations Plan. This is the maneuver commander’s first opportunity to shape the overall airspace plan. The Joint Air Operations Plan is similar to an operations order, in that is establishes the base plan and is written by the JFACC. The other time a maneuver commander could influence airspace is as updates to the Joint Air Operations Plan are written. The Army uses a fragmentary order to modify the operations order. The ATO allows a maneuver commander to request sorties and assets, but the maneuver commander should recognize a requirement to have input long before sorties are tasked, back in the development of the Airspace Control Order.

If a commander needs to control airspace to employ organic surface fires assets, airspace and FSCM are established in that document produced as part of the ATO. Of particular interest to the maneuver commander is the timeline for these products to be produced and implemented. Although there is no established requirement for the time period an ATO covers, it is recommended in JP 3-30 that a 72 hour cycle be employed with a 48 hours of planning and preparation and 24 hours of execution.[53] This has been the accepted practice during the most recent conflicts. The importance of this timeline to the maneuver commander is it establishes a timeline for his input. If there is a need for a specific fire support or airspace coordinating measure to be in place to support operations it must be communicated to the JFACC no later than 48 hours out from the desired implementation time.

A process exists to meet emergent battlefield needs but also has its challenges. “Future requirements for airspace management include dynamic airspace control and deconfliction during execution, while ADS (airspace deconfliction system) primarily functions as a static planning tool.”[54] This comment by researchers at the Air Force Research Lab highlights that technology must improve to better facilitate emergent needs for CAS as the battle progresses. However, a maneuver commander cannot wait for a future solution to be developed; he must work within the constraints and enter into the established process with foresight and timeliness.

How then does a maneuver commander ensure his needs are communicated into this planning process? The Army provides a liaison to the JFACC in the form of the Battlefield Coordination Detachment; however, this organization is not designed to interact with the BCT. “The Army component command established a BCD to act as the interface between the component commander and the JFACC. The BCD is collocated with the JFACC’s staff in the JAOC [Joint Air Operations Center]. The BCD processes land force requests for air support, monitors and interprets the land battle situation in the JAOC, and provides the necessary interface for the exchange of current operational and intelligence data."[55] It is important to take note that according to joint doctrine, the Battlefield Coordination Detachment works for the component commander. This implies high level management and interaction above the operational level. That is in stark contrast with the intent of the *United States Army Operating Concept 2016-2028*. "Brigades also require access to, and the ability to employ, a wide variety of joint, interagency, and multinational partner capabilities at lower levels. As described in joint concepts, joint integration that once took place at the component level or slightly below will occur routinely in the future at tactical echelons."[56] This implies that the Battlefield Coordination Detachment will need to be more closely tied to actual Combat Brigades as well as higher level staffs. However, for a maneuver BCT commander to influence the airspace discussions he must understand where to interject his needs.

Having established that a maneuver commander must provide his input to the Battlefield Coordination Detachment in a window of 72 to 48 hours prior to execution for optimal results. Analysis of the airspace and FSCM is required to examine what tools would facilitate a maneuver commander employing his organic surface fires assets.

Summary

Chapter 4 of this study set out to answer the thesis question, does doctrine adequately prepare maneuver commanders to enter into airspace discussions with the JFC by addressing the question of what does a maneuver commander need to know to employ the surface based fires at his disposal, with minimal constraint during decentralized full spectrum operations. By conducting an exploratory research method of graphical control and FSCM and the airspace process, it was found that with the exception of the Operations Area, the doctrine is sufficient. By utilizing a cost benefit analysis of surface-to-surface fires ranges compared to the amount of airspace required to fire those ranges, it provides the commander planning factors to meet his tactile objectives with fire, in an airspace unconstrained environment.

---

[1]Chairman, Joint Chiefs of Staff, JP 3-09, A-1.

[2]Ibid., GL-7.

[3]Ibid., A-4.

[4]John Horner, "The Fire Support Coordination Line: Optimal Placement for Joint Employment" (Master's Thesis, Command and General Staff College, Ft. Leavenworth, June 1998), 5.

[5]Ibid.

[6]Chairman, Joint Chiefs of Staff, JP 3-09, GL-6.

[7]Ibid., A-1.

[8]Ibid., III-12.

[9]Victoria T. Habas, "Effective Airspace Management to Facilitate Fires–Establishing an Airspace Management Authority (AMA)," *Air Land Sea Bulletin*, no. 2008-3 (September 2008): 17.

[10]Chairman, Joint Chiefs of Staff, JP 3-0, GL-6.

[11]Chairman, Joint Chiefs of Staff, JP 3-52, I-2.

[12]Chairman, Joint Chiefs of Staff, JP 3-0, II-16.

[13]Chairman, Joint Chiefs of Staff, JP 3-52, I-2.

[14]Ibid.

[15]Ibid., 6.

[16]Ibid., B-B-2 through 5.

[17]Ibid., B-B-1.

[18]U.S. Army TRADOC and the Curtis E. Lemay Center for Doctrine Development and Education, FM 3-52.1, AFTTP 3-2.78, 37.

[19]Ibid., 37.

[20]Ibid.

[21]Ibid.

[22]Bruce Pirnie et al., *Beyond Close Air Support* (Santa Monica, CA: RAND Corporation, 2005), 29.

[23]Chairman, Joint Chiefs of Staff, JP 3-09, GL-5.

[24]Chairman, Joint Chiefs of Staff, JP 3-52, B-B-7.

[25]U.S. Army TRADOC and the Curtis E. Lemay Center for Doctrine Development and Education, FM 3-52.1, AFTTP 3-2.78, 2.

[26]Ibid.

[27]Joint Staff, J7, "JP 3-52 RFD Adjudicated CRM" (Excel Table, e-mail from Mr. James Isitt, SAIC Site Lead, james.isitt.ctr@js.pentagon.mil, Washington, DC, 10 February 2012), Item 706.

[28]Ibid.

[29]Ibid., Item 775.

[30]Joint Staff, J7, "JP 3-52 RFC Consolidated Adjudicated Cmts Matrix 7 DEC 09" (Excel Table, e-mail from Mr. James Isitt, SAIC Site Lead, james.isitt.ctr@js.pentagon.mil, Washington, DC, 10 February 2012), Item 380.

[31]Ibid.

[32]Ibid.

[33]Ibid., Item 381.

[34]Ibid., Item 743.

[35]Ibid.

[36]Ibid., Item 746.

[37]Ibid., Item 915.

[38]Ibid.

[39]Ibid.

[40]Chairman, Joint Chiefs of Staff, JP 3-52, III-7.

[41]Department of the Army, Field Manual (FM) 3-52, *Airspace Integration*, Initial Draft (Washington, DC: Government Printing Office, June 2011), 3-3.

[42]Department of the Air Force, AFDD 3-52, 37.

[43]This data is found in table G, column 11 for 155mm and 105mm artillery and 120mm mortars. Table E, column 8 provides the same data for 81mm and 60mm mortars.

[44]U.S. Army ARDEC, *FT 105-AS-4*, XXI.

[45]Detailed analysis of computational data method can be found in Appendix A of this study.

[46]U.S. Army Training and Doctrine Command, TRADOC Pamphlet 525-3-6, 52.

[47]Department of the Army, ADRP 3-0. 22, 2-1.

[48]Ibid., 2-2.

[49]Ibid.

[50]Chairman, Joint Chiefs of Staff, JP 3-30, II-3.

[51]Ibid., III-1.

[52]Ibid.

[53]Ibid., III-20.

[54]Seifet et al., 15.

[55]Chairman, Joint Chiefs of Staff, JP 3-30, B-1.

[56]U.S. Army Training and Doctrine Command, TRADOC Pamphlet 525-3-1, 18-19.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

The overarching intent of this study was to address how to enable commanders to employ organic surface fires as described in *The United States Army Functional Concept for Fires: 2016-2028*, which states, “The authority to employ fires must also be decentralized to the lowest appropriate level according to METT-TC. Commanders at the point of decision will require the capability to clear fires on the ground and through the airspace, enabled by situational awareness and understanding.”[1] That quote requires authority to employ fires, the ability to do so decentralized, and the capability to clear those fires at the lowest level. To accomplish that, the study answers the thesis question, does doctrine adequately prepare maneuver commanders to enter into airspace discussions with the JFC. In an attempt to fill the gap in knowledge, this thesis addressed one primary and three secondary questions. The primary question was, “What does a maneuver commander need to know to employ the surface based fires at his disposal with minimal constraint during decentralized full-spectrum operations?” The secondary question: “What do graphical control and FSCM facilitate in relation to the ground commander?” In addition, “In an airspace unconstrained environment, what altitudes would be required for surface-to-surface fires to achieve the commander’s intent?” Finally, “How does a maneuver commander articulate his requirements within the airspace process?” This chapter will address the conclusions of this study, make recommendations for the future of organic surface fires and airspace doctrine in the 21st century joint fight, and recommend areas for future study on this topic.

Conclusion

Three main conclusions can be drawn from this study. The first conclusion relates to the initial secondary question addressing doctrine applicable to fires. The doctrine that currently exists is sufficient for a Brigade Commander to understand fire support and ACM to be able to employ his organic surface-to-surface fires. The second conclusion relates to the next secondary question regarding airspace required to enable fires. The study has revealed that surface based fires require varying amounts of airspace depending on their employment method and emplacement. The final recommendation relates to the last secondary question regarding how a commander establishes his requirements within the process. At the brigade level the commander must be included in the discussion of airspace planning if the Brigade Commander is to have the freedom to employ all of the tools of MC at his disposal.

Fire support and ACM are adequate for a maneuver brigade commander to understand their intent and employ fires within that intent. The FSCL has sufficient detail in both joint and service doctrine as well as supporting publications, for a commander to understand both, where optimally to place it, and how to employ fires short of or beyond it. The CFL, ROZ, and ACA are all well described and defined in doctrine.

Two gaps were discovered during this study. The first was the definition of AO, the second was with the lack of supporting discussion of CA, in joint or service doctrine. AO is the building block of all graphical control measures. It carves out the battlefield so a commander has an idea of where his responsibilities lie. It defines for them where they are to operate and what the limits of those operations are. However, absent from the doctrinal definition in JP 3-0 is any reference to airspace. It defines the battlefield by carving up the land into areas, but does not address the airspace above it. It could be said that there is clarity on this topic by referencing additional doctrine, however, this thesis contends that at the most basic level, a definition gap exists, leaving the commander to more deeply pursue clarity on the issue. His direct fire weapons operate on the surface so they are of no concern to this gap. His surface-to-surface fires do not. They operate almost exclusively in the area above the surface and have an impact on operations that are ongoing above him. This gap is significant to a commander and could be closed with additional clarity and specificity in joint definitions.

The second gap in joint doctrine is a lack of supporting discussion of the revised definition of CA. JP 3-52, dated May 2010 provides the definition but does little to provide commanders or planners with what considerations must be taken into account when placing the CA. Air Force Doctrine provides some additional discussion but that service publication only addresses what to consider when planning a CA. "The decision on where to place (or even to use) a CA requires careful consideration due to its impact on the integration of C2 agencies, fires, and maneuver. Placement should strike a balance between maximizing the effectiveness of air component and organic surface fires while not unduly inhibiting those same operations."[2] This discussion must extend beyond a single services doctrine and into joint doctrine. Some of this can be attributed to the nature of doctrine revision. The definition was revised, under much debate that was documented in chapter 4 of this study, in mid 2010. Although that was almost two years ago, the Air Force Doctrine on Airspace Control was updated in early 2011 and the Army Doctrine on airspace control has yet to be released in a final form. This paper uses the June 2011 initial draft of FM 3-52 for analysis and finds that discussion absent.

The second conclusion this study draws is that the volume of airspace necessary for a maneuver commander to employ unhindered fires is vast. Mortars require much more airspace due to their trajectory than does artillery. Although this is not surprising given physics, the fact that they are assigned at the company and battalion level creates a great strain on balancing the requirement of controlling airspace and managing risk. Army Publication 3-52 identifies this challenge by stating, “In order to preclude an airspace mishap, commanders establish controls to mitigate risk. However, these controls, if excessive can degrade operations.”[3] How then does the airspace system mitigate risk without degrading the operations of a company commander employing his mortars? Considering that these mortars require a MO of up to 7,500 feet AGL, this is a challenge for the future joint force. All artillery can achieve some ranges even at the lowest considered CA of 3,000 feet. That ensures the maneuver commander has some flexibility with fires and as the coordination altitude increases, so does the Brigade Commander’s ability to look first to his organic surface fires under mission command.

The final conclusion relates to the BCT Commander’s ability to have input into the airspace planning process. The BCT is the basic fighting formation of the United States Army. This was documented earlier in this study though doctrine. However, the study has uncovered that although there is an existing process where airspace is planned, there is not a place in that current system for brigade level inputs in the planning process, and the immediate process to make changes and alterations to the airspace plan is insufficient. Airspace planning has not adapted along with the Army’s move to modularity. The process remains at the component command level. This prevents a Brigade Commander from effectively having a voice to shape airspace to meet the needs of his operations. The Army must review the roll and function of the Battlefield Coordination Detachment to ensure it is properly structured, to directly support the BCT Commander.

Recommendation

As a result of this study, there are two recommendations to better facilitate organic surface fires and airspace doctrine in the 21st century joint fight. Based on the cost benefit analysis in chapter 4 it appears there is a technical solution beneficial to organic fire support systems, providing the maneuver commander the flexibility to employ his organic surface fires unhindered from coordination outside his headquarters. The second recommendation is a revision of the joint definition of operations area to include the airspace dimension.

Maneuver commanders are faced with considering airspace when employing fires from this point well into the 21st century. There are two known's; artillery and mortars are users of airspace, and the commanders desire to employ those assets must be counterbalanced with the need of the JFACC to support their fight and meet the JFCs objectives outside their AO. That means that it would be unreasonable to look to the MO of the largest system organically assigned to the BCT and request that as the CA.

Referencing table 1 below, it appears that a CA between 10,000 and 12,500 feet would meet the maneuver commander's requirements for airspace in order to employ his organic indirect fires, providing him the freedom to operate his surface fires decentralized from coordinating restrictions. Company and Battalion Commanders would be able to employ their mortars within the full complement of ranges for their systems. Light Infantry Brigade Commanders would be able to employ their 105mm howitzers out to two thirds of their range for all munitions types in the low angle. Mechanized Brigade Commanders would be able to employ their 155mm howitzers also at ranges out to two thirds of their maximum ranges. All these fires would be unhindered from coordination and ensure a commander was able to bring all the tools he has to the fight during combined arms operations.[4] It also simplifies the problem of who talks to whom when fires are needed, by removing the need to coordinate if fires are below the CA.

A 2008 Air Land Sea Bulletin articulated that as the specific problem facing commanders today. "The ground commander is forces to coordinate within that system to establish adequate freedom of maneuver, but oftentimes is not clear which tactical level agency (Army A2C2, ASOC, CRC, AWACS, JSATRS, TAC-A, FAC-A) has the information or vested authority to orchestrate a plan that will meet the needs of all dynamic airspace users."[5] This paper solves that issue by clearly identifying the Brigade Commander's airspace and provides him freedom of maneuver to employ his organic surface fires within it.

Table 1. Optimal CA to support all surface-to-surface fires.

System	Munition/Angle	Charge	Target Range to Maxord 2/3 Max Range: Range	Maxord: Meters	Maxord: Feet	FT / M	Maxord of Range to Target (Range in Meters): 10000 / 3049	12500 / 3811	15000 / 4573
60mm	ALL	4	2525	1603	5258				
81mm	ALL	4	4525	2746	9007		3400 to max	min	
120mm	ALL	4	4500	3370	11054		5500 to max	min	
105mm	HE,WP, HC, ILA/ LO	7	7500	708	2322		max		
	HE,WP, HC, ILA / HI	7	9500	5306	17404		none	none	11000 to max
	HE	8	12500	2314	7590		13000	max	
	RAP/ LO	8	14000	2757	9043		14000	max	
	RAP/ HI	8	13000	7587	24885		none	none	none
	RAP (ER)/ LO	8	17500	3623	11883		16500	17500	18500
	RAP (ER)/ HI	8	17500	10455	34292		none	none	none
	BB	7	9000	898	2945		12875	max	
	BB HI	7	11000	6077	19933		none	none	none
155mm	HE,WP, HC, ILA/ LO	MACS 4	12000	1150	3772		16000	17000	17775
	HE,WP, HC, ILA / HI	MACS 4	16000	9285	30455		none	none	none
	HE,WP, HC, ILA/ LO	7	12000	1230	4034		15000	16000	17000
	HE,WP, HC, ILA / HI	7	16000	8655	28388		none	none	none
	HE/ LO	8	15000	1559	5114		18000	19000	20000
	HE/ HI	8	20000	11148	36565		none	none	none
	BB/ LO	MACS 5	18000	1667	5468		21000	22000	24000
	BB/ HI	MACS 5	24000	15284	50132		none	none	none
	RAP RKT OFF/ LO	7	13000	1365	4477				
	RAP RKT OFF/ HI	7	16000	9721	31885		none	none	none
	RAP RKT OFF/ LO	8	17000	1986	6514		19000	20000	21000
	RAP RKT OFF/ HI	8	22000	12453	40846		none	none	none
	RAP RKT OFF/ LO	MACS 5	17000	1973	6471		19000	20000	21000
	RAP RKT OFF/ HI	MACS 5	22000	12554	41177		none	none	none
	RAP RKT ON/ LO	7	16000	1745	5724		18000	20000	21000
	RAP RKT ON/ HI	7	20000	12728	41748		none	none	none
	RAP RKT ON/ LO	8	20000	2364	7754		21000	22000	24000
	RAP RKT ON/ HI	8	27000	17097	56078		none	none	none
	RAP RKT ON/ LO	MACS 5	20000	2350	7708		21000	22000	24000
	RAP RKT ON/ HI	MACS 5	27000	17223	56491		none	none	none
	XCAL	MACS 4	21500	6975	22878		none	none	none

Source: Table created by author.[6]

A review of the Army and Air Force multi-service tactics, techniques, and procedures publication on airspace, appears to support a proposal such as this in both the Air Force and Army community. A *Multi-Serve Tactics, Techniques, and Procedures for Air Space Control* publication, signed by both the Army and the Air Force states, "Mortars are by their nature decentralized from traditional fires coordination and used as an infantry weapon that fills the immediate need for their commanders."[7] While this statement does not go as far as to say that the CA should be established above the MO of the mortar system, the next statement in that same publication removes them from the formal airspace process. "Infantry officers are trained and practice basic deconfliction vice integration of mortars with aircraft. If the infantry commander is aware that aircraft are in the area, he will hold his mortar fire until those aircraft are clear."[8]

It is clear that if the Army and Air Force are willing to exclude mortars from the formal airspace coordination process, then it seems the best way to maintain aircraft safety and allow decentralized mortar employment, is to establish the CA above the point of their MO. If doctrine uses the mortar CA to define the AO, then there is a balance between the operational needs of maneuver and the airspace concerns listed in Air Force doctrine. "These increased user demands require an integrated airspace control system to enable flight safety and prevent fratricide while enabling mission accomplishment."[9] A properly placed CA enhances the current process infantry commanders are utilizing to ensure flight safety and prevent fratricide. If an aircraft requires usage of the airspace below the CA, it would coordinate with the controlling authority to gain access. That would ensure the mortars are aware of their presence, decrease risk to fixed-wing and increase overall safety.

A CA of 12,500 could have an impact on fixed-wing platforms requiring usage of airspace below the CA. Similarly, it is documented in this study, it is also prohibitive for all artillery firing high angle mission. Either fixed-wing or surface fires would use the coordinating process to transition the airspace. There would be a request to the controlling authority to utilize the airspace above the CA for the mission. Another option is to employ the existing ACM to preplan routes or fires if there is a known need to do so. It is also important to point out that the operating environment should, and will drive the decision on the placement of the CA. The above recommendation is most suitable in a low surface-to-air threat environment where fixed-wing tactics are much different than what we have witnessed over the past 10 years. Acknowledging those limitations, this study provides the commander today a solid starting point in training and a standard solution during theater entry in combat operations, until Brigade Commanders can voice their requirements and risks to the JFC, as part of the airspace discussion.

The second recommendation this study advances is a review of the joint definition of operation area. Future definitions must include a consideration for airspace. This will simplify for a Brigade Commander what joint doctrine intends for him to do and what volume of airspace the joint service expects him to control. The simplest revision would be to include the words "extending to the coordinating altitude" in the updated definition. A more detailed solution would be a discussion based on this study's MO data to be included in the next revision of JP 3-52 to demonstrate to commanders and airspace planners the impact of various CAs and recommend to those planners considerations for optimal placement. For that to be complete however, additional study is required on the impact of this study on fixed-wing operations.

Areas for Future Study

This study looked at the problem of airspace only in terms of enabling the BCT Commander in employing surface-to-surface fires. The solutions this paper advanced only takes the force so far. Critics of this paper might claim that this paper proposes a step back by separating airspace by services. Army Major Randy James, in his monograph published in 2010 recommends that future revisions of JP 3-52 "should remove the allusion to service specific areas of operation."[10] That is not the intent of this study. The intent was to inform and educate Brigade Commanders on the requirements of airspace and propose a solution that is workable today, to increase their ability to employ their organic surface fires. Major James's notion does reveal an area that requires additional study. If integration means to bring all the tools together simultaneously on one point, then how will the joint force accomplish that? What technological advances are required to nullify the need for different coordinating authorities and replace it with digital systems that allow real time situational awareness of both aircraft and surface-to-surface munitions?

Another area of study that this paper does not address is artillery deconfliction for systems outside the BCT. The Fires Brigade brings the Multiple Launch Rocket System to the fight. Currently there are seven of these formations in the Army. Those systems require far more airspace than the systems addressed in this study. What future process would best deconflict them while preserving their timeliness and capitalize on their lethality? Reviewing the modular force structure relating to artillery units could provide a solution to that, as well as evaluate the requirements placed on a BCT commander to be as involved in airspace as the current force structure has required him to be.

A final area that is outside the scope of this paper, but would lend much to this conversation, is a counter study focused on the capabilities and ideal employment of the air-to-surface platforms. What altitudes do they require for optimal employment on the battlefield and what impact would a CA of 10,000 to 12,500 have on them. Unfortunately, the information to conduct that study is maintained at levels above unclassified and that comparison is outside this papers classification.

Final Thoughts

Airspace is complicated and complex as is well documented in this study. However, if artillery is to remain relevant to the Brigade Commander the systems which facilitate its employment need to be simplified and streamlined. Yesterday's fight was decisively over quickly with a short phase three, however tomorrows may not be as simple to achieve. Airspace was once a division problem, but now rests squarely in the lap of the BCT. Brigade Commanders must be able to rely on the systems they have at hand to achieve victory in battle, as well as look to the joint force to support them and fill the gaps in capabilities. For them to employ organic surface fires and understand airspace doctrine is critical, looking towards the 21st century joint fight, for our Army to continue to fight and win the Nations wars.

---

[1]U.S. Army Training and Doctrine Command, TRADOC Pamphlet 525-3-4, 19.

[2]Department of the Air Force, AFDD 3-52, 37.

[3]Department of the Army, FM 3-52, A-1.

[4]Department of the Army, ADRP 3-0, 1-13.

[5]Habas, "Effective Airspace Management to Facilitate Fires," 17.

[6]Table data: U.S. Army ARDEC, *FT 60-P-1*, *C16* (Aberdeen Proving Ground, MD, October 2007), 414-417; U.S. Army ARDEC, *FT 81-AR-2, wCO1 and CO* (Aberdeen Proving Ground, MD, 10 July 2005), 436-440; U.S. Army ARDEC, *FT 120-G-1*, *C-3* (Aberdeen Proving Ground, MD, January 2010), 694; U.S. Army ARDEC, *FT 105-AS-4* (Aberdeen Proving Ground, MD, 24 August 2005), 212, 248; U.S. Army ARDEC, *FT 105-AW-1* (Aberdeen Proving Ground, MD, 24 January 2006), 24, 68; U.S. Army ARDEC, *FT 105-BC-PROV* (Aberdeen Proving Ground, MD, February 2010), 234; U.S. Army ARDEC, *FT 155-AM-3* (Aberdeen Proving Ground, MD, May 2006), 266, 318; U.S. Army ARDEC, *FT 155-AR-2* (Aberdeen Proving Ground, MD, February 2007), 96. U.S. Army ARDEC, *FT 155-AO-2 Part 1* (Aberdeen Proving Ground, MD, October 2009), 40, 96, 418; U.S. Army ARDEC, *FT 155-AO-2 Part 2* (Aberdeen Proving Ground, MD, December 2009), 50, 118, 490; U.S. Army ARDEC, *FT 155-AU-PAD, C-4 (PROV)* (Aberdeen Proving Ground, MD, February 2008), 33; U.S. Army ARDEC, *FT 155-BB-PAD* (Aberdeen Proving Ground, MD, May 2007), 285.

[7]U.S. Army TRADOC and the Curtis E. Lemay Center for Doctrine Development and Education, FM 3-52.1, AFTTP 3-2.78, 27.

[8]Ibid.

[9]Department of the Air Force, AFDD 3-52, 1.

[10]Randy P. James, “The Army’s Role in Airspace Command and Control of the Warfighter’s Airspace” (Monograph, School of Advanced Military Studies, Ft. Leavenworth, KS, May 2010), 36.

APPENDIX A

EXPLANATION OF METHODOLOGY COMPUTATIONAL PROCESS

The TFTs for both mortar and artillery contain firing data. "These tables contain the fire control information (FCI) under standard conditions and data corrective for nonstandard conditions. These tables and equipment include the tabular firing tables, graphical firing tables, and graphical site tables. The tabular firing tables are the basic source of firing data. They present fire control information in a tabular format."[1] Because the TFT is the primary source for firing data, this study will rely on that information and will not review graphical firing tables or graphical site tables. These tools are simply a slide rule depiction of the TFT chart data[2] and meant for ease, speed, and convenience of use in a field environment.

The description of the TFT references standard conditions. It is important for the reader to understand what this means. "Tabular firing tables are based on test firing and computer simulations of a weapon and its ammunitions correlated to a set of conditions that are defined and accepted as standard. These standard conditions are points of departure."[3] This means that when Aberdeen Proving Ground conducts tests using "equations of motion and are compared with the data obtained in the firing. The computed trajectories are adjusted to the measured results and data are tabulated"[4] they are entering it with certain controls in place to ensure pure data is reached. Some of these standard conditions include air temperature of 59 degrees, propellant temperature of 70 degrees, no wind, and 1.225 grams per meter cubed of air pressure.[5] The importance of understanding this is to point out to the reader that this is considered in the data contained in Appendix B. Therefore, the data presented is for planning considerations only. For actual computation of a MO, all metrological and nonstandard computations are essential for accuracy and precision. Both the artillery and mortar communities have technological systems such as the Army Field Artillery Tactile Data System and Mortar Ballistic Computer to correct for these nonstandard conditions. It would be impossible for this study to account for every nonstandard condition and each given range to provide precise data usable in tactical operations.

Each table provides specific information relating to firing data such as table A, metrological message line numbers, table B complimentary range, table H correction to range to compensate for earth rotation etc. The table this study focuses on is table G, supplementary data. Table G is broken into 13 sub columns, each depicting a different data point corresponding to a given range. The entry argument used to extract a data point column A in table G, range to target.[6] Once the desired range is located, by moving across the chart the reader will discover data such as elevation of the tube to achieve that range. Other data points are probable errors in range, terminal velocity achieved etc. This study is concerned with column 11, MO. This column provides the "maximum height above the gun of the trajectory fires, under standard conditions, to the range in column 1."[7] This provides the point at which the round stops rising and begins falling enroot to a target at a given range and is the essential data point for establishing what volume of airspace is required to employ surface based fires.

As mentioned previously, the entry argument for this table is range to target. Ranges are expressed in groupings of whole numbers representing a range of ranges. For example, the 60mm TFT uses increments of 25 meters[8] whereas the 105mm TFT uses increments of 500 meters.[9] The importance of this recognition is to establish the method which this study used to extract data. Although a process exists to determine data between entry arguments, this study applies the round off rules listed in the TFT by selecting the nearest entry range. "When rounding off to the nearest whole number, round to the nearest even number when the value ends in .5, when rounding to the nearest tenth, round to the nearest even tenth when the value ends in .05. This same principle applies to round off to the nearest ten and to the nearest hundred."[10] This means that if the ranges listed are in 500 meter increments, and the desired entry range was 1,250 meters, data was extracted from the 1,500 meter line. Although precision was lost utilizing this process, this study is a planning reference and by doing so, it allows the reader to reference the extracted data without utilizing the mathematical process to interpolate data between entry ranges. Application of the round off rules also removes the possibility of mathematical errors by the author when presenting the MO comparison data in Appendix B.

This research method conducts analysis of organic fire support systems of a BCT. Therefore, in the Appendix B discussion of MO, there will be two tables for each system. The first will provide the comparison of four ranges to the MO required to achieve those ranges. This chart is a tool to inform the commander what MO he must request from the JFC to achieve a given range within his AO. These four ranges are, one third, half, two thirds, and maximum range of the system. These ranges intend to demonstrate to the commander what volume of airspace he must control depending on where he expects to deliver fires. The TFT reflects MO in meters, but the CA, as discussed in chapter 2, reflects feet AGL. By providing both data points it allows the reader to understand both where the data was extracted from as well as how it relates to the tactical application.

The conversion factor from meters to feet was 3.28 to convert meters to feet. This provides the answer to the question, “In an unconstrained environment what altitudes are required to deliver surface fires?” Each organic surface fires system reflects analysis by both ranges and the munitions those systems typically employ. It is noteworthy that for high explosive, white phosphorus, smoke, and illumination the MO is the same regardless of munitions fired. There is a substantial difference between MO for low angle or high angle artillery fires. Appendix B addresses this in further detail. Mortars only fire high angle so there is no distinction of low angle in those tables.

The second table in each section of Appendix B depicts various ranges that can be achieved under a prescribed CA. For example, if a 105mm howitzer is restricted by a 5,000 feet CA, it can only fire low angle high explosive munitions 9,500 meter without coordination. By providing this data point, maneuver commanders are armed with information that allows them to communicate risk to the JFC, if a published CA does not facilitate decentralized employment of surface based fires. In an ideal situation, the BCT command would turn to the Brigade Fire Support Officer during the operations order and ask what the impact of a 3,000 foot CA is. The Fire Support Officer would quickly respond by stating that without coordination, mortars could not fire at all and the howitzers could only fire out to 8,000 meters, low angle. This empowers the commander to communicate the operational risk of a 3,000 feet CA to the higher commander for immediate discussion. The author chose the various altitudes depicted on the comparison table in increments of 2,500 feet for the purpose of an entry point to analysis with the exception of the initial comparison CA of 3,000 feet. As was mentioned in chapter 2, in the author’s experience, this is the most common published CA in training environments.

The final point necessary to understanding the second table in each section of the cost benefit analysis contained in Appendix B is the understanding that for mortars and high angle artillery fire the MO increases as range decreases. This is due to the exterior ballistics of the arch required to fire in this mode. The table information for a given altitude restriction will show a range to maximum range versus a range achievable listed in low angle data. If "none" is listed in the column below a given altitude, that means no range is achievable with that prescribed CA without coordination. The annotations of "max" represent all ranges of that system or munitions are achievable under the prescribed altitude restriction. Altitudes listed are in both feet and meters. As mentioned, the TFT data is in meters, but the CA, as discussed in chapter 2, reflects feet AGL. The conversion factor from feet to meters is 3.28 to convert feet to meters. By providing both it allows the reader to understand both where the data was extracted from as well as how it relates to the tactical application.

---

[1]Department of the Army, United States Marine Corps, FM 6-40, MCWP 3-1.6.19, 7-1.

[2]Ibid.

[3]Ibid.

[4]Ibid., 7-2.

[5]Ibid., 7-1.

[6]This data is found in table G, column 11 for 155mm and 105mm artillery and 120mm mortars. Table E, column 8 provides the same data for 81mm and 60mm mortars.

[7]U.S. Army ARDEC, *FT 105-AS-4*, XXI.

[8]U.S. Army ARDEC, *FT 60-P-1, C-16* (Aberdeen Proving Ground, MD, October 2007), 68.

[9]U.S. Army ARDEC, *FT 105-AS-4*, 212.

[10]Ibid., XXIX.

APPENDIX B

TABULAR FIRING TABLE DATA COMPARISON

Two tables within each section provide the reader a summary of the TFT data points for each system. The first provides the comparison of four ranges to the MO required to achieve those ranges. This chart informs the commander what MO he must request from the JFC to achieve a given range within his AO. These four ranges are one third, half, and two thirds, and maximum range of the system. The selection of these ranges demonstrates to the commander what volume of airspace he must control depending on where he expects to deliver fires. This provides the answer to the question, "In an unconstrained environment what altitudes are required to deliver surface fires?"

The second table in each section depicts achievable ranges for a prescribed CA. The purpose of this analysis is to provide maneuver commanders with the information that allows them to communicate risk up to the JFC, if a prescribed CA does not facilitate decentralized employment of surface based fires.

The colors in the tables are red where the word "none" appears, representing that the listed CA would restrict the maneuver commander from firing any ranges with that system without coordination. Yellow represents that the prescribed CA would limit the maneuver commander to firing only up to the listed ranges with that system without coordination. Green represents that the prescribed CA would permit the maneuver commander to fire all ranges within the limits of that system without coordination. Inside the green box appears either the words "max" or "min". The word "max" will appear in low angle firing rows and "min" will appear in high angle mode. This represents that in low angle fires all ranges up to the maximum range is achievable. In high angle fires, all ranges to the minimum range are achievable. This is because for mortars and high angle artillery fire the MO increases as range decreases due to the exterior ballistics of the arc required to fire in the high angle mode.

60mm Mortar

Analysis of the firing trajectory in table 2 below shows that when fired at maximum range, the 60mm mortar fires roughly one third as high into the air as it does in distance before it descends. To fire 3,450 meters, the MO is 1,067 meters. At one third the maximum range, the ratio climbs to almost three times that amount. To fire 1,600 meters, the MO is 1,885. As discussed previously in this section, the angle of fire increases as range decreases. Therefore, the 60mm mortar utilizes less airspace the greater the distance. If employment of the mortars were at 50 percent of their maximum range, 2,050 meters, the MO would be 1,766 meters and for firing at two thirds maximum range, the MO would be 1603 meters.

Table 2. 60mm Mortar MO requirement by range

			Target Range to Maxord											
			1/3 Max Range			1/2 Max Range			2/3 Max Range			Max Range		
			Range	Maxord		Range	Maxord		Range	Maxord		Range	Maxord	
System	Munition/ Angle	Charge		Meters	Feet		Meters	Feet		Meters	Feet		Meters	Feet
60mm	ALL	4	1600	1885	6183	2050	1766	5792	2525	1603	5258	3450	1067	3500

Source: Table created by author. Table data from *FT 60-P-1, C16* (Aberdeen Proving Ground, MD, October 2007), 414-417.

Table 2 lays out the required volume of airspace for that Infantry Company Commander to operate his organic surface fires support unconstrained. Consider now the data provided in table 3. Table 3 assumes a CA has been established at prescribed altitudes and considers the ranges achievable to remain under that altitude. This table depicts what the maneuver commander could do under decentralized execution. A CA of 3,000 feet AGL or below would prevent any uncoordinated firing of 60mm mortars. CAs established at 5,000 feet would allow the 60mm mortar to fire at ranges of 2,725 meters to the maximum range of 3,450 meters, 725 meters of the systems total range. A CA of 7,500 feet allows the Infantry Company to fire the complete span of ranges within the capabilities of the system.

Table 3. 60mm ranges achievable under prescribed CAs

			Maxord of Range to Target (Range in Meters)			
			AGL (FT)	**3000**	**5000**	**7500**
System	**Munition/ Angle**	**Charge**	**AGL (M)**	**915**	**1524**	**2287**
60mm	**ALL**	**4**		**none**	**2725 to max**	**min**

Source: Table created by author. Table data from U.S. Army ARDEC, *FT 60-P-1,C16*. (Aberdeen Proving Ground, MD, October 2007), 414-417.

<u>81mm Mortar</u>

Analysis of the firing trajectory in table 4 below shows that when fired at maximum range, the 81mm mortar fires roughly one third as high into the air as it does in distance before it descends. To fire 5,792 meters, the MO is 1,752 meters. At one third the maximum range, the ratio climbs to almost three times that amount. To fire 3,250 meters, the MO is 3,067. Like the 60mm mortar, the 81mm mortar utilizes less airspace the greater the distance to target. If employment of the mortars were at 50 percent of their maximum range, 3,875 meters, the MO would be 2,945 meters and for firing at two thirds maximum range, 4,525 meters, the MO would be 2,746 meters.

Table 4. 81mm Mortar MO requirement by range

			Target Range to Maxord											
			1/3 Max Range			1/2 Max Range			2/3 Max Range			Max Range		
			Range	Maxord		Range	Maxord		Range	Maxord		Range	Maxord	
System	Munition/ Angle	Charge		Meters	Feet		Meters	Feet		Meters	Feet		Meters	Feet
81mm	ALL	4	3250	3067	10060	3875	2945	9660	4525	2746	9007	5792	1752	5747

Source: Table created by author. Table data from U.S. Army ARDEC, *FT 81-AR-2, wC01 and C02* (Aberdeen Proving Ground, MD, 10 July 2005), 436-440.

Table 4 lays out what volume of airspace an Infantry Battalion Commander requires to operate his organic surface fires support unconstrained. Consider now the data provided in table 5. Table 5 assumes a CA established at prescribed altitudes and considers the ranges achievable to remain under that altitude. Stated previously, elements can transition above and below but only by conducting coordination with the controlling authority. This table depicts what the maneuver commander could fire under decentralized execution. A CA of 5,000 feet AGL or below would prevent any uncoordinated firing of 81mm mortars. CAs established at 7,500 feet would allow the 81mm mortar to fire at ranges of 5,400 meters to the maximum range of 5,792 meters, 392 meters of the total system range. A CA of 10,000 feet would allow the 81mm mortar to fire at ranges of 3,400 meters to the maximum range of 5,792 meters, 2,392 meters of the total system range. A CA of 12,500 feet is required to allow the Infantry Battalion to fire the complete span of ranges within the capabilities of the system.

Table 5. 81mm ranges achievable under prescribed CAs

			Maxord of Range to Target (Range in Meters)					
			AGL (FT)	3000	5000	7500	10000	*12500*
System	Munition/ Angle	Charge	AGL (M)	915	1524	2287	3049	3811
81mm	ALL	4		none	none	5400 to max	3400 to max	min

Source: Table created by author. Table data from U.S. Army ARDEC, *FT 81-AR-2, wCO1 and CO2* (Aberdeen Proving Ground, MD, 10 July 2005), 436-440.

120mm Mortar

Analysis of the firing trajectory in table 6 below shows that when fired at maximum range, the 120mm mortar fires slightly less than one third as high into the air as it does in distance, before it descends. To fire 6,900 meters, the MO is 1,864 meters. At one third the maximum range, the ratio climbs to almost five times that amount. To fire 2,500 meters, the MO is 3,703. Like other mortars, the 120mm mortar utilizes less airspace the greater the distance to target. If employment of the 120mm mortars were at 50 percent of their maximum range, 3,500 meters, the MO would be 3,570 meters and for firing at two thirds maximum range, 4,500 meters, the MO would be 3,370 meters.

Table 6. 120mm Mortar MO requirement by range

			Target Range to Maxord											
			1/3 Max Range			1/2 Max Range			2/3 Max Range			Max Range		
			Range	Maxord		Range	Maxord		Range	Maxord		Range	Maxord	
System	Munition/ Angle	Charge		Meters	Feet		Meters	Feet		Meters	Feet		Meters	Feet
120mm	ALL	4	2500	3703	12146	3500	3570	11710	4500	3370	11054	6900	1864	6114

Source: Table created by author. Table data from U.S. Army ARDEC, *FT 120-G-1, C-3* (Aberdeen Proving Ground, MD, January 2010), 694.

Table 6 lays out what volume of airspace an Infantry Battalion Commander requires to operate his organic surface fires support unconstrained. Consider now the data provided in table 7. Table 7 assumes a CA established at prescribed altitudes and considers the ranges achievable to remain under that altitude. This table depicts ranges the maneuver commander could fire in decentralized execution. A CA of 5,000 feet AGL or below, would prevent any uncoordinated firing of 120mm mortars. CAs established at 7,500 feet would allow the 120mm mortar to fire at ranges only at maximum range, 6,900 meters. A CA of 10,000 feet would allow the 120mm mortar to fire at ranges of 5,500 meters to the maximum range of 6,900 meters, 1,400 meters of the total system range. A CA of 12,500 feet is required to allow the Infantry Battalion to fire the complete span of ranges within the capabilities of the system.

Table 7. 120mm ranges achievable under prescribed CAs

			Maxord of Range to Target (Range in Meters)					
			AGL (FT)	3000	5000	7500	10000	12500
System	Munition/ Angle	Charge	AGL (M)	915	1524	2287	3049	3811
120mm	ALL	4		none	none	6900	5500 to max	min

Source: Table created by author. Table data from U.S. Army ARDEC, *FT 120-G-1, C-3*. (Aberdeen Proving Ground, MD, January 2010), 694.

105mm Howitzer

Analysis of the firing trajectory in table 8 below shows that when a commander considers range to MO the 105mm howitzer breaks down into two categories. Low angle and high angle. When considering low angle fires the ratio of airspace required to range achieved is less than one to five. At maximum range, the 105mm howitzer can fire 11,000 meters with conventional munitions with a MO of only 2,346 meters. Even at extended ranges with Charge 8, the increase is ,1,000 meters of MO to gain 2,500 meters of range. Rocket Assisted Projectiles are even more permissive with 4,000 meters gained in range with for 1,400 meters of MO. This demonstrates the vast advantage to employing cannon fires versus mortars. High angle fires do not provide such an advantage.

Firing standard munitions to achieve the same maximum range of 11,000 meters, the MO is 4,373 meters. Restrictions prevent firing Charge 8 high angle; however, Rocket Assisted Projectiles can achieve that range if required. Although they achieve the same range in high angle as low angle, 15,000 meters, the MO is 6,065 during high angle. Extended Range Rocket Assisted Projectile is by far the most restrictive munitions to fire when considering airspace. To achieve the maximum range of 20,000 meters a MO of 7,399 meters is required. As with mortars, when firing high angle the round requires more airspace to achieve shorter ranges.

Looking at the standard munitions of high explosive, white phosphorus, smoke, and illumination in the low angle mode to fire at 50 percent of system range, 5,500 meters the MO is only 318 meters. However firing at 50 percent of the systems range in high angle achieves 8,500 meters with a MO of 5,665. The percentage listed is 50 percent of the achievable range with the given munitions and charge. For the howitzer, unlike the mortars, the entire range of the system cannot be fired utilizing the maximum charge.

Table 8. 105mm Howitzer MO requirement by range

			Target Range to Maxord												
			1/3 Max Range			1/2 Max Range			2/3 Max Range			Max Range		
			Range	Maxord		Range	Maxord		Range	Maxord		Range	Maxord	
System	Munition/ Angle	Charge		Meters	Feet		Meters	Feet		Meters	Feet		Meters	Feet
105mm	HE,WP, HC, ILA/ LO	7	4000	141	462	5500	318	1043	7500	708	2322	11000	2346	7695
	HE,WP, HC, ILA / HI	7	7500	5930	19450	8500	5665	18581	9500	5306	17404	11000	4373	14343
	HE	8	11500	1744	5720	12000	2006	6580	12500	2314	7590	13500	3210	10529
	RAP/ LO	8	12000	1627	5337	13000	2111	6924	14000	2757	9043	15000	3793	12441
	RAP/ HI	8	11000	8328	27316	12000	8004	26253	13000	7587	24885	15000	6065	19893
	RAP (ER)/ LO	8	14500	2000	6560	16000	2693	8833	17500	3623	11883	20000	7129	23383
	RAP (ER)/ HI	8	14500	11658	38238	16000	11149	36569	17500	10455	34292	20000	7399	24269
	BB	7	5000	201	659	7000	465	1525	9000	898	2945	13000	3115	10217
	BB HI	7	9000	6754	22153	10000	6459	21186	11000	6077	19933	13000	4589	15052

Source: . Table created by author. Table data from U.S. Army ARDEC, *FT 105-AS-4.* (Aberdeen Proving Ground, MD, 24 August 2005), 212, 248; U.S. Army ARDEC, *FT 105-AW-1* (Aberdeen Proving Ground, MD, 24 January 2006), 24, 68; U.S. Army ARDEC, *FT 105-BC-PROV* (Aberdeen Proving Ground, MD, February 2010), 234.

Table 8 lays out what volume of airspace an Infantry Battalion Commander requires to operate his organic surface fires support unconstrained. Consider now the data provided in table 9. Table 9 assumes a CA established at prescribed altitudes and considers the ranges achievable to remain under that altitude. This table depicts what ranges the maneuver commander could fire in decentralized execution. A CA of 3,000 feet would allow his 105mm howitzers to fire low angle, standard ranges, up to 8,000 meters. This is over two thirds of the maximum range of the systems. An additional range capability depicted in the base bleed munitions at low angle, but as that is an extended range munitions there is no value in selecting it over standard charges.

A CA of 5,000 feet allows for additional low angle fires with Charge 8 up to 11,000 meters, Rocket Assisted Projectiles out to 11,500, Extended Range Rocket Assisted Projectiles and 10,000 meters for base bleed. However, as these are all extended range munitions, they do not provide the commander any additional capability.

Considering a CA of up to 10,000 feet draws the same conclusion for all munitions. At this altitude the extended munitions of Charge 8, Rocket Assisted Projectiles and base bleed can now all achieve a roughly two thirds of their ranges providing the commander the opportunity to extend his ability to influence the battlefield beyond on 105mm standard munitions. A CA of 12,500 feet is the point at which all munitions, less high angle extended range munitions are able to extend the tactical advantage of the commander. He can achieve the maximum range of Charge 8, Rocket Assisted Projectiles and base bleed providing indirect fire support out to 15,000 meters.

The lowest CA acceptable to introduce high angle fires with any significant range is 20,000 feet. With this CA he can employ standard charges of high explosive munitions, rocket assisted projectile and base bleed all within two thirds of their maximum range. The most restrictive 105mm fires to employ under a prescribed CA is the Extended Range Rocket Assisted Projectile, high angle. Unless the CA is 45,000 feet, he would not be able to employ it with the full range capabilities of the system.

Table 9. 105mm ranges achievable under prescribed CAs.

			Maxord of Range to Target (Range in Meters)												
			AGL (FT)	3000	5000	7500	10000	12500	15000	20000	25000	30000	35000	40000	45000
System	Munition/ Angle	Charge	AGL (M)	915	1524	2287	3049	3811	4573	6098	7622	9146	10671	12195	13720
105mm	HE,WP, HC, ILA/ LO	7		8000	9500	10500	max								
	HE,WP, HC, ILA / HI	7		none	none	none	none	none	11000 to max	7000 to max	min				
	HE	8		none	11000	12000	13000	max							
	RAP/ LO	8		none	11500	13000	14000	max							
	RAP/ HI	8		none	none	none	none	none	none	15000 to max	13000 to max	min			
	RAP (ER)/ LO	8		none	13000	15000	16500	17500	18500	19500	max				
	RAP (ER)/ HI	8		none	none	none	none	none	none	none	20000 to max	19500 to max	17500 to max	12500 to max	min
	BB	7		9000	10000	12000	12875	max							
	BB HI	7		none	none	none	none	none	none	11000 to max	min				

Source: Table created by author. Table data from U.S. Army ARDEC, *FT 105-AS-4* (Aberdeen Proving Ground, MD, 24 August 2005), 212, 248; U.S. Army ARDEC, *FT 105-AW-1* (Aberdeen Proving Ground, MD, 24 January 2006), 24, 68; U.S. Army ARDEC, *FT 105-BC-PROV* (Aberdeen Proving Ground, MD, February 2010), 234.

155mm Howitzer

Not reflected in the tables of this section is Field Artillery scatterable mine field. Due to the planning considerations based on time required to fire the minefield, as well as the footprint it occupies, it requires special considerations and coordination making the issue of airspace only one of many considerations to it, as a capability to a maneuver commander. This is not to say they are not advantageous to a commander. However, by their nature they require coordination with higher headquarters and airspace planning for emplacement.

The 155mm fires in both the low angle and high angle trajectory range, meaning it can fire on a more flattened plane to achieve a given range, or similar to a mortar with a lobbing trajectory to achieve the same range. Like the 105mm, the purpose of high angle is to overcome significant terrain or employ bursting munitions overhead of the enemy at optimal angle.

Analysis of the firing trajectory in table 10 shows that when a commander considers range to MO the 155mm howitzer breaks down into three categories: low angle, high angle, and precision. When considering low angle fires the ratio of airspace required to range achieved is less than one to five. At maximum range, the 155mm howitzer can fire 18,000 meters with conventional munitions with a MO of 4,689 meters. Even at extended ranges with Charge 8, the increase is 2,100 meters of MO to gain 4,000 meters of range. Rocket Assisted Projectiles are even more permissive with 6,000 meters gained in range with for 3,100 meters of MO. Like the 105mm, there is a demonstrated advantage to employing cannon fires versus mortars when considering the range to MO ratio. High angle fires do not provide such an advantage.

Firing standard munitions to achieve the same maximum range of 18,000 meters, the MO is 7,844 meters. The 155mm howitzer can fire Charge 8, but is even more restrictive. To achieve a range of 22,000 the required MO is 9,229 meters. Rocket Assisted Projectiles also provide extended range in high angle as low angle, 29,000 meters. By comparison, the MO in low angle is 10,022 during high angle. Extended Range Rocket Assisted Projectile is by far the most restrictive munitions to fire when considering airspace. To achieve the maximum range with high angle a MO of 15,572 meters is required. As with mortars, when firing high angle the round requires more airspace to achieve shorter ranges. Looking at the standard munitions of high explosive, white phosphorus, smoke, and illumination in the low angle mode to fire at 50 percent of system range, 9,000 meters the MO is only 467 meters. However firing at 50 percent of the systems range in high angle achieves 15,000 meters with a MO of 9,718. The percentage listed is 50 percent of the achievable range with the given munitions and charge. For the howitzer, unlike the mortars, the entire range of the system cannot be fired utilizing the maximum charge.

Table 10. 155mm Howitzer MO requirement by range

			Target Range to Maxord											
			1/3 Max Range			1/2 Max Range			2/3 Max Range			Max Range		
			Range	Maxord		Range	Maxord		Range	Maxord		Range	Maxord	
System	Munition/ Angle	Charge		Meters	Feet		Meters	Feet		Meters	Feet		Meters	Feet
155mm	HE,WP,HC, ILA/ LO	MACS 4	7000	226	741	9000	467	1532	12000	1150	3772	18000	4689	15380
	HE,WP,HC, ILA / HI	MACS 4	14000	10060	32997	15000	9718	31875	16000	9285	30455	18000	7844	25728
	HE,WP,HC, ILA/ LO	7	7000	367	1204	9000	503	1650	12000	1230	4034	18000	5584	18316
	HE,WP,HC, ILA / HI	7	13000	9827	32233	15000	9144	29992	16000	8655	28388	18000	6498	21313
	HE/ LO	8	8000	233	764	12000	759	2490	15000	1559	5114	22000	6750	22140
	HE/ HI	8	17000	12347	40498	19000	11644	38192	20000	11148	36565	22000	9229	30271
	BB/ LO	MACS 5	10000	315	1033	14000	776	2545	18000	1667	5468	27000	7691	25226
	BB/ HI	MACS 5	22000	15964	52362	23000	15654	51345	24000	15284	50132	27000	13471	44185
	RAP RKT OFF/ LO	7	7000	224	735	10000	607	1991	13000	1365	4477	19000	5458	17902
	RAP RKT OFF/ HI	7	14000	10437	34233	15000	10115	33177	16000	9721	31885	19000	7328	24036
	RAP RKT OFF/ LO	8	9000	276	905	13000	817	2680	17000	1986	6514	24000	7769	25482
	RAP RKT OFF/ HI	8	19000	13845	45412	20000	13474	44195	22000	12453	40846	24000	10335	33899
	RAP RKT OFF/ LO	MACS 5	9000	275	902	13000	812	2663	17000	1973	6471	24000	7623	25003
	RAP RKT OFF/ HI	MACS 5	19000	13926	45677	20000	13559	44474	22000	12554	41177	24000	10542	34578
	RAP RKT ON/ LO	7	8000	264	866	12000	707	2319	16000	1745	5724	23000	6916	22684
	RAP RKT ON/ HI	7	17000	13821	45333	18000	13518	44339	20000	12728	41748	23000	10364	33994
	RAP RKT ON/ LO	8	10000	299	981	15000	899	2949	20000	2364	7754	29000	10052	32971
	RAP RKT ON/ HI	8	24000	18357	60211	26000	17596	57715	27000	17097	56078	29000	15572	51076
	RAP RKT ON/ LO	MACS 5	10000	298	977	15000	894	2932	20000	2350	7708	29000	9891	32442
	RAP RKT ON/ HI	MACS 5	24000	18459	60546	26000	17712	58095	27000	17223	56491	29000	15756	51680
	XCAL	MACS 4	17000	6681	21914	19500	6832	22409	21500	6975	22878	27000	7329	24039

Source: Table created by author. Table data from U.S. Army ARDEC, *FT 155-AM-3* (Aberdeen Proving Ground, MD, May 2006), 266, 318; U.S. Army ARDEC, *FT 155-AR-2* (Aberdeen Proving Ground, MD, February 2007), 96; U.S. Army ARDEC, *FT 155-AO-2 Part 1* (Aberdeen Proving Ground, MD, October 2009), 40, 96, 418; U.S. Army ARDEC, *FT 155-AO-2 Part 2* (Aberdeen Proving Ground, MD, December 2009), 50, 118, 490; U.S. Army ARDEC, *FT 155-AU-PAD, C-4 (PROV)* (Aberdeen Proving Ground, MD, February 2008), 33; U.S. Army ARDEC, *FT 155-BB-PAD* (Aberdeen Proving Ground, MD, May 2007), 285.

Table 11 lays out the required volume of airspace for the Infantry Battalion Commander to operate his organic surface fires support unconstrained. Table 11 assumes a CA established at prescribed altitudes and considers the ranges achievable to remain under that altitude. This table depicts what ranges the maneuver commander could fire in decentralized execution. A CA of 3,000 feet would allow a commander to fire his 155mm howitzers low angle at ranges up to 11,000 meters. This is 1,000 meters below two thirds of the maximum range of the systems. Base bleed munitions provide an additional capability and Rocket Assisted Projectile munitions at low angle, but as that is an extended range munitions there is not value in selecting it over standard charges. A CA of 5,000 feet allows for additional low angle fires with Charge 8 up to 14,000 meters, Rocket Assisted Projectiles out to 15,000, and Extended Range Rocket Assisted Projectiles and 17,000 meters for base bleed. However, as these are all extended range munitions, they do not provide the commander any additional capability.

A CA for up to 12,500 feet provides the same conclusion for all munitions. At this altitude the extended munitions of Charge 8, Rocket Assisted Projectiles and base bleed can now all achieve a minimum of two thirds of their ranges providing the commander the opportunity to extend his ability to influence the battlefield beyond on 155mm standard munitions. He can achieve the maximum range of Charge 8, Rocket Assisted Projectiles and base bleed providing indirect fire support out with a CA of 25,000 meters. The lowest CA acceptable to introduce high angle fires with any significant range is also 25,000 feet. With this CA, he can employ standard charges of high explosive munitions and Rocket Assisted Projectile but only at the extreme maximum of their ranges. Firing high angle with this CA would mean he would not be able to fire shorter than maximum range because as range decreases, MO increases during high angle. The most restrictive 155mm fires to employ under a prescribed CA would be the base bleed and Extended Range Rocket Assisted Projectile, high angle. To fire the full range capabilities of base bleed a CA of 55,000 feet is required and 65,000 feet for Extended Range Rocket Assisted Projectile. That is 12.3 miles up before the round begins to descend towards the target.

Table 11. 155mm ranges achievable under prescribed CAs

				Maxord of Range to Target (Range in Meters)															
			FT	3000	5000	7500	10000	12500	15000	20000	25000	30000	35000	40000	45000	50000	55000	60000	65000
System	Munition/Angle	Charge	M	915	1524	2287	3049	3811	4573	6098	7622	9146	10671	12195	13720	15244	16768	18293	19817
155mm	HE,WP, HC, ILA/ LO	MACS 4		11000	13000	14000	16000	17000	17775	max									
	HE,WP, HC, ILA / HI	MACS 4		none	none	none	none	none	none	none	none	17000 to max	min						
	HE,WP, HC, ILA/ LO	7		10000	12000	14000	15000	16000	17000	max									
	HE,WP, HC, ILA / HI	7		none	none	none	none	none	none	none	18000 to max	15000 to max	min						
	HE/ LO	8		12000	14000	16000	18000	19000	20000	21000	max								
	HE/ HI	8		none	none	none	none	none	none	none	none	none	21000 to max	18000 to max	min				
	BB/ LO	MACS 5		14000	17000	19000	21000	22000	24000	25000	26750	max							
	BB/ HI	MACS 5		none	none	none	none	none	none	none	none	none	none	none	27000 to max	25000 to max	min		
	RAP RKT OFF/ LO	7		11000	13000	max													
	RAP RKT OFF/ HI	7		none	none	none	none	none	none	none	19000 to max	18000 to max	14000 to max	min					
	RAP RKT OFF/ LO	8		13000	15000	17000	19000	20000	21000	23000	24900	max							
	RAP RKT OFF/ HI	8		none	none	none	none	none	none	none	none	none	24000 to max	23000 to max	20000 to max	min			
	RAP RKT OFF/ LO	MACS 5		13000	15000	17000	19000	20000	21000	23000	max								
	RAP RKT OFF/ HI	MACS 5		none	none	none	none	none	none	none	none	none	24000 to max	23000 to max	20000 to max	min			
	RAP RKT ON/ LO	7		13000	15000	17000	18000	20000	21000	22000	max								
	RAP RKT ON/ HI	7		none	none	none	none	none	none	none	none	none	23000 to max	21000 to max	18000 to max	min			
	RAP RKT ON/ LO	8		15000	17000	19000	21000	22000	24000	26000	27000	28000	max						
	RAP RKT ON/ HI	8		none	none	none	none	none	none	none	none	none	none	none	none	none	28000 to max	25000 to max	min
	RAP RKT ON/ LO	MACS 5		15000	17000	19000	21000	22000	24000	26000	27000	29500	max						
	RAP RKT ON/ HI	MACS 5		none	none	none	none	none	none	none	none	none	none	none	none	none	28000 to max	25000 to max	min
	XCAL	MACS 4		none	none	none	none	none	none	none	max								

Source: Table created by author.[1]

[1]Table data from U.S. Army ARDEC, *FT 155-AM-3* (Aberdeen Proving Ground, MD, May 2006), 266, 318; U.S. Army ARDEC, *FT 155-AR-2* (Aberdeen Proving Ground, MD, February 2007), 96; U.S. Army ARDEC, *FT 155-AO-2 Part 1* (Aberdeen Proving Ground, MD, October 2009), 40, 96, 418; U.S. Army ARDEC, *FT 155-AO-2 Part 2* (Aberdeen Proving Ground, MD, December 2009), 50, 118, 490; U.S. Army ARDEC, *FT 155-AU-PAD, C-4 (PROV)* (Aberdeen Proving Ground, MD, February 2008), 33; U.S. Army ARDEC, *FT 155-BB-PAD* (Aberdeen Proving Ground, MD, May 2007), 285.

BIBLIOGRAPHY

Books

Keaney, Thomas A., and Eliot A. Cohen. *Gulf War Air Power Survey Summary Report*. Washington, DC: US Government Printing Office, 1993.

Pirnie, Bruce, Alan J. Vick, Adam Grissom, Karl P. Mueller, and David T. Orletsky. *Beyond Close Air Support*. Santa Monica, CA: RAND Corporation, 2005.

Periodicals

Chairman, Joint Chiefs of Staff. "CJCS Vision 2020." *Joint Forces Quarterly* no. 25 (Summer 2000): 57-76. http://web.ebscohost.com/ehost/detail?sid=63d05ead-bc5d-49b2-a5b6-91ec65895e74%40sessionmgr4&vid=8&hid=9&bdata=JnNpdGU9ZWhvc3QtbGl2ZQ%3d%3d#db=mth&AN=4352206 (accessed 5 January 2012).

Habas, Victoria T. "Effective Airspace Management to Facilitate Fires–Establishing an Airspace Management Authority (AMA)." *Air Land Sea Bulletin*, no. 2008-3 (September 2008): 15-19.

Neal, Curtis V. "JAGC2: A Concept for Future Battlefield Air-Ground Integration." *Field Artillery Magazine* (January-February 2012): 16-19.

Seifert, Michael, Tony Dilego, Kenneth Hawks, Joshua Sterling, John Hitchings, and David Griffith. "JASMAD–Meeting Current and Future Combat Airspace Requirements." *The Air Land Sea Bulletin* no. 2006-1 (January 2006): 15-17.

Stricklin, Toney MG (Ret).. "Employment of the M982 in Afghanistan: US Army and Marine Corps Differences." *Fires* (January-February 2012): 16-19.

Tewksbury, Dennis D., and Joel E. Hamby. "Decentralized Fires in Afghanistan: A Glimpse of the Future?" *FA Journal* (November-December 2003): 10-15.

Government Documents

Chairman, Joint Chiefs of Staff. Joint Publication (JP) 1-02, *Department of Defense Dictionary of Military and Associated Terms.* Washington, DC: Government Printing Office, 2001 as amended 15 November 2011.

———. Joint Publication (JP) 3-0, *Joint Operations* Change 2. Washington, DC: Government Printing Office, March 2010.

———. Joint Publication (JP) 3-09, *Joint Fire Support.* Washington, DC: Government Printing Office, November 2006.

———. Joint Publication (JP) 3-30, *Command and Control of Joint Operations.* Washington, DC: Government Printing Office, June 2003.

———. Joint Publication (JP) 3-52, *Joint Airspace Control.* Washington, DC: Government Printing Office, May 2010.

Department of the Air Force. Air Force Doctrine Document (AFDD) 3-52, *Airspace Control.* Washington, DC: Government Printing Office, February 2011.

Department of the Army. Army Doctrine Reference Publication (ADRP) 3-0, *The Army in Unified Land Operations*, Final Draft. Washington, DC: Government Printing Office, September 2011.

———. Field Manual (FM) 3-52, *Airspace Integration,* Initial Draft. Washington, DC: Government Printing Office, June 2011.

Department of the Army. Fires Center of Excellence. *Army Functional Concept for Fires Capabilities-Based Assessment Functional Needs Analysis Report.* Fort Sill, OK, 9 November 2010.

Department of the Army, United States Marine Corps. Field Manual (FM) 6-40, MCWP 3-1.6.19, *Tactics, Techniques, and Procedures for Field Artillery Manual Cannon Gunnery.* Washington, DC: Government Printing Office, October 1999.

U.S. Army ARDEC. *FT 60-P-1, C-16*. Aberdeen Proving Ground, MD, October 2007.

———. *FT 81-AR-2, wC01 and C02*. Aberdeen Proving Ground, MD, 10 July 2005.

———. *FT 105-AS-4.* Aberdeen Proving Ground, MD, 24 August 2005.

———. *FT 105-AW-1*. Aberdeen Proving Ground, MD, 24 January 2006.

———. *FT 105-BC-PROV*. Aberdeen Proving Ground, MD, February 2010.

———. *FT 120-G-1, C-3*. Aberdeen Proving Ground, MD, January 2010.

———. *FT 155-AM-3*. Aberdeen Proving Ground, MD, May 2006.

———. *FT 155-AO-2 Part I*. Aberdeen Proving Ground, MD, October 2009.

———. *FT 155-AO-2 Part 2*. Aberdeen Proving Ground, MD, December 2009.

———. *FT 155-AR-2*. Aberdeen Proving Ground, MD, February 2007.

———. *FT 155-AU-PAD, C-4 (PROV).* Aberdeen Proving Ground, MD, February 2008.

———. *FT 155-BB-PAD*. Aberdeen Proving Ground, MD, May 2007.

U.S. Army Training and Doctrine Command. TRADOC Pamphlet 525-3-1, *The United States Army Operating Concept 2016-2028*. Fort Monroe, VA: Government Printing Office, August 2010.

———.TRADOC Pamphlet 525-3-4, *The United States Army Functional Concept for Fires 2016-2028*. Fort Monroe, VA: Government Printing Office, October 2010.

———.TRADOC Pamphlet 525-3-6, *The United States Army Functional Concept for Movement and Maneuver 2016-2028.* Fort Monroe, VA: Government Printing Office, October 2010.

U.S. Army Training and Doctrine Command and the Curtis E. Lemay Center for Doctrine Development and Education. FM 3-52.1, AFTTP 3-2.78, *Airspace Control, Multi-Service Tactics, Techniques, and Procedures for Airspace Control.* Fort Monroe, VA and Maxwell AFB, AL: Government Printing Office, May 2009.

Research Projects

Horner, John P. "The Fire Support Coordination Line: Optimal Placement for Joint Employment." Master's Thesis, Command and General Staff College, Ft. Leavenworth, June 1998.

James, Randy P. Jr. "The Army's Role in Airspace Command and Control of the Warfighter's Airspace." Monograph, School of Advanced Military Studies, Ft. Leavenworth, KS, May 2010.

Other Sources

Fires Center of Excellence, CDID. "FCoE Seminar Discussion Phase O&I." E-mail from Mr. John Folland, Integration Officer, US Field Artillery Commandant's Office. john.folland@us.army.mil. Fort Sill, OK., 23 January 2012.

Joint Staff, J7. "JP 3-52 RFD Adjudicated CRM." Excel Table. E-mail from Mr. James Isitt, SAIC Site Lead. james.isitt.ctr@js.pentagon.mil. Washington, DC, 10 February 2012.

———. "JP 3-52 RFC Consolidated Adjudicated Cmts Matrix 7 DEC 09." Excel Table. E-mail from Mr. James Isitt, SAIC Site Lead. james.isitt.ctr@js.pentagon.mil. Washington, DC, 10 February 2012.

MacFarland, Sean, Michael Shields, Jeffery Snow. "The King and I: The Impending Crisis in Field Artillery's ability to provide Fire Support to Maneuver Commanders." White Paper.

INITIAL DISTRIBUTION LIST

Combined Arms Research Library
U.S. Army Command and General Staff College
250 Gibbon Ave.
Fort Leavenworth, KS 66027-2314

Defense Technical Information Center/OCA
825 John J. Kingman Rd., Suite 944
Fort Belvoir, VA 22060-6218

Mr. Herbert F. Merrick
Department of Joint and Multinational Integration
USACGSC
100 Stimson Ave.
Fort Leavenworth, KS 66027-2301

Dr. Jeffrey J. Kubiak
School of Advanced Military Studies
USACGSC
100 Stimson Ave.
Fort Leavenworth, KS 66027-2301

LTC Jay A. Van Der Werff
Marine Corps Detachment
USACGSC
100 Stimson Ave.
Fort Leavenworth, KS 66027-2301