NAVAL POSTGRADUATE SCHOOL
MONTEREY, CALIFORNIA

19970527 031

THESIS

FRATRICIDE IN AIR-LAND OPERATIONS

by

Enrique E. Cruz

December, 1996

Thesis Co-Advisors: Daniel J. Moran
                       James J. Wirtz

DTIC QUALITY INSPECTED 1

REPORT DOCUMENTATION PAGE

Form Approved OMB No. 0704-0188

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE December 1996	3. REPORT TYPE AND DATES COVERED Master's Thesis

4. TITLE AND SUBTITLE: FRATRICIDE IN AIR-LAND OPERATIONS		5. FUNDING NUMBERS
6. AUTHOR(S) Enrique E. Cruz		
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Postgraduate School Monterey CA 93943-5000		8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)		10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government.

12a. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution is unlimited.	12b. DISTRIBUTION CODE

13. ABSTRACT (maximum 200 words)

   This thesis identifies evolutionary trends in ground maneuver, tactical air power, and fratricide during the 20th century. It explores two variables that account for most fratricides in warfare: the loss of situational awareness, and the lack of positive target identification. This study also addresses how contemporary U.S. warfighting doctrine contributes to the loss of situational awareness and compounds an already faulty target identification process. This thesis argues that the primary causes of fratricide have remained constant despite rapid changes in technology and the increasing complexity of U.S. air-land operations. When normal human failings are coupled with the absence of positive target identification, the end-result may often be casualties from friendly-fire. The complexity of maneuver and modern air-land operations often compound errors in human situational awareness. This thesis provides recommendations to help the U.S. armed forces improve combat identification efforts and reduce fratricide while retaining their existing superiority in air-land operations.

14. SUBJECT TERMS: Fratricide; Friendly-Fire; Amicide; Close-Air Support; Tactical Air Operations; Maneuver Warfare and Joint Combat Identification.			15. NUMBER OF PAGES 107
			16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT Unclassified	18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified	20. LIMITATION OF ABSTRACT UL

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. 239-18 298-102

i

FRATRICIDE IN AIR-LAND OPERATIONS

Enrique E. Cruz
Major, United States Marine Corps
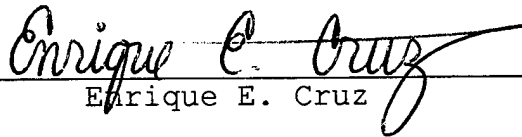B.A., University of Colorado, 1983

Submitted in partial fulfillment
of the requirements for the degree of

MASTER OF ARTS IN NATIONAL SECURITY AFFAIRS

from the
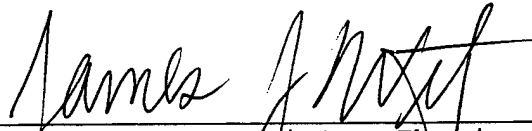
NAVAL POSTGRADUATE SCHOOL
December 1996

Author: _____
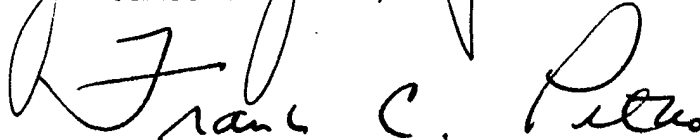
Enrique E. Cruz

Approved by: _____

Daniel J. Moran, Thesis Co-Advisor

_____

James J. Wirtz, Thesis Co-Advisor

_____

Frank Petho, Chairman
Department of National Security Affairs

ABSTRACT

This thesis identifies evolutionary trends in ground maneuver, tactical air power, and fratricide during the 20th century. It explores two variables that account for most fratricides in warfare: the loss of situational awareness, and the lack of positive target identification. This study also addresses how contemporary U.S. warfighting doctrine contributes to the loss of situational awareness and compounds an already faulty target identification process. This thesis argues that the primary causes of fratricide have remained constant despite rapid changes in technology and the increasing complexity of U.S. air-land operations. When normal human failings are coupled with the absence of positive target identification, the end-result may often be casualties from friendly-fire. The complexity of maneuver and modern air-land operations often compound errors in human situational awareness. This thesis provides recommendations to help the U.S. armed forces improve combat identification efforts and reduce fratricide while retaining their existing superiority in air-land operations.

TABLE OF CONTENTS

LIST OF ACRONYMS

ASCIET - All Service Combat Identification Evaluation Team

ATHS - Automated Target Hand-off System

AWACS - Airborne Warning and Control System

BCIS - Battlefield Combat Identification System

BVR - Beyond Visual Range

C^2 - Command and Control

C^3I - Command, Control, Communications, and Intelligence

CID - Combat Identification

CIP - Combat Identification Panel

CAS - Close Air Support

DARPA - Defense Advanced Research Projects Agency

DOD - Department of Defense

DRAW-D - Defend, Reinforce, Attack, Withdraw, and Delay

EO - Electro-Optical

FAC - Forward Air Controller

FFA - Free Fire Area

FLIR - Forward Looking Infrared

FO/FAC - Forward Observer / Forward Air Controller

GCCS - Global Command and Control System

GOSC - General Officer Steering Committee

GPS - Global Positioning System

IFF - Identification Friend or Foe

IR - Infrared

JADO/JEZ - Joint Air Defense Operations / Joint Engagement Zone

JCIDO - Joint Combat Identification Office

JEM - Jet Engine Modulation

JFACC - Joint Force Air Component Commander

JROC - Joint Requirements Oversight Council

JTTP - Joint Tactics, Techniques, and Procedures

KOCOA - Key Terrain, Obstacles, Cover and Concealment,
        Observation and Fields of Fire, Avenues of Approach

LAV - Light Armored Vehicle

LIC - Low Intensity Conflict

METT-T - Mission, Enemy, Terrain and Weather, Troops and
         Fire Support Available, and Time

MMW - Millimeter Wave

MNS - Mission Need Statement

NCA - National Command Authority

NCTR - Non-Cooperative Target Recognition

NTC - National Training Center

NVD - Night Vision Device

NVG - Night Vision Goggle

ORD - Operational Requirements Document

OOTW - Operations Other Than War

OSD - Office of the Secretary of Defense

OTA - Office of Technology Assessment

RAF - Royal Air Force

ROE - Rules of Engagement

SA - Situational Awareness

SABER - Situational Awareness Beacon with Reply

SALUTE - Size, Activity, Location, Unit, Time, and Equipment

SATCOM - Satellite Communication

SINCGARS - Single Channel Ground and Airborne Radio System

TADIL - Tactical Digital Information Link

TI - Target Identification

UHF - Ultra High Frequency

USAAF - United States Army Air Force

ACKNOWLEDGMENTS

EXECUTIVE SUMMARY

Fratricide, also known as friendly-fire, is defined as death or injury to friendly personnel from fire whose intended target is the enemy. It has always been a part of warfare. This study suggests that most fratricides stem from two causal factors: the loss of situational awareness, and the lack of positive target identification. The detrimental effects of these two factors are exacerbated by current U.S. air-land doctrine which strains the ability of humans to maintain situational awareness and identify targets on a fast-moving battlefield. The merging of technology with high tempo air-land operations often compounds errors in human situational awareness. When these interactions are coupled with the absence of positive target identification, the end-result will almost always be casualties from friendly-fire.

Chapter II analyzes situational awareness and target identification with emphasis on the influence that maneuver warfare has on these variables. In combat, the inability to maintain situational awareness often results in fratricide from failures in fire and maneuver control, navigation, and command and control. Combat also makes it difficult to identify forces as friendly, neutral, or hostile. In battle, targets can be acquired and engaged at long range, but they cannot be positively identified at long range. This imbalance in capabilities heightens the risk of fratricide for the U.S. military, which relies on high lethality weapons that frequently operate well beyond visual range. Mistaken identity on the battlefield often results in friendly-fire casualties because of difficulties identifying visual, thermal, or optical signatures, limited visibility or restricted terrain, and similarities between friendly and enemy equipment.

Chapter III examines evolutionary trends in fratricide stemming from the employment of tactical air power in support of ground maneuver. During World War I, significant problems were encountered with air-land integration, especially when battle lines shifted or fluctuated. These same difficulties were experienced on a much larger scale by German and Allied forces during World War II. Fluid, mechanized operations made air-land coordination and fratricide avoidance more problematic. Similar integration and friendly-fire problems were apparent in Southeast Asia where the use of improved weaponry greatly compressed the time available for target identification and engagement decisions. Finally, the Gulf War illustrated how difficult it is for combat leaders to maintain situational awareness and identify targets, even in the face of very light enemy resistance. Despite the high degree of Coalition unity and teamwork, 28 known instances of friendly-fire occurred, of which nine involved air-land forces. The thesis argues that the primary causes of fratricide have remained constant, but that the evolutionary trend toward technical complexity in warfare may exacerbate the primary causes of friendly-fire.

Chapter IV examines the challenge of solving the complex problem of fratricide. Most friendly-fire incidents have many causal pathways which requires a balanced and complementary strategy to approach the problem from a technological, doctrinal, and organizational perspective. Technical initiatives to enhance combat identification and reduce fratricide range from the application of VS-17 thermal panels to digitization of the battlefield. Joint doctrine also plays a critical role in enhancing fratricide awareness by addressing the problem in peacetime training and in war. Organizational measures include restructuring the defense establishment and emphasizing training measures to develop

U.S. combat identification capabilities and reduce fratricide.

Chapter V proposes that the following research findings should be considered in the formulation of U.S. policy on combat identification and fratricide reduction:

- The loss of situational awareness and the lack of positive target identification account for most incidents of air-land fratricide.

- U.S. target acquisition and weapon system technologies have outpaced target identification capabilities. Most target identification in battle is still visual.

- Similarities between friendly and enemy combat systems degrade target identification efforts and increase the risk of fratricide.

- Fratricide can be reduced but not eliminated.

- The American public and government leaders have become more aware of casualties caused by friendly-fire.

- Fratricide can significantly degrade U.S. warfighting capabilities.

- Military Coalitions are ad-hoc organizations that may be polarized by fratricide incidents.

The following policy recommendations identify areas that can be improved in joint combat identification and fratricide reduction efforts:

- Maintain the current broad-based emphasis on enhancing combat identification and avoiding fratricide.

- Apply a greater emphasis on training and professional education.

- The U.S. should vigorously pursue combat identification and fratricide avoidance capabilities with Alliance partners.

- Insist that new weapon systems have integrated combat identification capabilities that are commensurate with target engagement ranges.

I. INTRODUCTION

A. SCOPE, SOURCES AND METHODOLOGY

This study analyzes the critical and frequently misunderstood relationship between tactical air power, maneuver, and fratricide in modern warfare. This study suggests that most air-land fratricides occur because of two factors: (1) loss of situational awareness (SA) and, (2) the lack of positive target identification (TI). The effects of these factors are aggravated by the adoption of maneuver as the primary U.S. warfighting technique, and by the continued use of target identification capabilities that have not kept pace with advances in detection and engagement. This disparity in U.S. warfighting capabilities fosters many of the conditions leading to the problem of air-land fratricide, especially during joint and multinational operations.

In this thesis, the term "fratricide" means the employment of weapons and munitions against the enemy in a way that results in unforeseen and unintentional death or injury to friendly personnel.[1] Other frequently-used terms that have the same meaning include amicide, blue on blue, and friendly-fire. This thesis considers one important subset of the entire fratricide puzzle: losses inflicted on ground forces from the air. It focuses specifically on the interaction between ground maneuver elements and close air support (CAS) in order to illuminate common patterns, evolutionary trends, and interactions that can be used to address the general problem of fratricide in combat.

The study of fratricide in air-land operations requires

---

[1] U.S. Army, Combined Arms Command, Center for Army Lessons Learned, Fratricide: Reducing Self-Inflicted Losses, CALL Newsletter 92-4 (Fort Leavenworth, Kansas, April 1992), 3.

familiarity with a wide range of military subjects, and draws upon a wide range of literature on the subject of ground maneuver, CAS, and friendly-fire. The author has also interviewed many U.S. government officials who have been pursuing solutions to current and projected shortfalls in air-land integration and joint combat identification (CID). Their insights, suggestions, and encouragement helped this investigation into an enduring and troubling problem.

Two major themes predominate. The first revolves around U.S. air-land operations as they have evolved throughout the 20th century. The second focuses on the causal interactions that have resulted in air-land fratricides. The conceptual model applied throughout is based upon maneuver warfare theory.

As embraced by the U.S. military, maneuver warfare refers to a warfighting philosophy that seeks to shatter the enemy's cohesion through a series of rapid, violent, and unexpected actions that create a turbulent and rapidly deteriorating situation with which the enemy cannot cope.[2] The goal of maneuver warfare is to attack the enemy's critical vulnerabilities on the most favorable terms possible, thereby rendering attritional combat unnecessary. At the operational level, the art of maneuver does not rely solely on massed forces, set-piece battles, or superior firepower to reduce the enemy's strength and ability to resist, even when they are available. Maneuver hinges on destroying the enemy's will to fight by means other than the wholesale destruction of his armed forces, and specifically by pitting strength against weakness.

Military organizations that operate with high efficiency

---

[2] Department of the Navy, FMFM-1 Warfighting (Washington D.C.: Headquarters, U.S. Marine Corps, 1989), 59.

and minimum risk despite the chaos and uncertainty of combat will most likely achieve success. This study also argues that the intricacy of maneuver and air-land operations often compound errors in human situational awareness. When these human shortcomings are linked with the absence of positive target identification, the result may well be an increase in casualties from friendly-fire.

B. IMPORTANCE OF THE STUDY

Conventional warfare today is characterized by long range engagements, high kill probabilities, and massed formations capable of operating over vast areas at high speed. On the modern battlefield, what can be seen can generally be hit; by extension, what can be hit can also be destroyed. Exploiting these capabilities, however, is not risk-free, primarily because weapons acquisition and kill technologies have progressed faster than most target identification systems. The resulting imbalance between acquisition, targeting, and identification complicates engagement decisions by "trigger-pullers," and markedly increases the danger of fratricide.

From a historical perspective, fratricide is as timeless as warfare itself. Self-inflicted losses have always accounted for a significant portion of battle-related casualties. Consider Thucydide's description of the aftermath of the Athenian night attack at Epipolae in 413 B.C.:

> "The Athenians now fell into great disorder and perplexity...seeking one another, taking all in front of them for enemies, even although they might be some of their now flying friends...They ended by coming into collision with each other in many parts of the field, friends with friends, and citizens with citizens, and not only terrified one another, but even came to blows and could only be parted with difficulty."[3]

---

[3] Geoffrey Regan, Blue on Blue: A History of Friendly Fire (New York: Avon Books, 1995), 23.

Similar accounts can be found of battle during the middle ages, when densely packed masses of men on horse and foot fought hand-to-hand. Massed archery fire, which was a common tactic of English commanders particularly during this era, routinely resulted in accidental deaths, a problem that the advent of firearms made worse. One potential casualty might have been George Washington, who survived an encounter with a friendly British unit during the French and Indian War, in which more than 40 British soldiers died at the hands of their comrades. In the aftermath of Waterloo, the British Colonel commanding the 23rd Light Dragoons went so far as to declare that "we always lose more men by our own people than we do by the enemy."[4] And while his remark was an exaggeration, it may serve as a reminder that self-inflicted losses have always been a significant concern for field commanders.

In the 20th century, however, the fusion of technology and warfare has resulted in a frightful escalation of the total number of friendly-fire casualties. The armies that fought World War I had tremendous difficulties coordinating infantry maneuver with supporting fire from naval platforms, artillery, and aviation. After the First World War, French General Alexandre Percin alleged in his book Le Massacre de Notre Infanterie, that 75,000 of France's 3.3 million casualties were due to artillery fratricide, yet the conditions that prevailed during World War II were, if anything, worse.[5] Friendly-fire incidents soared as battlefields became more complex and nonlinear. The problem was also compounded by the need for timely and effective

---

[4] John Keegan, The Face of Battle (New York: Penguin Books, 1976), 195.

[5] Alexandre Percin, Le Massacre de Notre Infanterie 1914-1918 (Paris: Albin-Michel, 1921), 217-218.

4

combined arms integration between airplanes and increasingly mobile ground forces.

The doctrinal union between CAS and high-speed, mechanized ground forces was in its infancy during the Second World War, and not well understood by American or Allied forces, even at the end. During the breakout from Normandy in 1944, for instance, the Allies planned an operation, code-named Cobra, that called for a heavy air bombardment of German defenses as a prelude to a general ground advance. Inadequate target identification, and poor coordination among the Services, compounded by poor situational awareness on the part of Allied pilots, resulted in extensive bombing of U.S. ground positions, with a loss of more than 150 killed and nearly 800 wounded.[6] As a result, the Allies nearly abandoned the concept of using heavy bombers to support ground combat, though this was not done in the end because their usefulness, despite the difficulties, had become all too clear.

Similar organizational problems have hampered many U.S. military operations since World War II. Instead progress has, if anything, been slower than the pace of technological advancement. The 1991 conflict in the Persian Gulf provides a stark reminder of the deadly and unforgiving character of combat, even in the face of very light resistance. Over 17 percent of American casualties in Operation Desert Storm (107 of 613), and 24 percent of fatalities (35 of 146) are known to be the result of friendly-fire.[7]

One might expect fratricide to decline in low intensity conflict (LIC) and operations other than war (OOTW). In

---

[6] Russell F. Weigley, Eisenhower's Lieutenants: The Campaign of France and Germany, 1944-1945 (Bloomington: Indiana University Press, 1981), 153.

[7] U.S. Department of Defense, Final Report to Congress on the Conduct of the Persian Gulf War (Washington D.C.: U.S. Government Printing Office, 1992), 589.

practice, significant improvement may be difficult to achieve, given the intricate security challenges these operations pose. Greater U.S. involvement in LIC and OOTW may simply add another dimension to the problem by exposing it more clearly to public and political scrutiny.

On April 14, 1994, two U.S. Air Force F-15 jets under the control of an Air Force airborne warning and control plane (AWACS) accidentally shot down two U.S. Army Black Hawk helicopters in northern Iraq. This tragedy claimed the lives of 26 members of the Combined Task Force for Operation Provide Comfort, and paved the way for a comprehensive review of joint air command and control(C^2) procedures and theater-specific rules of engagement (ROE). The high-level interest and extensive media coverage it sparked highlights the degree to which the friendly-fire problem is likely to have special importance at the low end of the conflict spectrum. Unless positive actions are taken to deal with it, political and military leaders may find it difficult to obtain domestic and international support for similar operations in the future.

C.   FRAMING THE ISSUE

Fratricide has been defined as "death or injury to friendly personnel from fire whose intended target is the enemy." This definition incorporates two distinct criteria:

- Incidents must occur within the context of a U.S. military operation in which at least the potential for combat is recognized.
- Casualty figures from homicides, accidents, and equipment malfunctions are excluded from fratricide reports and statistics.

The definition of fratricide cited above does not address the issue of "near misses." It does provide a useful means of differentiating among the various sources of U.S. battle casualties. To be considered fratricide, incidents must take place in a combat setting and friendly forces must be trying

6

to engage the enemy.

The Vietnam War saw 1,013 documented cases of attempted or successful killings of officers by their own men.[8] Despite the obvious combat setting, these occurrences are not fratricide, because there was no intent to engage enemy forces. A similar rationale applies to accidents and equipment malfunctions. For example, in 1968 a U.S. F-4 Phantom jet supporting troops engaged near Ban Me Thout, Vietnam, dropped a napalm canister on a church, killing 13 civilians. An investigation revealed that the cause was due to a faulty bomb rack.[9] Again, this incident is not fratricide, since the pilot did not release the napalm with the intent to engage enemy forces. Instead, equipment failure led to the inadvertent release of the ordnance that caused the accidental deaths of the Vietnamese civilians.

Episodes of this kind share fratricide's primary effect – friendly-fire losses – but not its underlying logic, which depends upon a conscious attempt to engage the enemy. Fratricide can also be distinguished, perhaps less categorically, by what might be called its secondary effects, which result not from actual friendly-fire losses, but from fear of them. Fear of fratricide from supporting arms can quickly render a unit ineffective. Concern over the possible degradation of U.S. warfighting capabilities prompted the Office of Technology Assessment (OTA) in 1993 to report on the consequences of fratricide for military readiness. Table I outlines the major detrimental effects identified by the OTA

---

[8] Jonathan Shay, Achilles in Vietnam (New York: Touchstone, 1994), 127.

[9] Charles Schrader, Amicide: The Problem of Friendly Fire in Modern War (Fort Leavenworth, Kansas: U.S. Army Command and General Staff College, 1982), 55.

study:[10]

```
┌─────────────────────────────────────────────────────┐
│  •   Hesitation to conduct limited visibility operations │
│  •   Loss of confidence in unit's leadership        │
│  •   Increase in leader self-doubt                  │
│  •   Hesitation to use supporting combat systems    │
│  •   Oversupervision of units                       │
│  •   Loss of initiative                             │
│  •   Loss of aggressiveness during fire and maneuver │
│  •   Disrupted operations                           │
│  •   Needless loss of combat power                  │
│  •   General degradation of cohesion and morale     │
└─────────────────────────────────────────────────────┘
```

Table I. Detrimental Effects of Fratricide From (OTA Report, 1993)

Although not all these effects occur in all cases, fratricide's secondary effects clearly have the potential to disrupt operations across the entire battlefield. The consequences of tactical paralysis, aversion to risk, and so on, may well be as grave as those caused by friendly-fire itself. Combat leaders must not become so alert to the detrimental effects of fratricide that they also become too cautious, indecisive, or unwilling to take risks. During Operation Desert Storm, Coalition forces proved the importance of this point by maintaining constant pressure against critical Iraqi vulnerabilities in spite of many friendly-fire incidents.

D.   STRUCTURE OF THIS THESIS

This study argues that most fratricides occur because of two predominant factors: (1) the loss of situational awareness

---

[10] U.S. Congress, Office of Technology Assessment, Who Goes There: Friend or Foe?, OTA-ISC-537 (Washington D.C.: U.S. Government Printing Office, 1993), 19.

and, (2) the lack of positive target identification. Figure 1 illustrates the primary variables that influence situational awareness, target identification, and fratricide.[11] It also contends that these risks are heightened by the adoption of maneuver as the primary warfighting technique. Maneuver warfare is a high risk method of warfighting that carries with it a proportionately greater chance for both success and catastrophic failure, including fratricide.[12] These issues are described in detail in Chapter II.

Chapter III traces evolutionary trends in air-land fratricide, by means of historical case studies chosen to illustrate common patterns and key facets of the problem. The focus is on major conventional and unconventional conflicts where tactical air power and mobile ground forces were closely integrated.

Chapter IV explores a broad range of technological, doctrinal, and organizational remedies to address shortfalls in joint combat identification. Here, and throughout the thesis, it is argued that multiple strategies are needed to cope with the many challenges posed by air-land fratricide.

Chapter V outlines the research findings and provides policy recommendations to enhance U.S. efforts in the areas of CID and fratricide reduction. This study concludes by reinforcing the view that fratricide risks can be assessed, identified, and decreased with little degradation to the combat efficiency of U.S. military forces.

---

[11] U.S. Army, Combined Arms Command, Center for Army Lessons Learned, Fratricide: Reducing Self-Inflicted Losses, CALL Newsletter 92-4 (Fort Leavenworth, Kansas, April 1992), 9.

[12] Department of the Navy, FMFM-1 Warfighting (Washington D.C.: Headquarters, U.S. Marine Corps, 1989), 29.
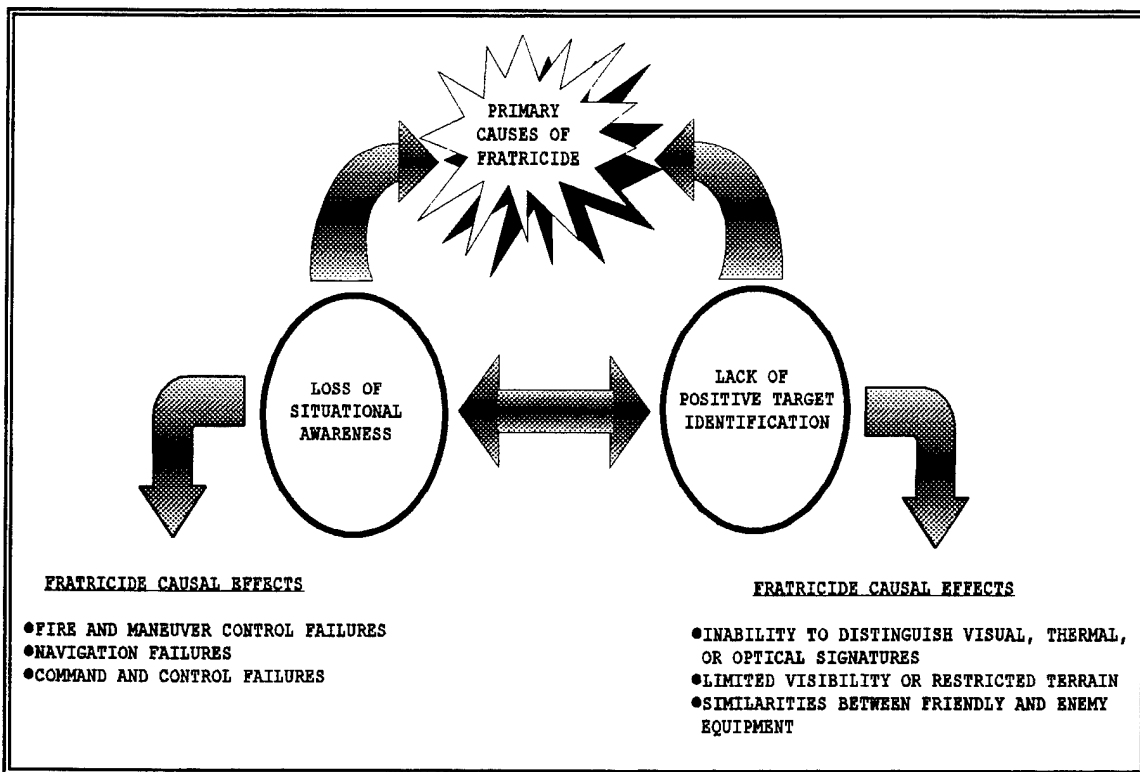
Figure 1. Dynamics of Situational Awareness and Target Identification From (CALL Newsletter, 1992)

II. CAUSE AND EFFECT: SITUATIONAL AWARENESS, TARGET IDENTIFICATION, AND MANEUVER WARFARE

A. WHAT IS GOING ON?

In a military context, situational awareness refers to the real or near-real time accurate knowledge of one's own location (and orientation), plus the locations of friendly, enemy, neutral, and noncombatant personnel.[13] Developing true situational awareness requires a thorough understanding of many factors, including the commander's intent, mission, enemy, terrain and weather, troops and fire support available, and time. The concept of situational awareness refers to the mental process of knowing what is going on at any point and time in the surrounding environment.

At a minimum, human beings need self-discipline, mental concentration, and time to develop good situational awareness for most tasks and activities. Humans must give a considerable amount of attention to build prioritized and sequential mental images of the immediate environment.[14] By comparison, losing situational awareness is very easy: it is the essence of what Clausewitz called the "fog of war."

Persons who have lost their situational awareness generally focus on limited aspects of an otherwise complex and dynamic environment.[15] When this occurs, the rest of the environment may change so drastically that the person may lose

---

[13] Kenneth J. Mellin and John R. Ferguson, "Combat Identification-Are We Fixing What's Broken," paper presented at the Naval Postgraduate School Joint Service Combat Identification Systems Conference, Monterey, CA (14-16 November 1995), 44.

[14] Robert L. Shaw, <u>Fighter Combat: Tactics and Maneuvering</u>, (Annapolis: Naval Institute Press, 1985), 291.

[15] Ibid, 291.

11

touch with the "actual" situation without realizing it. Depending upon the nature of the tasks and activities being performed, an attention lapse of a few seconds may lead to disorientation.

To develop situational awareness, people need access to timely and reliable information about the combat environment. Ideally, most of this information is provided on a real or near-real time basis by military command, control, communications, and intelligence (C^3I) networks. The real and near-real time qualities of U.S. C^3I networks have a significant impact on individual and collective situational awareness, systems interoperability, and the timely exchange of perishable combat information.

1. Commander's Intent and METT-T

One crucial aspect of situational awareness is a clear understanding of what the commander intends to do to the enemy. A well-crafted commander's intent conveys the senior leader's vision of success in a way that connects the mission with the concept of operations. Knowledge of the commander's intent is vital because it enhances situational awareness and enables subordinates to exercise sound judgement and decisive actions on a changing and fluid battlefield.[16] Another effective way to enhance situational awareness is to be familiar with combat factors like the mission, enemy, terrain and weather, troops and fire support available, and time. A helpful acronym that combines these military planning factors is referred to as METT-T, whose components are as follows:

- Mission. The mission statement specifies the unit actions to be taken. A clear-cut mission statement enhances situational awareness by ensuring that

---

[16] Department of the Navy, FMFM-1 Warfighting (Washington D.C.: Headquarters, U.S. Marine Corps, 1989), 72.

people understand what tasks they are expected to accomplish.

- **Enemy.** Who is the enemy, how is he equipped, what can he do, and what is he likely to do? The acronyms SALUTE (size, activity, location, unit, time, equipment) and DRAW-D (defend, reinforce, attack, withdraw, delay) may also be used to gain insights about the enemy and his intentions. SALUTE is used to identify who the enemy is, how he is equipped, and what he can do. DRAW-D is used to help determine what the enemy will probably do based upon capabilities.

- **Terrain and Weather.** Information about vegetation, soil type, hydrology, climatic conditions, and light data that can be used to estimate the impact of environmental factors on enemy and friendly operations. For detailed analysis, the military aspects of terrain are usually grouped under the acronym KOCOA.[17] This acronym stands for:

    -**Key Terrain.** Any locality or area the seizure of which or retention of which affords a marked advantage to either combatant.

    -**Obstacles.** Anything (natural or artificial) that stops, impedes, or diverts military movement.

    -**Cover and Concealment.** Cover is the physical protection from the effects of fire. Concealment on the other hand refers to protection from observation or surveillance.

    -**Observation and Fields of Fire.** Observation means the area over which surveillance can be exercised either visually or by using surveillance devices, both optical and electronic. Fields of fire refers to the area a weapon or group of weapons may cover effectively with fire from a given position.

---

[17] Department of the Army, <u>FM 101-5-1 Operational Terms and Symbols</u> (Washington D.C.: Headquarters, U.S. Army, 1985), 1-47.

-Avenues of Approach. A route by which a force
may reach its objective or key terrain.
Avenues of approach are notably different for
aviation, mechanized, and foot mobile units.

-Weather. Refers to local meteorological
conditions. This factor is usually considered
in terms of potential impact on friendly and
enemy operations, mobility, and morale.

- **T**roops and Fire Support Available. The quantity,
  level of training, and psychological state of
  friendly forces. Some planning factors include the
  availability of firing agencies, the amount and
  type of ordnance available, and integration
  requirements for fire support.

- **T**ime. This refers to the time available for
  planning, preparing, and executing military
  operations. This is usually considered from both
  the enemy and friendly point of view.

Maintaining good situational awareness in a complex,
changing, and uncertain combat environment is a profound
challenge, even under low threat conditions. Cognizance of the
commander's intent and METT-T factors enhances knowledge of
the combat environment which reduces the risk of fratricide.
Nevertheless, perfect situational awareness, and the
elimination of risk from all military actions, are obviously
unrealistic goals.

2. The Loss of Situational Awareness and Fratricide

The inability to maintain situational awareness in a
combat environment is one of the primary causes of fratricide.
Although every friendly-fire incident has unique
circumstances, those involving the loss of situational
awareness are often characterized by fire and maneuver control
failures, navigation failures, and command and control (C^2)
failures. Each of these requires additional elaboration.

a. Fire and Maneuver Control Failures

The senior ground commander is responsible for all fire support delivered on surface targets within his area of responsibility. Doctrinal fire support coordination measures are intended to safeguard friendly forces and speed up the destruction of targets. Permissive coordination measures indicate that no further coordination is required to engage the affected targets. Restrictive measures, in contrast, rely on specific requests for coordination before the engagement of targets affected by the measure. Restrictive measures are an important way to avoid fratricide by regulating the employment of all supporting arms.

The decisive application of combat power also requires commanders to convey their orders and intent to subordinates accurately and quickly. In prolonged combat, however, the commander and his staff are usually stretched to their limits. A fast-paced environment provides countless opportunities for human errors to develop, which may eventually lead to friendly-fire casualties. Many self-inflicted casualties can be attributed to one or more conditions: flaws in mission planning; improper distribution of fire support and maneuver control measures; lack of understanding by subordinates; and failures in mission execution.

Flaws in mission planning often result when military headquarters are careless in their approach to the combat decision-making process. Vital information may be unavailable or overlooked during the plan development phase. If no one detects and remedies these flaws in time, critical problems may develop. For example, plans that allow forces to converge without adequate controls are recipes for disaster. Similarly, plans that improperly task supporting arms or disperse units

15

along greater than doctrinal frontages may reduce the effectiveness of doctrinal fire and maneuver control efforts. Current doctrine also demands rapid and frequent changes to combat plans, which may result in the improper distribution of fire support and maneuver control measures. The combat environment is often in a state of flux that provides fleeting opportunities to seize the initiative and shape the course of events. To ensure unity of effort and take advantage of these opportunities, the commander must be able to distribute his plans and orders in a complete, timely, and accurate manner.

All units must receive the commander's operational plan with sufficient lead time to allow concurrent planning, preparation, and execution. Unfortunately, there are countless reasons why orders may fail to reach units. As a result, some friendly units may be out of touch with the changing situation or unaware of fire support control measures currently in effect. Under such conditions, units may inadvertently stray into "hot" zones or free fire areas where they are almost certain to suffer casualties from friendly-fire.

Lack of understanding by subordinates can easily lead to fire and maneuver control failures. The commander and his staff must attempt to create operational plans and orders that are simple to understand and easy to carry out. One way to ensure clarity and understanding is to employ a standardized system of military symbols and decision graphics that accurately identify objects of operational interest. An individual's level of understanding can also be enhanced through realistic walk-through rehearsals and commander's backbriefs.

Failures in mission execution have a high potential to cause friendly-fire casualties, especially during offensive operations. The execution phase marks the critical transition

from plans and concepts to actual operations against the enemy. By the execution phase, all friendly elements should be fully integrated into the commander's scheme of maneuver and functioning like a well-oiled machine.

One reason that some units fail to carry out assigned missions is simple, "friction." Clausewitz described friction as "the only concept which in a general way corresponds to that which distinguishes real war from war on paper."[18] Friction is that element in war, separate from enemy action, that militates against the success of the commander's plan.[19] It is the epitome of Murphy's Law, because simple details always seem to go wrong at the worst possible moment whenever military units try to communicate, move, or fight.

The effects of friction are inevitable and ubiquitous. Many combatants fail to accomplish their assigned missions because they simply cannot overcome the effects of mental or physical friction. Their failures disrupt operations by creating even more friction that impedes the commander's plan of action. Friction lowers performance levels to the point where seemingly simple functions may become too difficult to carry out. High levels of friction may create circumstances that are conducive to the loss of situational awareness and hence to fratricide.

For example, forward air controllers (FACs) rely extensively on two-way communications to control tactical aircraft. Lost or degraded communications between the FAC and supporting aircrew can easily result in disorientation and the complete loss of situational awareness. When this occurs, the

---

[18] Carl Von Clausewitz, On War (New York: Penguin Books, 1984), 164.

[19] Robert Leonhard, The Art of Maneuver: Maneuver Warfare Theory and AirLand Battle (Novato: Presidio Press, 1991), 242.

mission may have to be aborted because of the FACs inability to coordinate mission parameters and the extremely high risk of fratricide. A clear example of fratricide's secondary effects, stemming from fear, and not from actual friendly casualties.

Fire and maneuver control failures are key contributors to the occurrence of friendly-fire incidents. Measures that are well planned and implemented provide safeguards for friendly forces and ensure responsive and accurate delivery of fires from supporting agencies. To reduce the danger of fratricide, fire and maneuver control measures must be understood and consistently applied. Unfortunately, errors in their application often result in execution failures between supporting arms and ground maneuver elements.

b.   Navigation Failures

The U.S. military employs state of the art instruments to reduce navigational problems. Despite the use of these devices, individuals and units may become lost because they overlook basic navigational methods and techniques. Why do people sometimes get lost in the field? Navigation during combat should never be viewed as a matter of simply going from point A to point B. Tactical navigation is a complex and highly perishable skill that requires constant training and attention to detail.

Once situational awareness is lost, individuals or units may stray out of assigned sectors, employ fire support weapons from improper locations, or erroneously report their position to higher headquarters.[20] These shortfalls may create situations where friendly units collide unexpectedly or engage

---

[20] U.S. Army, Combined Arms Command, Center for Army Lessons Learned, Fratricide: Reducing Self-Inflicted Losses, CALL Newsletter 92-4 (Fort Leavenworth, Kansas, April 1992), 10.

each other by mistake. As fluid situations develop, navigational errors may compound at each level of command, resulting in a progressively distorted "picture" of the battlefield.

c.   Command and Control Failures

No single activity in war is more important than C^2.[21] By itself, C^2 does not shoot down enemy airplanes, put Marines across the beach, or ensure that front-line units get resupplied. However, none of these vital functions would be possible without effective C^2. In joint and combined operations, C^2 is defined in the following manner:

> The exercise of authority and direction by a properly designated commander over assigned and attached forces in the accomplishment of the mission. Command and control functions are performed through an arrangement of personnel, equipment, communications, facilities, and procedures employed by a commander in planning, directing, coordinating, and controlling forces and operations in the accomplishment of the mission.[22]

The C^2 process is the commander's principal way of cutting through the "fog of war" to reduce uncertainty and enhance collective situational awareness. One must nevertheless be aware of the degree to which information flows, even under the most sophisticated C^2 system. For example, a Joint Force Air Component Commander (JFACC) monitoring air operations from a C^2 facility may be tempted to believe that he can "control" all theater air activities. For the JFACC, the illusion of control can be very captivating, especially when subordinates fuse multiple sources of real

---

[21] Department of the Navy, <u>Command and Control, A U.S. Marine Corps Concept Paper</u> (Washington D.C.: Headquarters, U.S. Marine Corps, 1996), 19.

[22] U.S. Department of Defense, Joint Pub 1-02, <u>DOD Dictionary of Military and Associated Terms</u>, (Washington D.C.: U.S. Government Printing Office, 1994), 82.

time and near-real time information to provide a "comprehensive picture" of the environment. Armed with a god's eye view of the airspace, the JFACC may be inclined to believe the air situation to be "well in hand" or "completely under control." Yet, how could this be possible if the JFACC never exercises precise "control" over variables like the thoughts and actions of friendly pilots, the weather, friction, and of course, the enemy?

Commanders never have "control" in the strict sense of the term. Combat is far too complex and unpredictable to ever allow operations to unfold with such precision and ease. Military leaders must be receptive to the idea that effective C^2 does not require all actions and decisions to be tightly controlled. The tempo and complexity of modern combat precludes the use of such a narrow approach. An effective C^2 process compensates for the inherent uncertainty of warfare. The ideal approach to C^2 emphasizes simplicity, flexibility, and decentralization as opposed to micro-management, centralization, and the absence of feedback. In such a system, the commander commands with a loose rein--command by influence--allowing subordinates significant freedom of action and requiring them to act with sound judgement and initiative.[23] It should be noted, however, while this C^2 philosophy is desired in principle, it also carries a proportionally higher risk of fratricide.

For example, commanders, leaders and their command posts may not generate timely, accurate, and complete reports or track subordinates as locations and the tactical situation

---

[23] Department of the Navy, <u>Command and Control, A U.S. Marine Corps Concept Paper</u> (Washington D.C.: Headquarters, U.S. Marine Corps, 1996), 54.

change.[24] As information passes through reporting channels it may become increasingly distorted and ambiguous until there is little correlation with the "real" combat environment. This is a dangerous situation that could easily result in the inadvertent clearance of supporting fires against friendly units.

Decentralized C^2 procedures can also break down when the tempo of operations strain organizational capabilities. Survival on today's battlefield calls for dispersal and frequent movement. Advancements in mobility, lethality, and information management continue to compress time and space, forcing higher operating tempos and creating an even greater demand for information.[25] Managing the sheer volume of information can overwhelm the C^2 architecture, leading to systemic failures from over complexity. Developing an effective C^2 architecture is one of the most important steps that a commander can take to reduce friendly-fire and establish some measure of order.

The inability to gain and maintain situational awareness is one of the primary reasons for the occurrence of fratricide. Many fratricides occur as a direct result of failures in fire and maneuver control, navigation, and C^2. There is no question that the loss of situational awareness accounts for many friendly casualties and a large portion of the total fratricide problem. Another major source of self-inflicted casualties comes from critical shortfalls in the target identification process.

---

[24] U.S. Army, Combined Arms Command, Center for Army Lessons Learned, Fratricide: Reducing Self-Inflicted Losses, CALL Newsletter 92-4 (Fort Leavenworth, Kansas, April 1992), 10.

[25] Department of the Navy, Command and Control, A U.S. Marine Corps Concept Paper (Washington D.C.: Headquarters, U.S. Marine Corps, 1996), 40.

B. Target Identification Failures and Fratricide

1. Who Goes There?

Combat forces require positive, timely, and accurate identification of friends, foes, and neutrals. The advanced technologies of the modern battlefield have complicated the fratricide problem exponentially. Today, a great disparity exists between the range of modern weapon systems and the resolution of optical, thermal, and radar sensors. For instance, the process of identifying ground combat systems and troop formations remains largely visual (or "aided visual"). The range at which identification can be accomplished by these techniques, relative to optimum weapons firing range, is marginal in daylight and completely inadequate at night or when visibility is limited.

Targets can be acquired and engaged at long range, but they cannot be positively identified at long range. Massed, high tempo operations on a nonlinear battlefield further complicate identification and force protection measures. The growing imbalance between weapons and their target identification capabilities do not support emerging air-land doctrines. This presents many problems for U.S. military forces. For example, identification shortfalls may lead to highly restrictive rules of engagement (ROE), the inability to exploit range and lethality advantages of high technology systems, and the unraveling of politically sensitive Coalitions because of the detrimental effects of fratricide.

Target identification refers to the capability for immediate, positive identification of forces as either friendly, hostile, or unknown.[26] There are several kinds of

---

[26] Brian K. Hughes, "Combat Identification Advanced Concept Technology Demonstration," paper presented at the Naval Postgraduate School Joint Service Combat Identification Systems Conference, Monterey, CA (14-16 November 1995), 297.

information used to identify combat forces. Identification at the allegiance level determines the hostile, friendly, or neutral status of a target. Identification at the class level differentiates between classes of targets such as "jet" versus "helicopter." Finally, identification at the platform type reports a specific target designation, such as MIG-29 Fighter or T-72 Main Battle Tank.[27]

Different tactical situations require different levels of target identification. For example, a pilot flying a CAS mission requires allegiance information at a minimum. Air battle managers on a carrier battle group may require specific class and platform information to defend the carrier. Most of the information needed for positive target identification is derived from multiple sources that include direct and indirect means, active and passive means, and cooperative and non-cooperative techniques. A "direct" system is one in which the shooter collects the information about a target, while an "indirect" system is one where another observer collects the information.[28] The direct system has the advantage of immediacy since the shooter usually processes the target information himself.

Passive observers and targets may also be distinguished as either active or passive. Passive observers do not transmit any energy themselves but only collect energy normally transmitted or reflected from a target. Similarly, a passive target only reflects energy from its environment and does not transmit its own energy. Thus, an abandoned tank on the

---

[27] U.S. Department of Defense, Office of the Under Secretary of Defense (Acquisition and Technology) Combat Identification Task Force Architecture Working Group Final Report (Washington D.C.: U.S. Government Printing Office, 1995), 1-5.

[28] U.S. Congress, Office of Technology Assessment, Who Goes There: Friend or Foe?, OTA-ISC-537 (Washington D.C.: U.S. Government Printing Office, 1993), 39.

battlefield merely reflects incident energy (sunlight, heat, etc.) but is unable to generate any of its own (i.e., radio transmissions, movement, and internal heat generation). An active observer transmits energy at the target so that it can be observed.[29] A good example of this would be an air defense unit that uses fire control radars to "sample" intermittent or ambiguous target returns. An active target is one that transmits its own energy, typically as electromagnetic signals. An AWACS platform is an active target since it generates an easily detectable electronic signature whenever it performs its air surveillance and C^2 mission.

Cooperative and non-cooperative techniques obtain information on friendly units with the aid of some form of response from the friendly unit.[30] In these systems, a target responds to or performs some action to identify itself to a sensor attempting identification. One of the most widely used cooperative techniques is the identification friend or foe (IFF) system found on most military aircraft. An IFF beacon system is similar to radar except that the return signal is radiated from a transmitter on board the target rather than being a reflection.[31] Thus, the beacon system operates with a cooperative "active" target, while the radar operates with a "passive" target.

In an IFF beacon system, a ground-based transmitter usually initiates the identification sequence (interrogator)

[29] Ibid, 30.

[30] U.S. Department of Defense, Office of the Under Secretary of Defense (Acquisition and Technology) Combat Identification Task Force Architecture Working Group Final Report (Washington D.C.: U.S. Government Printing Office, 1995), 2-1.

[31] U.S. Marine Corps, Marine Aviation Weapons and Tactics Squadron One, Basic Radar Principles, (Marine Corps Air Station Yuma, Arizona, August 1995), 5-3.

that sends a coded signal to any aircraft of unknown identity. Aboard friendly aircraft, pulses from the interrogator trigger a combined receiver/transmitter (transponder) to reply by transmitting a coded signal back to the ground station. The interrogator then receives and processes this signal to obtain target range, azimuth, and identity status. IFF systems complement radar capabilities by providing a means not only to detect but identify targets.

IFF systems cannot determine whether an improper or negative response indicates a hostile track, operator error, or equipment malfunction. This suggests that cooperative systems are nothing more than friend identifiers, since they do not positively identify enemy targets. If no reply is received, the shooter may assume that the target is the enemy but perhaps it is a neutral or a friend without an operating transponder.[32] Combat aircraft may launch with incorrect IFF codes or they might sustain battle damage that makes the IFF subsystem inoperable. IFF systems are sensitive electronic devices that are susceptible to damage, enemy exploitation, and human error. All these factors may contribute to steep fratricide rates in a high air threat environment.

Non-Cooperative Target Recognition (NCTR) systems are designed to obtain identification information from emission signatures (such as aural, optical, or electromagnetic emissions) of friendly and hostile units.[33] Most systems are fully automated, in the sense that identification declarations are determined via computer processing; but several, such as

---

[32] U.S. Congress, Office of Technology Assessment, Who Goes There: Friend or Foe?, OTA-ISC-537 (Washington D.C.: U.S. Government Printing Office, 1993), 42.

[33] U.S. Department of Defense, Office of the Under Secretary of Defense (Acquisition and Technology) Combat Identification Task Force Architecture Working Group Final Report (Washington D.C.: U.S. Government Printing Office, 1995), 2-1.

electro-optic or other IR systems are non-automated.[34] NCTR systems are of great value to friendly forces because of their unique capabilities against hostile targets, especially those encountered during air operations. The main advantage NCTR systems offer is that targets can be passive and need not perform any actions or respond to identify themselves (like IFF) to sensors or weapons attempting identification.

Non-cooperative identification varies from the very simple--visual recognition--to detection, analysis, and classification based on extremely subtle differences among targets.[35] The majority of all NCTR systems are employed for the detection and identification of aerial targets. Effective ground applications are still many years away. The primary sensors currently available for the detection of ground targets are non-automated, and consist almost entirely of electro-optical systems.[36] The major non-cooperative techniques used by the U.S. military to detect and identify friendly and hostile targets include:

- <u>Visual / Outward Appearance</u>. The examination of physical traits and characteristics such as markings, size, color, shape, and telltale signatures. For example, Stinger Gunners must be able to detect, recognize, and identify small aerial objects at long ranges. Without early warning information, they rely on in-depth training about aircraft characteristics, tactics, and telltale signatures (i.e., noise from helicopter blades, vapor trails from jets, or fin-flashes). Visual detection can be problematic, especially

---

[34] Ibid, 2-2.

[35] U.S. Congress, Office of Technology Assessment, <u>Who Goes There: Friend or Foe?</u>, OTA-ISC-537 (Washington D.C.: U.S. Government Printing Office, 1993), 50.

[36] U.S. Department of Defense, Office of the Under Secretary of Defense (Acquisition and Technology) <u>Combat Identification Task Force Architecture Working Group Final Report</u> (Washington D.C.: U.S. Government Printing Office, 1995), 2-5.

when factors like terrain, climate, obscuration, and angle of view may complicate identification efforts. Furthermore, visual identification is a perishable skill that requires constant training emphasis. One of the difficulties with visual identification is that many targets look alike in a combat environment. For instance, an untrained observer could easily misidentify the U.S. A-10 Thunderbolt for a Russian SU-25 Frogfoot since both aircraft are similar in appearance and design.

- <u>Radio-Emission Intercept</u>. This refers to the passive interception of radio and radar transmissions.[37] This technique is based on the fact that all radio and radar systems have unique modulation signals that may be used for identification purposes. Systems that friendly forces may exploit include navigation systems, air traffic control systems, radar altimeter systems, and IFF systems. In theory, radio-emission intercept systems provide a "fingerprint" of individual platform emitters that can be catalogued in a signal library to provide prompt and accurate identification information.

- <u>Radar</u>. The detailed analysis of radar returns reveals much more about a target than just its bearing, range, and altitude.[38] For instance, high resolution radars may be employed to identify particular structures on targets such as leading wing edges and jet engine nacelles.[39] One unique target identification system that may have practical applicability in the future is Jet Engine Modulation (JEM). In this technique, active systems are employed to analyze the Doppler frequency shift of radar signals reflected from the compressor blades of jet engines. Conceptually the idea has merit but a major shortfall is that JEM identifies engines and not specific aircraft. The difficulty is that there are a limited number of military jet

---

[37] U.S. Congress, Office of Technology Assessment, <u>Who Goes There: Friend or Foe?</u>, OTA-ISC-537 (Washington D.C.: U.S. Government Printing Office, 1993), 50.

[38] Ibid, 51.

[39] Ibid, 51.

engines available worldwide and a whole spectrum of aircraft that can be powered by the same type of engine.

- Electro-Optical Detectors. Electro-Optical (EO) sensors are normally employed by the military to determine the range, visual, and infrared (IR) signature of objects.[40] They are also useful for precision guidance weapons, fire control devices, navigation, and communications systems. EO detectors can be either active or passive depending on the system's application. Active EO systems consist of lasers, laser designators, and laser rangefinders while passive systems include night vision goggles (NVGs) and thermal imaging systems like forward looking infrared (FLIR) sensors. Most active systems are employed to provide accurate range, azimuth, and elevation information that can be used to locate and identify friendly and hostile targets. On the other hand, passive systems are very important to combat units that must fight in varying light and weather conditions. NVGs are EO image intensification devices used to detect visible and near-IR energy, intensify that energy, and provide a visible image to the user at night.[41] While NVGs are extremely useful, they do have limitations that affect target identification such as a narrow field of view and a short focal range. FLIR sensors provide target acquisition and tracking capabilities in low-visibility conditions and at night.[42] Like NVGs, FLIR systems have considerable military utility but their use must be balanced against the limitations of target identification at maximum FLIR detection ranges.

Cooperative and non-cooperative target identification systems allow military forces to operate safely day or night, and under adverse field conditions. Both techniques are

---

[40] U.S. Marine Corps, Marine Aviation Weapons and Tactics Squadron One, Introduction to Laser Radiation, (Marine Corps Air Station Yuma, Arizona, August 1995), 6.

[41] Ibid, VI.

[42] Department of the Army, FM 44-31 Tactics, Techniques, and Procedures for Avenger Operations (Washington D.C.: Headquarters, U.S. Army, 1990), F-3.

complementary and enhance the target acquisition and identification process. In particular, the battlefield integration of NCTR systems provides a real force multiplier because positive identification of both friendly and hostile targets is vital to the engagement process. Effectively using NCTR techniques allows combat units to maximize their beyond visual range (BVR) weapons, while reducing the risks of fratricide. NCTR systems are critically important in circumstances when the rules of engagement (ROE) do not permit friendly units to fire unless there has been a positive indication that the contact is hostile as is normal in most combat operations. Understanding how the ROE fit into the target identification and engagement process is a critically important dimension of all fratricide avoidance efforts.

Unsurprisingly, U.S. forces prefer to operate in environments where the ROE can be permissive rather than restrictive in nature. The permissive environment offers the best opportunities to maximize the range and killing potential of most U.S. combat systems. Political limitations coupled with the absence of a reliable means to positively identify targets will often force the ROE to be restrictive.

2. Modalities of Target Identification Failure

The fact that U.S. forces cannot positively identify targets in all dimensions and conditions explains a great deal about the occurrence of fratricide. Though each friendly-fire incident results from a complex and unique set of variables, those directly attributed to target identification failures are often characterized by the inability to distinguish visual, thermal, or optical signatures, limited visibility or restricted terrain, and similarities between friendly and enemy equipment.

a. The Inability to Distinguish Visual, Thermal, or Optical Signatures

Most target identifications in battle are made visually. This poses a major problem for U.S. forces which can acquire and kill targets beyond visual range but cannot identify them except through close-in, visual techniques. Potential adversaries must often be allowed to penetrate into friendly held areas before positive identification can be made. Today's thermal imaging and targeting systems have the capacity to acquire targets well in excess of 4,000 meters but positive identification is usually limited to approximately 1,200 meters.[43] This obviously reduces combat efficiency and jeopardizes friendly units who may be inside the effective envelope of enemy weapon systems before positive identification is made.

The visual identification of ground targets takes on new meaning for pilots flying CAS missions, especially at night or under adverse weather conditions. High speed survival tactics coupled with the employment of area weapons greatly reduces target acquisition and identification times. This makes accurate surface deliveries highly problematic and risky. One recognized expert on the subject of fratricide, Lieutenant Colonel Charles Schrader USA (Ret), summarized the problem when he noted that "it is too much to hope that a pilot, diving at 600 m.p.h. through smoke while taking evasive action and attempting to deliver area-type ordnance accurately, could instantaneously and correctly identify camouflaged friendly ground troops making maximum use of

---

[43] U.S. Army, Armor Training Center Video, <u>Fratricide Awareness and Prevention,</u> (Fort Knox, Kentucky, 1992).

available cover and concealment."[44] The harsh reality is that pilots do not have the time or the tools to identify targets during their final attack run.

To offset these complications, FACs typically employ IR pointers, beacons, lasers, and flares to mark friendly positions and/or designate hostile targets. Effective CAS missions also require airborne platforms that are compatible with the systems used by ground observers. Most U.S. close support aircraft are equipped with lasers or laser receivers, radar, FLIR, and GPS devices for position location. While these systems offer many advantages, they also suffer some major limitations. For instance, reduced illumination levels caused by the moon phase, weather, or battlefield obscuration degrades the ability of human operators to employ night vision devices (NVDs) without artificial illumination.[45] When improperly employed, NVDs can easily lead to disorientation, vertigo, and the loss of situational awareness. These conditions may have deadly implications for friendly units near the target area.

At close-in ranges, visual recognition training becomes a critical step in the shooter's decision to engage a target or not. Threat recognition skills, especially for thermal images, are highly perishable and subject to errors in human perception and interpretation. In battle, these shortfalls may easily lead shooters to fire first and identify later, often as a result of anxiety and repetitive training that cultivates automatic and conditioned responses.

---

[44] Geoffrey Regan, <u>Blue on Blue: A History of Friendly Fire</u> (New York: Avon Books, 1995), 137.

[45] U.S. Department of Defense, Joint Pub 3-09.3, <u>Joint Tactics, Techniques, and Procedures for Close Air Support,</u> (Washington D.C.: U.S. Government Printing Office, 1995), IV-18.

To be proficient, operators must be able to exercise good judgement based on the recognition of subtle design differences among a wide-range of friendly and enemy combat systems. The difficulties of target identification are compounded when friendly and enemy systems are similar in appearance such as M-1A1 and T-72 Main Battle Tanks. Obscuration and angle of view are additional factors that can mask or disguise many subtle characteristics thus making acquisition and identification more difficult.

Dust from mechanized forces and indirect fires raises a curtain that significantly degrades thermal capabilities.[46] Fog and smoke can also impair thermal effectiveness as can fires and burning vehicles which cause thermal washout. These factors nullify some advantages offered by high technology weapons and create situations where friendly units in close contact can easily mistake each other for the enemy.

b.   Limited Visibility or Restricted Terrain

Most target identifications in combat are made by visual means. This indicates that shooters like to see clearly and recognize targets before classifying them as friend or foe. Many fratricides have occurred because of identification difficulties posed by terrain and climatic conditions. While these same conditions may be used for battlefield advantage, they can also hamper operations by obscuring views and restricting visibility thus making target identification uncertain.

Many natural and man-made events influence visibility on the battlefield. Darkness and the effects of

---

[46] U.S. Army, Armor Training Center Video, <u>Fratricide Awareness and Prevention,</u> (Fort Knox, Kentucky, 1992).

weather are among the most important factors governing the conduct of all military operations. Low clouds, fog, haze, and precipitation may restrict visibility for extended periods and cover vast geographic areas. Even bright sunlight can hinder visibility under some conditions, as often happens when ground or air units attack with the sun at their backs.

The ability of units to see each other in the field can also be limited by the effects of man-made factors like smog, smoke, illumination, and camouflage. Visibility was drastically reduced during the ground war phase of Operation Desert Storm because of the numerous oil-well fires intentionally set by the retreating Iraqi Army. Greasy smoke and soot from these fires combined with moisture to create an oily film that seriously degraded the performance of many thermal and optical devices.

Mountains, deserts, jungles, and alpine environments present unique surroundings that may distort visibility and confound visual target identification. Mountainous areas are characterized by rugged, compartmented terrain with steep slopes and few natural or man-made lines of communication.[47] High altitude effects can also make simple mental tasks difficult, decrease concentration, lead to memory loss and less vigilance, and impair critical judgement skills.[48] Additionally, mountain operations often require the use of specialized protective clothing and equipment like face masks and goggles which further restrict visual acuity.

Jungle environments also present many hazards and complications for military operations. Heavy rainfall and lush

---

[47] Department of the Army, FM 44-31 Tactics, Techniques, and Procedures for Avenger Operations (Washington D.C.: Headquarters, U.S. Army, 1990), A-1.

[48] Department of the Army, FM 21-11 First Aid for Soldiers (Washington D.C.: Headquarters, U.S. Army, 1985), 57.

vegetation reduce visibility and restrict operations. The dense jungle provides excellent concealment for ground forces and makes observation and target identification difficult, if not impossible at times. This was one of the major problems U.S. forces experienced in Southeast Asia, which explains why defoliants were used extensively during that conflict.

Desert operations also pose challenges that exact a heavy toll on military efficiency. Many people mistakenly believe that desert environments offer unrestricted visibility. Visibility is usually high but most desert regions experience suspended dust that can severely reduce visibility for hundreds of square miles.[49] Heat shimmers, blowing sand, and thunder storms further restrict visibility on the desert battlefield, which in turn, places a heavy burden on accurate target identification. During Operation Desert Storm dust, smoke, and darkness often aided Coalition forces by shielding them from enemy observation. These same battlefield conditions also impaired the sighting systems used by many Coalition members.

Sorting out friends and foes by visual means becomes nearly impossible when visibility is poor or terrain is restrictive. Though U.S. forces routinely train to standards where poor visibility and difficult terrain are givens, in actual combat these dynamic factors work to conceal forces and degrade target identification efforts. Unfortunately, most U.S. target identification systems remain very sensitive to battlefield degradation, as well as to the inevitable shortcomings of human operators.

---

[49] Lucien S. Vandenbroucke, Perilous Options: Special Operations as an Instrument of U.S. Foreign Policy, (new York: Oxford University Press, 1993), 128.

c. Similarities Between Friendly and Enemy Equipment

Few things complicate the target identification and engagement sequence more than the presence of identical or similar combat systems among friendly, neutral, and hostile forces. Uncertainty about the friendly or hostile character of targets can easily create widespread confusion, indecision, and the loss of aggressiveness during fire and maneuver. This is not a new problem. Similarities between friendly and enemy combat systems have plagued battlefield target identification efforts for years. The fact that many American weapons are sold or reproduced throughout the world makes it likely that U.S. forces will one day have to fight an adversary equipped with virtually identical combat systems. The process of sorting out friends and foes has also become much more involved in recent years because of greater emphasis on multinational operations.

Alliance and Coalition operations are among the most complex and demanding of all military activities. To organize a Coalition, political and military leaders must achieve unity of purpose and interoperability among all the members. Coalitions are often brittle organizations that are susceptible to disjointed command relationships, poor cooperative planning, and fears about sharing technology and information. These factors may lead to organizational strife, higher political and military risk, and even the unraveling of the Coalition.

Coalitions differ from Alliances in that they tend to be ad-hoc arrangements for common action, usually for single occasions and for narrowly defined sectors of common

interest.[50] The absence of habitual working relationships, C^2 differences, and the diversity of individual partners explains why force integration and target identification efforts among Coalition forces are often so intense.

For example, Operation Desert Storm was fought by one of the most diverse Coalitions in history. Apart from U.S. forces, Coalition partners included the British, French, Italians, Saudis, Syrians, Kuwaitis, and Egyptians to name only the most prominent "junior partners." One of the major concerns that surfaced during the build-up phase of the operation was that some Coalition members operated equipment that was identical to that of the Iraqi military. While this obviously created problems, it should not have come as a great surprise to the Coalition's leadership since Iraq was one of the top arms importers in the world.

From the onset of the Gulf crisis, Coalition planners struggled to discriminate between friendly and enemy combat vehicles, aircraft, and IFF techniques. Many innovative techniques like inverted "V" markings on vehicles and non doctrinal "kill boxes" were used to simplify targeting and reduce the hazards of Coalition fratricide. The kill boxes were nothing more than geographically defined areas used to facilitate the destruction of enemy targets of opportunity. All surface targets inside the designated areas were presumed hostile. The permissive nature of the kill boxes maximized the range capabilities of many U.S. weapons and drastically cut down fratricide risk. The concept worked well largely because Iraq's lackluster performance produced little intermixing of forces, but it still placed a heavy burden on Coalition forces to navigate properly and maintain effective C^2.

---

[50] U.S. Department of Defense, Joint Pub 1-02, DOD Dictionary of Military and Associated Terms, (Washington D.C.: U.S. Government Printing Office, 1994), 75.

Though the Gulf War may have been an extreme example, the fact remains that the ability to identify targets declines whenever friendly and enemy forces possess armaments that are similar in design. Spiraling arms sales and security transfers to Third World countries have only made the likelihood of encountering these systems in the future worse. The appearance of similarly equipped combatants adds one more layer of complexity and uncertainty to military operations. Clearly, it is in the interests of the U.S. to help Allies and Coalition partners avoid fratricidal attacks on themselves or on U.S. forces. Unfortunately, the need to strike a balance between the protection of identification techniques and mutual collaboration creates dilemmas, especially when today's ad-hoc partner might become tomorrow's adversary.[51]

The absence of positive target identification coupled with the inability to maintain situational awareness are two of the most important reasons for fratricide. Having accurate, real time knowledge about the combat environment helps friendly forces reduce the likelihood of fratricidal exchanges from failures in fire and maneuver control, navigation, and C^2.

Instances of mistaken identity and the loss of situational awareness point to the fact that human operators are the weak link in the fratricide prevention chain. If this premise holds true, then fratricide rates may continue to climb as the tempo and complexity of warfare increases. While fratricide may occur under all battlefield conditions, it may be more prevalent in highly fluid, fast moving, offensive operations. This creates major problems for maneuver oriented militaries because the same warfare concepts that disorient

---

[51] U.S. Congress, Office of Technology Assessment, <u>Who Goes There: Friend or Foe?</u>, OTA-ISC-537 (Washington D.C.: U.S. Government Printing Office, 1993), 44.

the enemy may prove equally, if inadvertently effective among friendly troops.

III. EVOLUTIONARY TRENDS IN AIR-LAND FRATRICIDE

A. THE EMERGENCE OF MILITARY AVIATION

The first military use of gas filled balloons was by the Army of the Potomac during the American Civil War. Early in the war, the Union Army employed balloons to observe enemy troop movements, find entrenchments, spot for artillery, and develop maps.[52] Although Union forces employed balloons during several major campaigns, their use was largely abandoned before the war's end because of competing demands and a lack of operational interest. Despite their obvious limitations, balloons represented a major technological breakthrough that prompted further exploration into long-range aerial reconnaissance of the battlefield.

Airships, like the German Zeppelins, were another technical refinement of the evolving air warfare concept, but the arrival of the faster and more maneuverable airplane quickly overshadowed their combat utility. Orville and Wilbur Wright's successful airplane flight on December 17, 1903 changed the course of modern warfare. However, the airplane's full potential remained largely unrecognized for several years. Military leaders only thought of it as the airborne eyes of the Army. By 1910, Americans and Europeans recognized that the airplane might revolutionize battle by conducting air-to-ground combat.[53]

In 1911, Italy became the first country to use the airplane in war when 2d Lt. Giulio Gavotti of the Squadriglia

---

[52] Edward Hagerman, The American Civil War and the Origins of Modern Warfare (Bloomington: Indiana University Press, 1988), 53.

[53] Richard P. Hallion, Strike From the Sky: The History of Battlefield Air Attack 1911-1945 (Washington, D.C.: Smithsonian Institution Press, 1989), 11.

di Tripoli dropped four small bombs from his airplane during fighting in Tripoli against the Turks.[54] The Italians continued to employ these simple bombing tactics for the rest of the campaign with minimal effect. Nevertheless, military organizations soon came to realize that by mounting bombs and adapting machine guns for aerial warfare, they could enhance the capabilities of the airplane. Although military aircraft were mostly unarmed at the start of World War I, all of the major combatants had at least experimented with the airplane for both reconnaissance and ground attack.

B. WORLD WAR I

The First World War was a conflict that few wanted, but which quickly grew beyond the ability of governments to contain.[55] It was characterized by military organizations that used innovative technologies like tanks, submarines, and of course, airplanes. When the Germans launched their offensive in 1914, they hoped to achieve a quick and decisive victory by outmaneuvering the Allies. Years earlier, German planners had anticipated a two-front war against France and Russia. To employ their forces decisively, Germany developed the Schlieffen Plan that aimed to hold the Russians in check with minimum force while the bulk of the German Army crushed France, deemed the more dangerous enemy. Had the plan been carried out as originally conceived, Germany may have ended the war quickly and decisively.

However, the ambitious German strategy failed for various reasons, including some critical changes made to the original plan by General Helmuth von Moltke (who did not want to violate Dutch neutrality) and communication and logistic

---

[54] Ibid, 11.

[55] Ibid, 13.

40

inefficiencies. The initial German failure to outmaneuver the Allied nations ended the possibility of a quick victory, especially since the Allies were in a better position to wage a protracted conflict. Thus, a stalemate developed on the Western Front that was characterized by static trench warfare and constant, bloody attempts by all parties to restore a war of mobility and maneuver.

During the initial phases of the war, military leaders still focused on the reconnaissance aspects of air power. As the war progressed, however, the major powers sought to exploit the broader potential of the airplane. A great deal of attention was focused on air power to learn how it could be harnessed in a ground attack role against a static enemy. A critical problem affecting the quality of air support appeared that still continues today: poor communications and integration between the air and land forces.[56] Air-land communications during the war were primitive, to say the least. Pilots relied on ground units to use flares, smoke signals, lights, and colored panel markers to mark their positions, while ground forces waited for pilots to drop written messages down to them or use other prearranged signals.

The static nature of the war nevertheless made it possible to get by with such primitive air-land communications. Except at night or when the weather was bad, the massive trench system dividing the European countryside provided a reliable means of distinguishing one's own troops from those of the enemy.[57] The linear nature of the battlefield

---

[56] Ibid, 21.

[57] Martin van Creveld, Steven L. Canby and Kenneth S. Brower, <u>Air Power and Maneuver Warfare</u> (Montgomery: Air University Press, 1994), 25.

markedly increased the risk of aerial fratricide.

Toward the end of the war, however, the tactical stalemate on the ground finally gave way to large-scale mobile operations, which quickly shifted the battlefront.[58] These changes complicated CAS procedures, making aerial fratricide more likely. Significant problems were experienced with air-land integration, target identification, and tactical communications. While air power could be concentrated more rapidly than even a few years before, it could not easily be used on a battlefield with which the pilots were unfamiliar, or one on which the battle lines were shifting or fluctuating.[59] In this war, the inadequacies of air-land doctrines and the limits of technology were too great to allow effective CAS on a changing and fast-moving battlefield.

Overall, air power played an important but limited role in the outcome of World War I. The war transformed the airplane from a limited reconnaissance platform into a full-fledged instrument of modern combat. The most significant problem with air power during this conflict was the poor integration between air operations, whether for reconnaissance or attack, and major ground offensives. Inadequate doctrines, primitive communications, and inexperience with tactical air operations created favorable conditions for the occurrence of many friendly-fire casualties during the last year of the war. Although the static nature of the conflict before then produced a low rate of aerial fratricide, the First World War was nevertheless a test bed for evolving air warfare concepts that were to become much more important in years to come.

---

[58] Benjamin F. Cooling, <u>Case Studies in the Development of Close Air Support</u> (Washington, D.C.: U.S. Government Printing Office, 1990), 25.

[59] Ibid, 26.

C. WORLD WAR II

By the time war came to Europe in 1939, each belligerent had equipped and trained its air services to perform clearly defined functions. The United States, Great Britain, and Italy emphasized the development of long-range strategic bombers while Germany, Russia, and Japan developed air forces to support army operations. When war broke out, the German Luftwaffe probably had the most integrated and effective close air support system of any of the great powers. For other belligerents, the first campaigns of the war revealed serious doctrinal and procedural weaknesses in this area.[60]

1. The German Concept of Air-Land Warfare

World War Two began on September 1, 1939 when Germany unleashed the full fury of the Blitzkrieg against Poland. Within two weeks, the massive German pincer movement that closed around the capital of Warsaw had either destroyed or surrounded most Polish forces. The Wehrmacht achieved similarly decisive and quick results in Western Europe during 1940 as Luxembourg, the Netherlands, Belgium, and France were knocked out of the war in rapid succession.

Germany's exceptional success in battle stemmed from the bold application of a new and innovative doctrine that emphasized sudden and coordinated attacks with armor, infantry, and tactical air power. Known as the Blitzkrieg, this approach to fighting aimed at breaking through an enemy's front line and penetrating his rear area as quickly as possible.[61] At the operational level, Blitzkrieg aimed to outmaneuver an enemy and attack his fragile and exposed

---

[60] Ibid, 56.

[61] Barry R. Posen The Sources of Military Doctrine:France, Britain, and Germany Between the World Wars (Ithaca: Cornell University Press, 1984), 206.

command, control, communications, and intelligence (C^3I) infrastructure. The stunning success of Germany's doctrine was possible because of the synergy achieved by the integrated employment of combined arms. Air support from the Luftwaffe played a vital role by establishing local air superiority, disrupting critical nodes, interdicting enemy lines of communications, and providing close support to ground maneuver elements.

The initial German campaigns of World War II were not without faults. The application of Blitzkrieg doctrine was highly dependent on reliable communications. The Germans learned that high-speed, mobile warfare made it difficult to keep air command authorities informed of army movements on the battlefield.[62] To simplify communications and reduce the risk of fratricide, German forces used common air-land radio frequencies and employed liaison officers to enhance the flow of information between air and ground units.

The use of liaison officers at major command levels was an important means of synchronizing efforts, enhancing situational awareness, and reducing fratricide. Liaison officers were crucial because fast-paced German units often moved beyond communications range or pre-briefed map boundaries. The use of smoke and clearly marked recognition devices were additional techniques used by the Germans to identify advancing troops in fluid situations. Despite the emphasis on fratricide prevention, serious incidents still occurred, especially during fast-paced, offensive operations.

During the Polish campaign, for instance, the 10th Panzer Division was constantly machine gunned and bombed by German aircraft. One Luftwaffe attack left 13 soldiers dead and 25

---

[62] Benjamin F. Cooling, Case Studies in the Development of Close Air Support (Washington, D.C.: U.S. Government Printing Office, 1990), 83.

badly wounded. This particular episode occurred despite the use of prearranged recognition devices by the ground troops.[63] In a similar incident, a group of JU-87 Stuka dive-bombers attacked the 2nd Panzer Brigade at Querrieu, near Amiens.[64] To avoid losses to his armored units, General Heinz Guderian ordered his flak gunners to fire on the attacking German planes, eventually downing one of them.

The Luftwaffe's record for providing tactical air support to fast-moving ground forces is mixed. While steps were taken to reduce fratricide, practical solutions to the problems of air-land integration remained elusive. The challenge was to provide responsive CAS to fast moving armored spearheads without generating self-inflicted casualties through air actions.

The Germans recognized that air support operations worked well against static defensive positions but became more problematic during highly fluid situations. As in Poland, the Luftwaffe did not try to coordinate its missions with the racing armies but instead, flew against targets behind the front. The problem of distinguishing friend from foe and securing good air-to-ground cooperation was not so much solved as evaded.[65]

2. Anglo-American Views on Air-Land Warfare

The six years of fighting on the battlefields of Western Europe, North Africa, and the Pacific account for most American and British air-land fratricides. The widespread use

---

[63] Ibid, 86.

[64] Geoffrey Regan, Blue on Blue: A History of Friendly Fire (New York: Avon Books, 1995), 142.

[65] Martin van Creveld, Steven L. Canby and Kenneth S. Brower, Air Power and Maneuver Warfare (Montgomery: Air University Press, 1994), 54.

of the airplane in nearly all combat settings coupled with dramatic increases in the lethality of weapons led to a sharp escalation in the total number of friendly-fire casualties. Contributing to this disturbing trend was the raging controversy over the role of air forces on the battlefield. In both the United States and Great Britain, air power advocates lobbied for the centralized control of all air assets for long-range strategic bombardment. Unfortunately, the obsession with strategic bombing of the enemy's heartland often meant that methods and techniques for conducting tactical missions like CAS remained crude. The absence of an efficient and responsive air C^2 system reflects one of the key problems the Allies needed to overcome before they could effectively fight on land.

From the outset of the war, the Royal Air Force (RAF) and the U.S. Army Air Force (USAAF) had many similar beliefs about the command and employment of air power in combat. After years of frustration and disagreement with ground commanders, the air services still maintained that land power and air power were coequal, independent forces; neither was an auxiliary of the other.[66] The RAF and USAAF also had corresponding views about the mission priorities necessary to conduct an air campaign. The priorities of the air services were to gain air superiority, interdict troops and supplies, and finally, support ground forces in the battle area.

Unlike the RAF, the USAAF had a much more difficult time separating itself from the problem of air-land integration because it was not a coequal and independent service like the RAF. Battlefield support for the army continued to be a source of great friction and rivalry between air and ground

---

[66] Richard P. Hallion, Strike From the Sky: The History of Battlefield Air Attack 1911-1945 (Washington, D.C.: Smithsonian Institution Press, 1989), 173.

components. The harsh realities of the war forced both the RAF and the USAAF to develop more efficient tactical air support procedures by rewriting doctrine and streamlining air control procedures. In early 1942, the War Department published FM 31-35, "Aviation in Support of Ground Forces."

This manual provided a tiered system to manage air assets and process army requests for air support. Air assets were divided into a series of support commands that were linked with specific ground maneuver units. The problem with this approach was that the network of aircraft, air support parties, liaison officers, control centers, and communications pathways were redundant, cumbersome, and awkward. The new system also violated the principles of mass and unity of effort by parceling out limited aviation assets to act as "air umbrellas" for division, corps, and army level commanders.

The air C^2 system was ineffective when used in combat. The problem stemmed from the inability of some commanders to integrate CAS in battle. It took the fiasco at Kasserine Pass in February 1943 to make the USAAF and the RAF realize that the Allied air C^2 system was broken and in need of repair. FM-31-35 was abandoned in favor of ad-hoc procedures for air-land coordination and control. In light of Kasserine, General Eisenhower assembled a study group of air and ground officers to examine the doctrinal implications and prepare a new draft field manual on air power. The result of this endeavor was a document that had a staggering impact on the future nature of Air Force--Army ground force relations: FM 100-20, "Command and Employment of Air Power."[67]

FM-100-20 was a cooperative product between British and American officers to streamline the use of air-land forces. It

---

[67] Ibid, 172.

was an innovative doctrinal publication that spelled-out the relationships between air and ground commanders. The new doctrine affirmed the coequality of air and ground commanders in addition to standardizing theater air campaign procedures. The new doctrine helped integrate air-land operations by providing greater flexibility and unity of effort. It also reduced the piecemeal employment of air power.

Years of jockeying over the roles and missions of air power had created many inefficiencies in the use of tactical air power. By redesigning the air C^2 system from the ground up, the Allies exploited their advantage in air power and reduced the likelihood of aerial fratricides. Transitioning to a new tactical air doctrine was time-consuming, and opposed by some Army ground commanders who believed their battlefield needs were not a priority for the air services. Unfortunately, many of the same problems with Allied air-land operations resulted in friendly-fire casualties. This became readily apparent during the final campaigns in the Mediterranean and Western European theaters.

During the Sicilian campaign USAAF A-36 Invaders repeatedly attacked elements of the 2nd Armored Division which were pursuing a retreating German Panzer division. Poor situational awareness and inadequate mission coordination resulted in misplaced bombs that claimed more than 75 friendly troops. During this campaign General Omar Bradley narrowly missed falling victim to an A-36, which dive-bombed and strafed him while he was visiting General Allen's headquarters.[68] In another instance, a fratricidal attack by a group of A-36 aircraft led to the loss of Monte Cipolla to the Germans. A small detachment of American infantrymen and

---

[68] Geoffrey Regan, Blue on Blue: A History of Friendly Fire (New York: Avon Books, 1995), 156.

48

artillerymen had been desperately battling the Germans when the A-36's bombed them, killing or wounding 19 men and forcing a retreat.[69] The Sicilian campaign was plagued by many of the traditional problems with CAS, namely poor communications, the loss of situational awareness by aircrews, difficulties identifying friendly ground forces, and procedural flaws with liaison officers and air control agencies.

Several instances of air-land fratricide also occurred during the Italian campaign. The most notable incident was the U.S. heavy bomber strike at Monte Cassino. In this case, Allied pilots lost situational awareness and bombed the town of Venafro, which was 15 miles from the designated target area of Monte Cassino, causing the deaths of 57 soldiers and civilians.[70] This fratricidal engagement resulted from poor navigation and the use of heavy bombers in a direct support role. While the concept of using strategic bombers for CAS has some merit in theory, expecting bombers at 14,000 feet to have the accuracy needed for CAS was simply absurd in 1943. Another serious mishap occurred during the advance on Rome, when U.S. warplanes strafed several Allied columns inflicting hundreds of casualties. Again, poor C^2, the loss of situational awareness, and target misidentification resulted in many self-inflicted casualties.

In France, the initial success of the D-day amphibious and airborne landings soon gave way to frustration as geography and a tough German defense halted the expansion of the Normandy lodgement. By July, the delays led to the development of a breakout plan, code-named Operation Cobra.

---

[69] Richard P. Hallion, Strike From the Sky: The History of Battlefield Air Attack 1911-1945 (Washington, D.C.: Smithsonian Institution Press, 1989), 178.

[70] Geoffrey Regan, Blue on Blue: A History of Friendly Fire (New York: Avon Books, 1995), 158.

The goal of this operation was to rupture the German lines with a heavy air bombardment. Confusion, poor situational awareness, and inadequate air-land coordination led to the bombing of U.S. ground positions, resulting in more than 150 soldiers killed and nearly 800 wounded.[71] Among the friendly-fire casualties was Lieutenant General Lesley J. McNair, the senior Allied officer killed in Europe during the war, who was visiting the front lines to inspect the effectiveness of the bombing.

Weeks after the friendly bombings in Normandy, the Allies conducted two more heavy bomber raids, code-named Totalize and Tractable. During Operation Totalize, the USAAF inflicted more than 300 casualties on Canadian and Polish mechanized units that were close to German defensive positions. One week later, RAF bombers flying in support of Operation Tractable dropped their ordnance on units from the Canadian 2nd Corps. This time, poor situational awareness by air-ground liaison officers, navigational error, and signal failures caused the bombing error that cost the Canadians 112 dead, 376 wounded, and more than 265 combat and combat support vehicles.[72]

Both incidents occurred even though Allied commanders had withdrawn friendly forces in anticipation of the airstrikes against the German positions. The cumulative fratricide counts for Operations Cobra, Totalize, and Tractable were appalling, nearly 2,000 men killed and wounded. These high casualty figures convinced the Allies to stop using heavy bombers for CAS missions. Instead, medium bombers and fighter-bombers were used because they could deliver their ordnance with greater

---

[71] Russell F. Weigley, Eisenhower's Lieutenants: The Campaign of France and Germany, 1944-1945 (Bloomington: Indiana University Press, 1981), 153.

[72] Richard T. Bickers, Friendly Fire: Accidents in Battle from Ancient Greece to the Gulf War (London: Pen & Sword Books, Ltd., 1994), 126.

precision, and they did not need such a large safety zone.[73]

Allied ground forces experienced additional air-land fratricides before the war ended. Incidents at Malmedy and the Ardennes during the Battle of the Bulge claimed many casualties. In nearly all cases, human error, poor situational awareness, and faulty target recognition by attacking aircrews were to blame. Fratricide became so common during operations in the European theater that many Allied ground units lost confidence in the ability of USAAF to provide safe and effective CAS and dubbed them the "American Luftwaffe."[74]

D. SOUTHEAST ASIA

Fighting an enemy with resolve and expertise in guerilla warfare is no simple process. It was made more difficult in Southeast Asia by the fact that the Army and Air Force could not agree on matters relating to air-land combat integration. In Vietnam, the Army wanted to establish a decentralized air support system where the local ground commander received CAS to deal with targets in his area of responsibility. The Army wanted dedicated support because it feared that Air Force planes would be diverted for other missions, leaving ground units unsupported during battle.

For its part, the Air Force maintained its traditional view that control of air power should be centralized at the theater level to enhance the effectiveness of the air campaign. The Air Force argued that in the fluid, rapidly changing circumstances of combat, battlefield priorities could shift quickly and unexpectedly. These sudden changes might

---

[73] Richard P. Hallion, Strike From the Sky: The History of Battlefield Air Attack 1911-1945 (Washington, D.C.: Smithsonian Institution Press, 1989), 224.

[74] Geoffrey Regan, Blue on Blue: A History of Friendly Fire (New York: Avon Books, 1995), 156.

require the concentration of CAS resources at the expense of denying support to ground units less heavily engaged.[75] The conflicting views of the two Services fueled traditional rivalries and impaired the combat efficiency of air-land forces in Vietnam.

Two critical air support issues further divided the Services: the Army's new airmobile concept, and the evolving battlefield role of the helicopter. The airmobile concept was an offshoot of the Army's preparation for ground combat against Soviet forces. The idea was to use light airmobile units to outmaneuver the enemy and destroy him through highly fluid engagements. The only way to make this concept work was to use large numbers of helicopters to provide the necessary lift, flexibility, and battlefield mobility. During the Korean War the Marines had proven the utility of the helicopter, and as the build-up for Vietnam went into high gear, the Army followed suit by obtaining large numbers of helicopters for transport and logistical duties.

Throughout this period, the Air Force voiced concerns that the Army was creating its own organic air arm to compete for CAS resources. Air Force suspicions grew when the Army started arming helicopters. The concept of helicopters armed with offensive weapons was very popular with the Army and Marine Corps, who employed them to carry out escort, aerial cavalry, "search and destroy," and CAS missions. The attack helicopter quickly became the aerial weapon of choice for ground commanders, who longed for responsive CAS without the delays and procedural headaches of Air Force fixed-wing support.

Facing a major insurgency, the Army and Air Force could

---

[75] Benjamin F. Cooling, Case Studies in the Development of Close Air Support (Washington, D.C.: U.S. Government Printing Office, 1990), 417.

not have been much further apart on issues involving air-land doctrine, battlefield cooperation, and the C^2 of tactical air power. These high-level problems created a great deal of confusion and friction for units in the field who already had the difficult task of carrying out a flawed counterinsurgency strategy. Poor inter-service cooperation also complicated fratricide reduction measures because the firepower oriented strategy demanded high efficiency to deconflict all fires.

Inter-service quarrels over the conduct of air-land operations, plus an emphasis on overwhelming firepower, created favorable conditions for aerial fratricide during the Vietnam War. Many incidents occurred even though fire support agencies delivered ordnance in Vietnam with greater restraint and more concern for safety than in any previous American war.[76] Vietnam also exposed how damaging fratricide incidents could become in relation to popular support for the U.S. war effort. On a linear battlefield, an artillery round fired long, or a bomb dropped in error behind enemy lines, was just another shot at the enemy. In a war without fronts, any mistake was likely to cause casualties, particularly when made in or near populated areas.[77] Air-land fratricides in Vietnam were more physically and psychologically damaging, because of improved weaponry and the nature of guerilla warfare.

During the battle of the Ia Drang Valley, for example, troops were subjected to friendly-fire as the enemy moved in close to avoid the devastating firepower of Air Cavalry units. The close-in employment of artillery and tactical air power punished the enemy but also took its toll on American units.

---

[76] Robert H. Scales, Firepower in Limited War (Washington, D.C.: National Defense University Press, 1990), 144.

[77] Ibid, 145.

The worst case occurred when a canister of USAF napalm was dropped on a U.S. command post, scorching many of the nearby troops and killing one soldier.[78] In another case, during the battle of Dak To in 1967, the pilot of an F-100 Super Sabre jet lost situational awareness and flew in the wrong direction over a company of paratroopers. Two bombs were dropped that killed 42, wounded 45, and effectively halted the company's attempt to capture Hill 875. As luck would have it, 53 different news agencies and reporters were present in the 173d Brigade headquarters at the time, and word of the tragic incident soon spread to all the newspapers and wire reports.[79] In another incident during the battle of Dak To, a helicopter gun ship approached an infantry company's position and fired its rockets right on top of the company, killing the executive officer and wounding 29 other troops.[80]

Inadequate target recognition and poor situational awareness by FAC's and combat aircrews were responsible for many air-land fratricides. For instance, during a firefight in the 1st Division area, a misdirected canister of napalm glanced off a tall tree and exploded near a group of soldiers. Fortunately, no one was seriously injured but the USAF pilot attributed the near miss to faulty target identification.[81] Poor target recognition was responsible for a nighttime

[78] David H. Hackworth, <u>About Face: The Odyssey of an American Warrior</u> (New York: Touchstone Books, 1989), 486.

[79] Robert H. Scales, <u>Firepower in Limited War</u> (Washington, D.C.: National Defense University Press, 1990), 146.

[80] David H. Hackworth, <u>About Face: The Odyssey of an American Warrior</u> (New York: Touchstone Books, 1989), 776.

[81] Robert H. Scales, <u>Firepower in Limited War</u> (Washington, D.C.: National Defense University Press, 1990), 146.

incident in the III Corps Tactical Zone, when helicopter gun ships fired rockets that hit a friendly armored personnel carrier, killing two men and wounding three. At the time of the incident, the friendly ground forces were attempting to adjust the helicopter's fire when the aircrew lost situational awareness and some of the rockets strayed and fell short on their own position.[82]

Target identification was a particularly challenging aspect of fighting in the dense jungles of Vietnam. American troops employed colored cloth panels, smoke, flares or flashing strobe lights at night to make themselves more visible and avoid fratricide. During one such incident, members of the Vietnamese Irregular Defense Group marked their position in the thick jungle by using green smoke. Two Air Force bombers were called in to provide ground support, but one misidentified the target and managed to hit friendly troops, killing four men and wounding 28.[83] This incident occurred as a result of confusion over target markings and last minute changes to the strike request that decreased situational awareness.

E.   SOUTHWEST ASIA

Diverse combat forces fought the Persian Gulf War at a relentless pace, employing state of the art sensors and weapons. Combat during Operation Desert Storm was marked by fluid, long-range engagements with accurate and lethal weapons that crushed the Iraqi military. A review of the Gulf War suggests that U.S. acquisition and kill technologies have

---

[82] Charles R. Schrader, "Friendly Fire: The Inevitable Price," Parameters, vol. 8 (Autumn 1992), 32.

[83] Geoffrey Regan, Blue on Blue: A History of Friendly Fire (New York: Avon Books, 1995), 181.

outpaced target identification capabilities. Many of the combat systems used in Southwest Asia were designed during the Cold War to capitalize on range and lethality advantages necessary to deal with numerically superior Soviet forces. While highly effective, many Cold War weapon systems, like Maverick and Hellfire missiles, do not support emerging doctrines that emphasize high-tempo operations on a fluid and nonlinear battlefield. In addition, some of the current weapon systems and air-land tactics compress the time available for human decision making and occasionally, they may take the man out of the loop altogether.

The military campaign against Iraq was broken down into two phases, an intensive air campaign followed by a massive ground assault. The framework for the Coalition's ground assault was based on the U.S. Army's AirLand Battle doctrine, which is similar to the maneuver warfare concepts embraced by the U.S. Marine Corps. The AirLand Battle concept aims to defeat the enemy by conducting simultaneous offensive operations over the full breadth and depth of the battlefield.[84] It places tremendous demands on combat leaders who must be able to fight concurrent battles in close, deep, and rear areas. AirLand Battle, like maneuver warfare, hinges on the ability of combined arms to shift and concentrate firepower at the decisive time and place.

Tactical air support operations during the ground offensive were a key part of the Coalition's scheme of maneuver. Many of the air sorties flown during the ground campaign were CAS missions to destroy or suppress Iraqi forces in proximity to friendly units. Offensive air strikes were used during day, night, and adverse weather to augment all

---

[84] U.S. Department of Defense, Final Report to Congress on the Conduct of the Persian Gulf War (Washington D.C.: U.S. Government Printing Office, 1992), 238.

other supporting fires. Joint operational doctrine and flexible C² procedures helped Coalition forces achieve timely CAS response times and integrate supporting arms with ongoing and planned air-land operations. Yet in spite of the high degree of teamwork and unity of effort, Coalition forces experienced 28 known instances of fratricide of which nine were in the air-to-surface mission area.[85]

During the battle of Khafji in late January, Coalition forces suffered multiple casualties from two separate air-land fratricides. In one instance, an Air Force A-10 jet fired a Maverick air-to-surface missile that malfunctioned while in flight, causing it to fall short of the intended target. The "smart" missile slammed into a Marine Corps Light Armored Vehicle (LAV) killing seven Marines and wounding two. Normal procedures called for the aircraft to attack perpendicular to friendly forces but in this case the attack was parallel and initiated over friendly forces. The second incident occurred when a Marine Corps AH-1 Cobra attack helicopter mistook a Saudi armored personnel carrier for an Iraqi vehicle and engaged it from long range. Fortunately no one was killed in this incident but seven Saudi soldiers were wounded. Air Force A-10's were also at fault for a strafing attack against two Coalition vehicles. Luckily, only two minor casualties were sustained from the A-10 pilot's loss of situational awareness and failure to properly identify the designated target.

In early February, a Marine Corps A-6E Intruder attacked a column of Marine artillery and other vehicles moving toward the Western Saudi-Kuwaiti border. After making several passes over the target area, the pilot dropped a cluster bomb that killed one Marine and wounded two. The cause of this incident

---

[85] U.S. Congress, Office of Technology Assessment, <u>Who Goes There: Friend or Foe?</u>, OTA-ISC-537 (Washington D.C.: U.S. Government Printing Office, 1993), 27.

was faulty target identification since the pilot believed the ground vehicles to be Iraqi.

Early in the morning of February 17, 1991, AH-64 Apache helicopters launched from their base to conduct an armed reconnaissance mission to find and destroy suspected enemy vehicles. At approximately 1:00 a.m., one the Apaches fired two Hellfire missiles that destroyed two friendly vehicles, killing two U.S. soldiers and wounding six others. The pilot, who was the commander of the Apache unit, believed that the vehicles were enemy because he had lost situational awareness and mistakenly read and reported the vehicles' position as that of an earlier enemy sighting.[86] An Army investigation of the mishap revealed that pilot error led to poor situational awareness and misidentification of the friendly vehicles. Another key factor that contributed to this fratricide incident was the Apache commander's failure to exercise C^2 over the Apache team by virtue of his personal involvement in the fighting.

One of the most politically charged incidents of the Gulf War occurred when nine British soldiers were killed and 11 wounded after Air Force A-10 jets fired Maverick air-to-surface missiles against their armored personnel carriers. In this case, a British FAC had cleared the A-10's to engage Iraqi vehicles inside a 4-km square area of Iraqi territory.[87] Spotting a large column of armored vehicles, the A-10's proceeded to attack and destroy two British Warrior armored personnel carriers believed to be Iraqi T-54/55 tanks.

---

[86] U.S. Congress, General Accounting Office, OPERATION DESERT STORM: Apache Helicopter Fratricide Incident, GAO/OSI-93-4 (Washington D.C.: U.S. Government Printing Office, 1993), 30.

[87] Richard T. Bickers, Friendly Fire: Accidents in Battle from Ancient Greece to the Gulf War (London: Pen & Sword Books, Ltd., 1994), 151.

Incident investigations by British and American officials were contradictory and inconclusive. Differences between the statements of the A-10 pilots and the British FAC could not be easily reconstructed against the known facts of incident.

A British Board of Inquiry was unable to establish why the A-10 pilots misidentified the Warrior vehicles as enemy T54/55 tanks, particularly in view of earlier identification runs made by both pilots at 8,000 feet and 15,000 feet.[88] The British maintained that the Americans were 100% responsible for the incident which they attributed to navigational error and misidentification of the target vehicles (despite the British use of inverted "V" markings and colored visual panel markers.

The primary causes of fratricide have remained constant despite the changing nature of technology and air-land operations. While many factors may contribute to the occurrence of air-land fratricide, nearly all of the incidents examined in this thesis involved the loss of situational awareness or faulty target identification to some degree. Upward trends in the fratricide rate suggest that technological advances and the growing complexity of warfare may exacerbate the primary causes of friendly-fire. As combat becomes deadlier, more complex, and maneuver oriented, fratricide rates can be expected to climb even higher. Non-stop air-land operations on current and future battlefields will push humans and combat systems to their limits, thereby creating favorable conditions for the occurrence of fratricide.

---

[88] Ibid, 153.

IV. FRATRICIDE REDUCTION MEASURES

A. THE CHALLENGE OF FINDING SOLUTIONS

Fratricide has been an important source of combat casualties for the U.S. military. Insights into the causes of fratricide have been difficult to obtain because, until recently, no serious effort has been made to document the total number of U.S. casualties from friendly-fire. As a result, many casualties from fratricide can never be identified, and many that were recognized as fratricides were probably never reported. The Gulf War was different, because all known fratricide incidents were thoroughly investigated. The war also changed many perceptions about fratricide, by revealing the scope and urgency of the problem to the American people and Congressional leaders. Despite the war's short duration and light enemy resistance, 24 percent of all U.S. battle deaths and 15 percent of all wounds resulted from fratricide. Whether or not fratricide in the Persian Gulf was particularly high compared with previous conflicts is irrelevant since the trend in self-inflicted casualties may represent the nature of future conflicts.[89]

Most air-land fratricides occur because of a complex chain of events involving the loss of situational awareness and the lack of positive target identification. While these two variables represent the primary causes of fratricide, most incidents of friendly-fire have many causal pathways. This suggests that multiple strategies are needed to deal with fratricide. It also means there are no simple answers or "black box" solutions that will eliminate the problem of

---

[89] U.S. Congress, Office of Technology Assessment, <u>Who Goes There: Friend or Foe?</u>, OTA-ISC-537 (Washington D.C.: U.S. Government Printing Office, 1993), 2.

friendly-fire in all battlefield situations. A balanced and complementary fratricide reduction strategy, which approaches the problem simultaneously from a technological, doctrinal, and organizational perspective is called for.

B. TECHNOLOGY AND FRATRICIDE AVOIDANCE

Technology plays a critical role in dealing with some conditions that lead to fratricide. Current technical initiatives to address this problem may be grouped into immediate, near term (fielded within five years), and mid term (fielded within seven or more years) categories. The systems currently fielded or under development draw upon both cooperative and non-cooperative target recognition techniques. In terms of air-land operations, non-cooperative techniques are favored since they enable shooters to obtain positive hostile identification, a critical requirement for long-range weapon engagements. Regardless of the actual technical approach, successful antifratricide technologies must meet several key criteria:[90]

- Systems must not increase the user's vulnerability in the field.

- Systems must not be too complex or time consuming to use.

- Systems must have applicability at multiple levels on the battlefield and should not become too specialized.

- Systems must have a high degree of reliability under all battlefield conditions.

- Systems must be cost effective in light of requirements and alternative solutions.

---

[90] Ibid, 45.

1. Immediate Solutions

Technological measures in the "immediate" category have been developed to provide limited tactical protection against air-land fratricide. Most of these systems were introduced during the Gulf War where they provided low cost, readily available solutions to help cut down the risk of fratricide. Such "quick fix" solutions can help reduce fratricide if U.S. forces are committed to combat before more mature technologies are developed and fielded. Specific "quick fix" solutions include the BUDD and DARPA lights, receivers for Global Positioning System (GPS) data, VS-17 Thermal Cloth Panels, and infrared Combat Identification Panels (CIPs).

a. BUDD and DARPA Lights

Both of these devices are small, near infrared strobes that emit a steady or codeable pulse that can be detected by infrared imaging night vision equipment. The pocket size BUDD Light has an omnidirectional range of 6-8 km and may be strapped onto vehicles or worn by individuals to designate them as friendly.

The DARPA Light was developed by the Defense Advanced Research Projects Agency (DARPA) for use in the Gulf War. The DARPA Light operates on the same principle as the BUDD Light except it is larger and has an adjustable shroud that blocks ground observation while keeping it visible from airborne platforms at ranges up to 8 km.[91] The DARPA Lights were manufactured and prepared for use in the Gulf War but the conflict ended before they could be put to use.

Near infrared devices like the BUDD and DARPA Lights have several drawbacks. First, they are visible to anyone, friend or foe, who has night vision image intensifiers.

---

[91] Ibid, 73.

Second, they are not visible to the far infrared imaging devices used to aim many U.S. weapon systems.[92] Additionally, near infrared devices can easily be obscured or degraded by atmospheric effects and terrain masking.

b. Receivers for GPS Data

Although not specifically designed to prevent friendly-fire casualties, high technology navigational systems like GPS, help reduce the risk of inadvertently firing on friendly ground forces.[93] Provided in large numbers to Coalition forces during the Gulf War, these passive devices enabled units to pinpoint their locations and navigate throughout the featureless desert. The widespread use of GPS receivers during the Gulf War helped units stay in assigned sectors, employ fire support weapons from precise locations, and maintain situational awareness during highly fluid combat situations. While having a GPS receiver is not insurance against fratricide, being able to navigate and report battlefield positions accurately does cut down the risk of self-inflicted casualties.

c. VS-17 Thermal Cloth Panels

In addition to standard markings on all combat vehicles, ground forces may use colored panels to help pilots identify surface targets. Thermal panels are a refinement of traditional cloth panels because they enhance the identification process during day, night, and adverse weather conditions. The VS-17 panels are best suited for daylight and fair-weather use. The use of VS-17 colored panels on the roof of combat vehicles improves all-around visibility within a few

---

[92] Ibid, 74.

[93] U.S. Department of Defense, Final Report to Congress on the Conduct of the Persian Gulf War (Washington D.C.: U.S. Government Printing Office, 1992), 592.

kilometers however, some important disadvantages must be considered. First, VS-17 panels are visible to friend and foe. The enemy can use this information to identify U.S. units and possibly confuse identification efforts by applying the same markings to his own forces. Second, air-to-surface detection ranges vary greatly depending on atmospheric conditions. The operational parameters of most fixed-wing CAS aircraft will often exceed the range at which the panels can be detected and identified before weapons release.

d. Combat Identification Panels

The CIP is a rectangular piece of aluminum covered with durable thermal or infrared reflective tape that is attached to multiple points on combat vehicles. The thermal / infrared tape-covered CIP provides an aid in distinguishing friendly and enemy vehicles when thermal imaging sights are used. The CIP operates as a thermal mirror that reflects temperature away from cooler areas such as the sky. This reflection is only visible to thermal sights that detect the unique "cold spot" created by the CIP. The device is useful to identify friendly forces in the close, direct-fire battle, but even with infrared reflecting tape it has limited value for CAS platforms. CAS aircraft may not be able to detect and identify CIP equipped forces at tactically useful ranges.

2. Near Term Solutions

Technological measures in this category are designed to expand upon many immediate solutions introduced during the Gulf War. Most of the systems are simple, built with off-the-shelf technologies, and nearing either completion or prototype field-testing with U.S. units. Some of the most prominent near-term systems to enhance CID and decrease air-land fratricide include the Battlefield Combat Identification System (BCIS), the Situational Awareness Beacon with Reply

(SABER), and the Forward Observer/Forward Air Control System (FO/FAC).

a. Battlefield Combat Identification System

The BCIS is a cooperative, all-weather, digitally encrypted question and answer system that provides a ground-based IFF capability for combat vehicles.[94] The operational concept calls for a BCIS-equipped unit to interrogate a ground target via a highly directional millimeter wave (MMW) antenna while the interrogated unit responds via an omnidirectional MMW band antenna.[95] The use of MMW technology enables BCIS to provide greater range and penetration than laser and infrared systems through the conditions of a "dirty" battlefield (e.g., smoke, haze, rain, etc.). Adding a digital data link to the standard BCIS configuration provides a substantial increase in overall system performance. Data-link-configured BCIS platforms will be able to exchange information with other BCIS-equipped forces, thus enhancing collective situational awareness and target identification for air-land engagements. Long-term plans call for a joint, integrated capability that can be employed with other target identification and situational awareness enhancing initiatives on the digitized battlefield.

BCIS provides many combat advantages such as a low probability of detection, high reliability, and embedded GPS position information. Unfortunately, its cost (roughly $20,000 per unit) may be prohibitive in light of competing budget

---

[94] Department of the Army, Office of the Deputy Chief of Staff for Operations and Plans Operational Requirements Document (ORD) for the Battlefield Combat Identification System (BCIS) (Washington D.C.: 1993), 2.

[95] U.S. Department of Defense, Office of the Under Secretary of Defense (Acquisition and Technology) Combat Identification Task Force Architecture Working Group Final Report (Washington D.C.: U.S. Government Printing Office, 1995), 2-5.

demands and the total number of air-land platforms that must be fitted with the new hardware.

b.   Situational Awareness Beacon with Reply

The SABER is a Navy-developed, man-portable system that uses GPS data and ultra high frequency (UHF) satellite communications (SATCOM) to provide coded battlefield awareness information to C^2 nodes and warfighting platforms.[96] Using line-of-sight UHF and SATCOM over the horizon communications, users relay their identification and GPS parameters (location, course, speed, altitude, and time) to all other SABER-equipped users.[97] Through this data relay, a SABER-equipped unit can find any other SABER platform within line of sight, or a C^2 node can monitor platform locations and movements over the horizon through UHF SATCOM connectivity.

The planned architecture for SABER encompasses global, theater, and line-of-sight networks. Transceiver beacons can be provided for all major combatant elements such as ships, tanks, aircraft, and personnel while C^2 terminals can be deployed aboard ships, wide-bodied aircraft, or ground stations. The SABER system enhances flexibility for users by combining accurate, real-time GPS positional data with an improved knowledge of the tactical environment. When coupled to the Global Command and Control System (GCCS) and Link 16 (Tactical Digital Information Link-J), SABER provides commanders with the capability to follow the movements and activities of friendly forces in theater.[98] While SABER has many positive attributes, there are some limitations to

---

[96] Austin Boyd, "Know Your Friends," Space Tracks, (Fall 1995), 2.

[97] Ibid, 2.

[98] Ibid, 4.

67

widespread use of the system. For instance, the enemy could jam or exploit the UHF and SATCOM pathways used by the system. In addition, serious short-term consequences might result if an operational beacon were to fall into the wrong hands. Armed with a SABER unit, the enemy could have detailed knowledge (for up to 24 hours or until the encryption was changed) of all SABER-equipped forces in the area of operations.

c. Forward Observer/Forward Air Control

The FO/FAC system is a one-man, integrated, target acquisition system that provides all the functional capabilities forward observers and forward air controllers need to accomplish current and future missions.[99] The system consists of four main components: a GPS antenna, a laser rangefinder/compass that has been integrated into binoculars, a tactical computer planning station, and a hand-held control display unit. The system easily interfaces with Single Channel Ground and Airborne Radio Systems (SINCGARS) currently fielded throughout the U.S. military. Users of the FO/FAC system are provided with a method to designate, interrogate, and identify ground targets to CAS aircraft. The use of burst transmission techniques speeds the exchange of critical "nine line mission brief" information between the FAC and supporting CAS aircraft.

With the new system, FAC's no longer have to rely on imprecise and time-consuming methods to attack close-in targets with supporting arms. Aboard properly equipped CAS aircraft, the pilot receives the tactical air request via the automatic target hand-off system (ATHS). The ATHS provides a visual indication on the heads-up display of where the target

---

[99] Stephen V. Giusto and Phillip M. Patch, "FO/FAC: Forward Observer/Forward Air Controller," Marine Corps Gazette, vol. 80 no. 4 (April 1996), 21.

should be, based on information provided by the FAC. The FO/FAC system represents a significant improvement in the way traditional CAS procedures are carried out. Use of the system enhances CAS aircraft survivability, streamlines the tactical air request process, and minimizes air-land confusion that often results in the loss of situational awareness and fratricide.

3. Mid Term Solutions

Mid term technological measures will be used to develop the ideal combat identification system. The requirement calls for an integrated, embedded situational awareness, and positive identification capability that provides an automatic data hand-off from sensor to shooter. Mid term solutions emphasize the application of advanced NCTR and multi-sensor identification technologies. In addition, automated C^2, data fusion, advanced infrared, electro optical, and radar technologies will be used on a large-scale to enhance situational awareness and target identification. By digitizing the battle space, U.S. forces aim to achieve dominance over future adversaries while reducing friendly vulnerabilities through enhanced situational awareness, real- time information sharing, and positive target identification.

C. THE ROLE OF DOCTRINE

Since doctrine plays such a critical role in how military organizations plan, organize, and conduct operations, it stands to reason that it also provides many opportunities to address the problem of fratricide. Traditionally, fratricide avoidance measures have not received much emphasis in doctrinal publications. Fortunately, this situation has changed over the last few years as people have become more interested in understanding why fratricide occurs. Military organizations are assimilating many lessons learned from

training, exercises, and operations for the purpose of updating doctrines and challenging previously accepted ways of operating.

For example the current edition of Joint Pub 3-09.3, Joint Tactics, Techniques, and Procedures for Close Air Support, addresses the impact of fratricide on the CAS process. This joint service publication identifies many areas in the CAS mission cycle requiring special attention because the potential risks of fratricide may be high. It also contains fratricide prevention guidance that joint forces at the tactical level may easily understand and apply. Joint Pub 3-09.3 provides standardized, situation-specific guidance that is applicable to conduct effective and safe joint CAS. Use of this publication by joint and multinational forces strengthens interoperability and reduces battlefield confusion which in turn, lessens the risks of fratricide.

As Joint Pub 3-09.3 illustrates, the development cycle for doctrine now incorporates fratricide awareness and risk assessment measures. Applicable doctrinal publications are being developed, reviewed, and validated with fratricide awareness and risk reduction measures in mind. This provides a common frame of reference for users in the field to identify high-risk missions and procedures, so that appropriate fratricide avoidance techniques may be implemented. This thesis does not suggest that fratricide reduction should be the main consideration in the development of doctrine. However, it argues that fratricide is a battlefield reality that doctrine must thoroughly address in peacetime training and in war.

D. ORGANIZATIONAL REMEDIES

Before the Gulf War there was surprisingly little concern in the U.S. defense establishment about fratricide in combat.

Perhaps this was caused by perceptions that fratricide was not a significant source of battlefield casualties or conversely, that nothing could be done to address a problem that seems to be inherent in the chaos and "fog of war." Accidents, it may be thought, will happen. Either way, fratricides usually claim many casualties and provide a source of embarrassment for the military. This embarrassment may provide an incentive for military organizations to downplay the severity of fratricide. They may also explain why the U.S. military did so little to overcome the problem of friendly-fire or how to integrate CID efforts before the Gulf War.

The high ratio of friendly-fire casualties during Desert Storm reveals a degree of organizational complacency in the realm of CID and fratricide avoidance. Since the end of the Gulf War, the U.S. has pursued many organizational reforms to improve CID capabilities and reduce fratricide. This study examines some of these efforts from an organizational and training perspective.

1.   Restructuring the Bureaucracy

The post Gulf War military faced tremendous pressures to downsize and restructure. This reorganization established a national-level program to integrate all joint CID issues. The key components of the present day Department of Defense (DOD) CID effort include the General Officer Steering Committee for Combat Identification (GOSC-CID), the Joint Combat Identification Office (JCIDO), and the All Service Combat Identification Evaluation Team (ASCIET).

The GOSC-CID was established in 1993 to provide senior-level review and coordination of all Army, Navy, Air Force,

and Marine Corps CID requirements.[100] The committee, which includes two Flag Officers or Senior Executive Service representatives from each Service, functions as the senior military interface with Congress, industry, and the international military community. The main function of the GOSC-CID is to ensure the development and implementation of the Joint CID Master Plan that contains Service-unique CID requirements, milestones, and programs. The GOSC-CID reports to the Joint Requirements Oversight Council (JROC) which provides final direction on all material and non-material related CID efforts within the U.S. defense establishment.

Subordinate to the GOSC-CID, the JCIDO was established to provide action officer level coordination on all DOD CID efforts and to serve as the primary center of information for all CID issues, programs, and requirements.[101] Operating from the Pentagon, the JCIDO is the hub around which all Service level CID requirements, organizations, and programs function to ensure commonality and integration with the CID Master Plan. The Director of the JCIDO reports directly to the Chairman of the GOSC-CID and provides support and direction for the ASCIET.

The ASCIET stemmed from the Office of the Secretary of Defense (OSD) sponsored Joint Air Defense Operations/Joint Engagement Zone (JADO/JEZ) Joint Test and Evaluation Program conducted during fiscal years 1990 through 1994.[102] The

---

[100] U.S. Department of Defense, Office of the Vice Chairman of the Joint Chiefs of Staff USA/USN/USAF/USMC Memorandum of Agreement on Combat Identification (Washington D.C.: January 1993), 2.

[101] Ibid, 3.

[102] U.S. Department of Defense, Chairman, General Officer Steering Committee for Combat Identification USA/USN/USAF/USMC Memorandum of Agreement on the All Service Combat Identification Evaluation Team (Washington D.C.: September 1994), 1.

JADO/JEZ program was an early attempt by the military to address the problems of shared airspace between aircraft and surface-to-air missiles so that joint engagements could be conducted with minimum fratricide risk. This program evolved into the ASCIET in October 1994 at the direction of the JROC. ASCIET is an expanding organization that fosters new ideas about tactics, techniques, and procedures across all CID mission areas. ASCIET is chartered to employ the equipment and personnel of all the Services to evaluate, investigate, and assess various concepts of CID on the "high-tech" battlefield.[103]

The first ASCIET exercise was conducted during September 1995 in the Gulfport, Mississippi area and incorporated sea-air-land forces to evaluate joint C^3I and CID systems and procedures. The annual, two-week exercise provides training opportunities to all participants on CID and fratricide avoidance techniques. The use of instrumented ranges, video teleconferencing capabilities, and mass debriefs provides a forum for the Services to examine their CID capabilities. ASCIET provides an effective means to challenge participants and test combat systems in realistic force-on-force scenarios. The goal of ASCIET is to enhance joint interoperability and understanding about the battlefield conditions that complicate unit identification efforts.

2. Training Measures

Training is the key to combat effectiveness and therefore is the focus of effort of a peacetime military.[104] While technology and doctrine may improve CID and help reduce

---

[103] Ibid, 1.

[104] Department of the Navy, FMFM-1 Warfighting (Washington D.C.: Headquarters, U.S. Marine Corps, 1989), 46.

fratricide, their cumulative effects will be marginal without well-trained military leaders and troops. Training programs that emphasize the crawl-walk-run approach are an integral part of current fratricide reduction efforts. To provide maximum value, training must identify critical deficiencies that can be addressed through realistic and complementary exercises.

a.   Unit Level Training

Unit training programs are an important link in the fratricide prevention chain. Training priorities should reflect practical, challenging, and progressive goals beginning with individual and small-unit skills and culminating in a combined arms view of air-land warfare.[105] Special measures to enhance CID and fratricide awareness must be continuous and closely aligned with regular training programs. This approach develops individual and small-unit warfighting skills by highlighting some of the key factors that contribute to fratricide. For instance, frequent and specialized training on subjects like combat vehicle recognition, ROE, and risk management techniques build on routine training by minimizing the potential for fratricide.

The use of simulations and combat modeling techniques are additional ways to reinforce individual skills and unit level training programs. Simulators are highly useful training devices that provide combat system operators with realistic scenarios that represent real-world CID challenges. Personnel being trained on simulators or with combat modeling programs must be thoroughly evaluated on their ability to accomplish tactical scenarios without causing fratricide. This is a longstanding problem since most computer models and

---

[105] Ibid, 47.

74

simulations do not deal with the intricacies of CID and fratricide. Most training simulations make no provision for examining the effects or causes of fratricide.[106]

b. Training at Major Command Levels

Training functions at division/wing levels and higher strive to integrate assets and build on the diverse and complementary capabilities of subordinate units. Major field commands play a vital role in ensuring that subordinates are combat ready and able to function as highly cohesive elements of the total force. To get the most value out of training, major commands must be able to measure, analyze, and critique operations on the simulated battlefield. Live training against opposing forces in scenario-driven exercises is an excellent way to assess unit proficiency and identify the fratricide risk potential of most battlefield functions. Large-scale exercises on instrumented ranges provide a unique and realistic opportunity to synchronize the actions of all participants and collect valuable data that may shed some light on how fratricides occur and how they can be avoided.

One of the best examples of such focused, air-land battle training is the Air Warrior exercise conducted regularly at the U.S. Army National Training Center (NTC). Air Warrior evolutions are designed to provide fighter aircrews, senior Army commanders, and joint battle staffs with CAS and air interdiction training in a realistic, simulated combat environment.[107] Army brigades participating in Air Warrior exercises are encouraged to train and maneuver on the

---

[106] U.S. Congress, Office of Technology Assessment, <u>Who Goes There: Friend or Foe?</u>, OTA-ISC-537 (Washington D.C.: U.S. Government Printing Office, 1993), 47.

[107] U.S. Air Force, Air Combat Command, 549th Combat Training Squadron, <u>Air Warrior 96-06 Final Report</u>, (Nellis AFB, Nevada, March 1996), 2.

instrumented ranges of the NTC as they would during real world operations. The exercise offers a great opportunity to refine the warfighting skills of joint and multinational air-land forces by duplicating the high tempo, stress, and uncertainty of the modern battlefield.

The rate of fratricide during training missions becomes a key indicator of the systemic functioning of all units. Immediate and accurate after action reporting through the use of video teleconferencing and automated debriefing systems provide a forum to reinforce the learning process and measure operational success or failure in the training environment. During mock training battles, fratricides are viewed as negative statistics that all participants may critically analyze to understand the causes of friendly-fire. The Air Warrior exercise is just one example of how battle focused training at the major command level can have an immediate and positive impact on fratricide awareness.

There are no simple solutions to the compound problem of fratricide. Realistic and challenging exercises like Air Warrior and ASCIET enable major commands to notably improve their combat efficiency and minimize the potential for fratricide. The pursuit of such joint and multilateral training activities create open and honest working relationships and allow participants to analyze what really happened on the training battlefield. At the major command level, the key to dealing with the fratricide problem is to train subordinates on the proper ways to orchestrate tactical air operations with ground maneuver. Reducing fratricide at the upper echelons of any military organization clearly depends on a balanced and complementary approach that incorporates the benefits of technology, doctrine, and organization.

V. CONCLUSIONS AND RECOMMENDATIONS

A. RESEARCH FINDINGS

Fratricide is a serious and persistent problem that is aggravated by the complexity of the modern combat environment and the increasing lethality of weapons. This thesis has identified many of the factors that contribute to the occurrence of air-land fratricide. The following are the main research findings of this study:

1. The loss of situational awareness and the lack of positive target identification account for most incidents of air-land fratricide.

Fratricide has been an important and largely unrecognized source of combat casualties for the U.S. military. Although every fratricide incident is unique, history suggests that most friendly fire casualties result from the loss of situational awareness and the lack of positive target identification. The effects of these two primary factors are attenuated by fluid, air-land operations that complicate efforts to maintain situational awareness and differentiate between friend and foe.

2. U.S. target acquisition and weapon system technologies have outpaced target identification capabilities.

Most of the combat systems currently used by the U.S. military were designed during the Cold War to exploit range and lethality advantages necessary to deal with numerically superior Warsaw Pact forces. While these state-of-the-art combat systems are highly effective, they do not support air-land doctrines that emphasize high tempo operations on a nonlinear battlefield. The imbalance between weapons and target identification capabilities is further complicated by

77

the preference of U.S. forces to operate at night and under conditions of limited visibility. While these conditions provide natural battlefield advantages, they also make target identification more problematic.

3. Effective air-land operations demand teamwork and close integration between air and land forces.

Today's air-land battlefield is characterized by highly mobile forces operating at high speed over vast areas while employing lethal weapons from beyond visual range. Joint operational doctrine is also more sophisticated and reliant on the synchronized employment of combined arms, especially air power. Maneuver warfare techniques further complicates friendly efforts to maintain situational awareness and positively identify targets. A high degree of inter-service cooperation and combat integration is necessary to achieve operational synergy between air and land forces. This is particularly true during deliberate attacks where the massing of combat units and the high density of weapons systems greatly enhance the risk of fratricide.

4. Fratricide can be reduced but not eliminated.

Fratricide is a battlefield reality that is as enduring as warfare itself. The primary causes of fratricide (loss of situational awareness and lack of positive target identification) persist despite vast changes in weapons technology and the way air-land operations are carried out. Experienced leaders recognize that combat is inherently dangerous and that reasonable measures must be taken to assess and reduce the risk of fratricide. While practical steps can be taken to reduce the risk of friendly-fire, there are no simple solutions to fratricide. A balanced and complementary approach that embodies technology, doctrine, and organizational remedies offers the greatest payoff in reducing

the risk of fratricide. Warfare is simply too complex and unpredictable to unfold with the precision and certainty necessary to eliminate the risk of fratricide.

5.   The American public and government leaders have become more aware of casualties caused by friendly fire.

The large number of friendly fire casualties sustained by U.S. forces during the Persian Gulf War provided a much needed "reality check" for the American people and members of Congress. Before the Gulf War people had been largely ignorant of the scope or urgency of the fratricide problem. As a result, the total number of U.S. casualties from friendly fire have never been accurately documented or analyzed. Today the U.S. defense establishment does a much better job of identifying, reporting, documenting, and analyzing all instances of friendly fire. Appropriate national-and service-level organizations have been established to administer CID and fratricide reduction efforts. High-level interest and extensive media coverage of Gulf War fratricides changed many perceptions about the nature of friendly fire incidents. In the absence of comprehensive solutions, current sensitivities about fratricide-related casualties may undermine popular support for U.S. military operations. This may become critically important in the future, especially in low-intensity settings where U.S. national interests may be limited in scope, or inherently ambiguous.

6.   Fratricide can significantly degrade U.S. warfighting capabilities.

Fratricidal effects have the potential to render units ineffective, thereby threatening mission completion and battlefield survival. The physical and psychological effects of fratricide can disrupt operations across the entire battlefield. The secondary effects may be just as devastating,

producing paralysis, loss of confidence in supporting arms, loss of initiative, and risk aversion. Combat leaders must be attuned to the detrimental effects of fratricide, but not to the extent that they become too cautious, indecisive, or unwilling to take calculated risks. Concerns over the occurrence of fratricide may also drive the ROE to restrictive extremes, thereby limiting the combat effectiveness of U.S. weapon systems. The full potential of the U.S. military cannot be realized unless fratricide rates are brought under tight control.

7. **Most target identifications are visual.**

Despite U.S. technological advancements, the process of identifying ground combat systems and troop formations remains largely visual. The range at which positive identification can be accomplished by visual techniques, relative to optimum weapons acquisition and firing range, is marginal in daylight and inadequate at night or when visibility is limited. Targets can be acquired and engaged at long range, but they cannot be positively identified at long range because current visual techniques do not support such actions. This poses major problems for U.S. combat forces who can acquire and kill targets from beyond visual range but cannot identify them except through close-in, visual techniques. Even at close-in ranges, visual recognition skills and training become key considerations for target identification and fratricide avoidance. Additionally, threat recognition skills are perishable and subject to errors in human perception and interpretation. Maintaining proficiency requires constant training and attention to detail. Most U.S. combat systems require shooters to see and recognize targets before classifying them as friendly, hostile, or neutral. Sorting out friends and foes by visual means is extremely difficult,

especially when visibility is poor or when other factors degrade target identification efforts. Today's high technology target identification systems are quite sensitive to battlefield degradation and the many shortcomings of human operators.

8.   Similarities between friendly and enemy combat systems degrade target identification efforts and increase the risk of fratricide.

The appearance of virtually identical or similar combat systems among friendly, neutral, and hostile forces adds one more layer of complexity and uncertainty to an already difficult target identification process. Uncertainty about the friendly or hostile character of targets on the battlefield can generate widespread confusion, indecision, and the loss of aggressiveness during fire and maneuver. It also contributes to the likelihood of fratricidal exchanges in battle. Transfers and sales of U.S. arms to countries throughout the world have increased the possibility that someday, American forces will fight an adversary equipped with virtually identical combat systems.

9. Military Coalitions are ad-hoc organizations that may be polarized by fratricide incidents.

Multinational operations are among the most complex and demanding of all military activities. Since Coalitions are ad-hoc arrangements, they are often highly susceptible to disjointed command relationships, poor cooperative planning, and misgivings about sharing information and state of the art technologies. High fratricide rates may drive a wedge between Coalition partners leading to organizational strife and political instability. It is in the U.S. interest to help Allies and Coalition partners avoid fratricidal attacks on themselves or on U.S. forces.

**10.   Human operators are the weak link in the
fratricide prevention chain.**

Warfare places extreme demands on all participants. Air-
land operations on today's battlefield are complex and
unforgiving. This suggests that meticulous planning, close
supervision, and team oriented activities are of vital
importance. Modern combat has become so complex and
interconnected that human operators are often stretched beyond
their performance limits to manage operations and control
highly lethal technologies. Individuals can easily become
disoriented and lose touch with the "actual" situation around
them. Such dangerous situations are exacerbated by "round the
clock" operations that demand sound judgement and zero defects
from people at all times. Human errors are an inevitable
aspect of warfare. No matter how hard people try, mistakes may
sometimes occur that result in fratricidal losses.
Unfortunately, operating on the high technology battlefield
leaves little margin for error or human deficiencies.

B.   U.S. POLICY RECOMMENDATIONS

The following recommendations aim to identify areas where
there is room for improvement in carrying out air-land
operations with minimum risk of fratricide. These policy
recommendations hinge upon the belief that fratricide risks
can be assessed, identified, and decreased with virtually no
degradation to the warfighting efficiency of U.S. military
forces. Specific recommendations include:

**1.   Maintain the current broad-based emphasis on
enhancing CID and avoiding fratricide.**

The U.S. defense establishment is on the right track to
deal with the intricacies of CID and fratricide. Senior level
interest and adequate resource allocation in an austere budget
climate are crucial to long-term improvements in CID and

reductions in fratricide rates. Current measures to deal with fratricide are still insufficient to meet future operational requirements. Fratricide prevention must remain a funding and leadership priority at the national level, among the combatant commands, and within each of the military Services.

2. Greater emphasis on training and professional education.

There are no simple answers or "black box" solutions to the complex problem of fratricide. Training offers the most immediate and readily attainable way to deal with fratricide. Focused, air-land battle exercises like Air Warrior and ASCIET allow diverse combat forces to realistically integrate their warfighting activities, thus revealing potential weaknesses that could result in fratricide. Unquestionably, a more educated military force will be able to assess the dynamics of fratricide and implement appropriate risk-reduction measures. This enhances the ability of combat units to accomplish the mission, protect their troops, and focus all weapon systems squarely against the enemy.

3. The U.S. should vigorously pursue CID and fratricide avoidance capabilities with Alliance partners.

The end of the Cold War and budget constraints in the United States and among North Atlantic Treaty Organization (NATO) members have altered military priorities. Nevertheless, multinational operations demand military forces that are interoperable and able to differentiate friend from foe on the battlefield. By virtue of its unparalleled military capabilities, the United States should assume the leading role in Alliance CID and fratricide avoidance efforts. This action should help focus cooperative efforts and ensure NATO-wide systems compatibility to deal with new risks and operational tasks on the multinational battlefield.

4. Insist that new weapon systems have integrated CID capabilities that are commensurate with target engagement ranges.

Future weapon systems should have embedded CID capabilities that reduce the risk of fratricide for all target engagements within normal design parameters. Enhanced capabilities for CID and fratricide avoidance should be part of the design and system development process and not merely an afterthought. Military requirements in CID and fratricide avoidance for new combat systems must be clearly articulated in Mission Need Statements (MNS) and Operational Requirement Documents (ORD). Defense contractors should be reminded that military requirements must drive material developments and not vice-versa.

BIBLIOGRAPHY

Bickers, Richard Townshend, *Friendly Fire Accidents in Battle From Ancient Greece to the Gulf War* (London: Leo Cooper, 1994).

Boyd, Austin, "Know Your Friends," *Space Tracks,* (Fall 1995).

Clausewitz, Carl Von, *On War* (New York: Penguin Books, 1984).

Cooling, Benjamin Franklin, *Case Studies in the Development of Close Air Support* (Washington D.C.: U.S. Government Printing Office, 1990).

Giusto, Stephen V., and Patch, Phillip M., "FO/FAC: Forward Observer/Forward Air Controller," *Marine Corps Gazette,* vol. 80, no. 4 (April 1996).

Hackworth, David H., *About Face: The Odyssey of an American Warrior* (New York: Touchstone Books, 1989).

Hagerman, Edward, *The American Civil War and the Origins of Modern Warfare* (Indianapolis: Indiana University Press, 1988).

Hallion, Richard P., *Strike From the Sky: The History of Battlefield Air Attack 1911-1945* (Washington: Smithsonian Institution Press, 1989).

Hughes, Brian K., "Combat Identification Advanced Concept Technology Demonstration," paper presented at the Naval Postgraduate School during the Joint Service Combat Identification Systems Conference, Monterey, CA (14-16 November 1995).

Keegan, John, *The Face of Battle* (New York: Penguin Books, 1976).

Leonhard, Robert R., *The Art of Maneuver: Maneuver-Warfare Theory and AirLand Battle* (California: Presidio Press, 1991).

Mellin, Kenneth J, and Ferguson, John R., "Combat Identification-Are We Fixing What's Broken," paper presented at the Naval Postgraduate School during the Joint Service Combat Identification Systems Conference, Monterey, CA (14-16 November 1995).

Percin, Alexandre, Le Massacre de Notre Infanterie (Paris: Albin-Michel, 1921).

Posen, Barry R., The Sources of Military Doctrine: France, Britain, and Germany Between the World Wars (New York: Cornell University Press, 1984).

Regan, Geoffrey, Blue On Blue: A History of Friendly Fire (New York: Avon Books, 1995).

Scales, Robert H., Firepower in Limited War (Washington D.C.: National Defense University Press, 1990).

Schrader, Charles, Amicide: The Problem of Friendly Fire in Modern War (Fort Leavenworth, Kansas: U.S. Army Command and General Staff College, December 1982).

Shaw, Robert L., Fighter Combat (Maryland: United States Naval Institute, 1985).

Shay, Jonathan, Achilles in Vietnam: Combat Trauma and the Undoing of Character (New York: Touchstone Books, 1994).

Tzu, Sun, The Art of War (Boston: Shambala Publications, Inc., 1988).

U.S. Air Force, Air Combat Command, 549th Combat Training Squadron, Air Warrior 96-06 Final Report (Nellis AFB, Nevada: March 1996).

U.S. Army, Armor Training Center Video, Fratricide Awareness and Prevention (Fort Knox, Kentucky: 1992).

U.S. Army Combined Arms Command (CAC), Center for Army Lessons Learned (CALL), Fratricide: Reducing Self-Inflicted Losses, No. 92-4 (Kansas: April 1992)

U.S. Congress, General Accounting Office, OPERATION DESERT STORM: Apache Helicopter Fratricide Incident, GAO/OSI-93-4 (Washington D.C.: U.S. Government Printing Office, 1993).

U.S. Congress, Office of Technology Assessment, Who Goes There: Friend or Foe? (Washington D.C.: U.S. Government Printing Office, June 1993).

U.S. Department of the Army, FM 21-11 First Aid for Soldiers (Washington D.C.: Headquarters, U.S. Army, 1985).

U.S. Department of the Army, FM 44-31 Tactics, Techniques, and Procedures for Avenger Operations (Washington D.C.: Headquarters, U.S. Army, 1990).

U.S. Department of Defense, Chairman, General Officer Steering Committee for Combat Identification, USA/USN/USAF/USMC Memorandum of Agreement on the All Service Combat Identification Evaluation Team (Washington D.C.: September 1994).

U.S. Department of Defense, Final Report to Congress on the Conduct of the Persian Gulf War (Washington D.C.: U.S. Government Printing Office, April 1992).

U.S. Department of Defense, Joint Pub 1-02, DOD Dictionary of Military and Associated Terms (Washington D.C.: U.S. Government Printing Office, May 1994).

U.S. Department of Defense, Joint Pub 3-09.3, Joint Tactics, Techniques, and Procedures for Close Air Support (CAS) (Washington D.C.: U.S. Government Printing Office, December 1995).

U.S. Department of Defense, Office of the Deputy Chief of Staff for Operations and Plans, Operational Requirements Document (ORD) for the Battlefield Combat Identification System (BCIS) (Washington D.C.: 1993).

U.S. Department of Defense, Office of the Under Secretary of Defense (Acquisition and Technology), Combat Identification Task Force Architecture Working Group Final Report (Washington D.C.: U.S. Government Printing Office, 1995).

U.S. Department of Defense, Office of the Vice Chairman of the Joint Chiefs of Staff, USA/USN/USAF/USMC Memorandum of Agreement on Combat Identification (Washington D.C.: January 1993).

U.S. Department of the Navy, Headquarters United States Marine Corps, Command and Control, A U.S. Marine Corps Concept Paper (Washington D.C.: 1996).

U.S. Department of Navy, Headquarters United States Marine Corps, FMFM 1 Warfighting (Washington D.C.: U.S. Government Printing Office, March 6, 1989).

U.S. Department of Navy, Headquarters United States Marine Corps, FMFM 1-1 Campaigning (Washington D.C.: U.S. Government Printing Office, January 25, 1990).

U.S. Marine Corps, Marine Aviation Weapons and Tactics Squadron One, Basic Radar Principles (Marine Corps Air Station Yuma Arizona: August 1995).

U.S. Marine Corps, Marine Aviation Weapons and Tactics Squadron One, Introduction to Laser Radiation (Marine Corps Air Station Yuma Arizona: August 1995).

Van Creveld, Martin L. with Steven L. Canby and Kenneth S. Brower, Air Power and Maneuver Warfare (Maxwell Air Force Base: Air University Press, 1991).

Vandenbroucke, Lucien S., Perilous Options: Special Operations as an Instrument of U.S. Foreign Policy (New York: Oxford University Press, 1993).

Weigley, Russell F., Eisenhower's Lieutenants: The Campaign of France and Germany, 1944-1945 (Bloomington: Indiana Press, 1981).

INITIAL DISTRIBUTION LIST

1. Defense Technical Information Center................2
    8725 John J. Kingman Road, Suite 0944
    Ft. Belvoir, VA 22060-6218

2. Dudley Knox Library, Code 52......................2
    Naval Postgraduate School
    411 Dyer Road
    Monterey, CA 93943-5101

3. Director, Training and Education..................1
    MCCDC, Code C46
    1019 Elliot Road
    Quantico, VA 22134-5027

4. Director, Marine Corps Research Center............2
    MCCDC, Code C40RC
    2040 Broadway Street
    Quantico, VA 22134-5107

5. Director, Studies and Analysis Division...........1
    MCCDC, Code C45
    3300 Russell Road
    Quantico, VA 22134-5130

6. CAPT Frank Petho..................................1
    Chairman, National Security Affairs (NS/PF)
    Naval Postgraduate School
    Monterey, CA 93943

7. Superintendent....................................1
    ATTN: Professor Gordon H. McCormick (CC/MG)
    Naval Postgraduate School
    Monterey, CA 93943

8. Superintendent....................................1
    ATTN: Professor Daniel J. Moran (NS/MD)
    Naval Postgraduate School
    Monterey, CA 93943

9. Superintendent....................................1
    ATTN: Professor James J. Wirtz (NS/WJ)
    Naval Postgraduate School
    Monterey, CA 93943

10. United States Special Operations Command..........1
     Joint Special Operations Forces Institute
     Ft. Bragg, NC 28307-5000

11. Ms. Jennifer Duncan.............................5
     Center for Special Operations
     Naval Postgraduate School
     Monterey, CA 93943-5000

12. Director..1
     Joint Combat Identification Office (JCIDO)
     Room 5D-577
     2600 Defense, The Pentagon
     Washington, D.C. 20301-2600
     Attention: Colonel Anderson

13. Director..1
     All Service Combat Identification Team (ASCIET)
     307 West Van Matre Ave, Suite 105
     Eglin Air Force Base, Florida 32542-6805

14. MAJ Enrique E. Cruz.............................3
     P.O. Box 3350
     Estes Park, CO 80517-3350

15. Mr. & Mrs. Robert E. Trumbull...................2
     P.O. Box 3350
     Estes Park, CO 80517-3350

16. Mr. & Mrs. Robert Roche.........................1
     4325 Samoset Avenue
     San Diego, CA 92117