FRATRICIDE: THE ULTIMATE COST OF JOINT INTEROPERABILITY FAILURE

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> FORWARD MARINE BASE, Afghanistan, Dec. 5, 2001 -- Three U.S. Special Forces soldiers were killed and 20 injured in Afghanistan today when a 2,000-pound "smart bomb" missed its Taliban target north of Kandahar and exploded within 100 yards of the American forces and a group of opposition fighters. The Pentagon offered no immediate explanation for the deadliest "friendly fire" incident of the war…. [O]ne theory gaining attention is that the coordinates of the Special Forces troops who called in the airstrike were mistakenly loaded into the satellite-guided bomb, instead of the coordinates for the Taliban forces they were attacking (Morello&Loeb:A1).

INTRODUCTION

Elimination of fratricide in war is arguably an impossible task, but the Services have yet to support a true "joint" approach to alleviating friendly fire casualties. Currently, there is no universal system for either target identification or identification of friendly forces. The problem is largely due to insufficient training, inadequate integration of Service systems, and outdated tactics and doctrine. "The problem (is one) that falls between the services – in this case, primarily Army ground troops and Air Force and Navy fliers – and therefore a matter that is not the immediate responsibility and priority of any single service bureaucracy" (Wood:18). In the absence of a strong proponent for fratricide prevention, each Service expects the others to take the lead in resolving acknowledged shortfalls in adapting training, doctrine, and acquisition strategy to protect ground forces from friendly fire. Only a true "joint" approach to the problem can overcome Service reluctance to change. To initiate close air support (CAS) interoperability reform in an age of increasingly high-technology weaponry, the military must establish a single entity as the principal agent for fratricide prevention. The Secretary of Defense should charge U.S. Joint Forces Command (USJFCOM) with the responsibility to refine joint CAS doctrine, improve joint CAS training, and develop a common positional picture to reduce fratricide.

FRATRICIDE AND THE TECHNOLOGY REVOLUTION

Fratricide is not a new phenomenon, but as modern media brings play-by-play coverage of warfare to America's living rooms, reducing its likelihood takes on new importance. Loss of American life, and worse, the failure of the armed Services to safeguard their forces, poses a significant threat to what may well be the United States' most important center of gravity, the nation's will to fight. A brief summary of fratricide in the twentieth century illustrates that increased reliance on technology has inadvertently increased the relative significance of fratricide, if not the actual percentage of self-inflicted casualties.

Twentieth-Century American Fratricide

Friendly fire fatalities in the World Wars were largely due to indirect fires, the inadvertent result of artillery shelling friend and foe alike, and of bombers loosing their ordnance on locations held by friendly forces.

> Of the five million French casualties in World War I, artillery caused two-thirds, regardless of friend or foe. French General Alexandre Percin believed that French artillery fire caused one million, or 20 percent of French casualties. During the breakout from Normandy in the Second World War, British aircraft inadvertently bombed the 30th Division for over two days, killing, among others, American Lt. Gen. Leslie J. McNair. At the Battle of the Bulge, the First Infantry Division became the target of heavy "friendly" bombing. In St. Lo, over 750 casualties occurred as a result of U.S. bombers attacking American ground forces (Doton:3).

American forces fighting in both Korea and Vietnam suffered friendly indirect fires from new ordnance. American deaths due to napalm dropped by American planes in both theaters received prominent media attention and helped fuel the antiwar movement.

Though casualties were low in both Grenada and Panama, incidents of fratricide represented between 10 and 15 percent of all American casualties. In Grenada, four Navy A-7 Corsair aircraft strafed a U.S. Army command post, inflicting 17 American casualties (Doton:3). That

tragedy highlighted the Services' failure to establish a common positional picture. Each Service brought its own maps and map systems to the fight. The ground forces were unable to accurately describe a point on the ground to the supporting pilots. Air, ground, and sea Services planned and operated using separate maps referenced to three distinctly different coordinate systems. Accustomed to large-scale maps depicting terrain in familiar grids, Army units deploying from Fort Bragg used maps constructed by the Army's 100th Engineer Company (Cartographic), from a tourist map with an arbitrary grid overlay. Despite pictures of palm trees in the margins, the map was excellent. Constructed by British military engineers, the base map included highly accurate survey data replete with topographic contours. The American Army engineers merely added black grid lines for ground troops to use as a grid reference system.

While this worked well for the Army, coordinates from the gridded overlay were useless to any combatant without a copy of the modified tourist map. Some historians link the strafing of the U.S. Army command post to this lack of a common positional picture. "Ground units experienced difficulty in orienting themselves and in directing supporting gunfire and airstrikes. [This] inadvertent airstrike…has been blamed partly on this chart confusion problem" (Rivard:24). The failure to create a common reference for planning highlighted the Services' utter lack of attention to planning the joint fight. The "tourist map" debacle merited considerable media attention, providing further grist for 1986 Goldwater-Nichols Act proponents. After Grenada, Congress tasked the Services to improve interoperability for the next war. This "next war" promised to test both the Services' ability to fight jointly and their ability to integrate rapidly evolving high-technology weaponry.

Fratricide in the Age of Technology

The first "high-technology war," Operation DESERT STORM, proved to be a showcase for the weapons designed and built during the Reagan years. Experts lauded the performance of the high-technology systems used during the conflict. Confident in the superiority of American weapons systems, the American public watched in satisfaction as precision-guided munitions flew through the streets of Baghdad to impact their targets. However, the deadly precision of high-technology weaponry had an unexpected side effect: the fratricide rate for the Gulf War exceeded that of all previous conflicts in this century (Doton:4). Combat forces used reconnaissance technology capable of detecting targets at previously unattainable ranges. Beyond visual range technology recognized the existence of potential targets significantly smaller than one pixel on sensor displays, thereby making positive identification of the nature of the target nearly impossible (Doton:7). "Differentiation between friend or enemy leapt beyond the capability of the 'sensor-aided eyeball'" (Demonte:35). The American public, well versed in the superiority of American weapon systems, demanded an explanation for the friendly fire deaths – and a solution. Though national will to support the fight in the Gulf War never wavered, politicians and military leaders got the message that friendly fire deaths must be reduced in future conflicts.

The Army and the Air Force launched significant campaigns to identify the causes of fratricide and to leverage American technology to reduce its likelihood and effects. While the U.S. technology sector evolved dramatically successful methods for acquiring targets at long distances, the newest initiatives to aid shooters in positive combat identification lagged behind. The Services pursued new identification of friend or foe (IFF) technology separately, relying on communications systems that did not always interface well with those of other Services (Doton:13). In addition, IFF implementation proved to be extremely expensive. Current Army

initiatives in millimeter wave technology promise solid solutions in the near future, but come with a staggering price tag. At $1000 per application, completely outfitting a division will cost approximately $250 million (Doton:12).

Despite significant efforts resulting in multiple-Service initiatives to improve the situation, recent events in Afghanistan imply that the Services have yet to reduce the likelihood of friendly fire casualties. Nearly a decade after the Gulf War, the rapid evolution of weapons technology continues to outpace the U.S. military's capability to positively differentiate between friend and foe, and to accurately identify the precise location of desired targets to the weapons systems that deliver modern munitions.

The U.S. military has made significant improvements to munitions in the past ten years, and has changed its delivery strategy.

> For all the breathless headlines at the time, precision weapons during the Gulf War were still a niche specialty. Only about 10 percent of the bombs dropped in the Gulf War were precision-guided, meaning they could sense and hit a target dot from a laser beam, or could pick up signals from a global positioning system (GPS) satellite. By contrast, 90 percent of the bombs dropped in Afghanistan have been precision munitions (Ricks:A1).

In the first six months of the Global War on Terrorism, the U.S. military rained ordnance upon the Afghanistan battlespace, hitting intended targets with unprecedented precision. From aging bomber aircraft flying extremely long ranges, satellite-guided bombs carried the war on terrorism to Al Qaeda forces hiding in caves and mountain fortresses. For the first time, American pilots were dropping the majority of their ordnance "on coordinate" without obtaining "eyes on target" combat identification. This increased reliance on the accuracy of target information increases our reliance upon the human-technology interface.

This newest version of American combat uses the 1950s-era, eight-engine B-52 Stratofortress bomber as a precision weapons system. The high-cost, laser-guided munitions covered

extensively by CNN during the Gulf War have evolved into lower-cost weaponry guided to target by the GPS satellite constellation. "In Afghanistan, the centerpiece of the air campaign is the Joint Direct Attack Munition (JDAM), a kit that makes dumb bombs smart by attaching a GPS system and tail fins that can guide a bomb 10 miles from aircraft to target" (Ricks:A1). In the view of Air Force Lieutenant General Charles F. Wald, the commander of early air operations in Afghanistan, the high-technology weaponry was largely responsible for clearing the way for the Northern Alliance's success in the vicinity of Mazar-e-Sharif in November 2001 (Ricks:A1).

Despite the apparent success of JDAM, increased reliance on bomb-on-coordinate weaponry raised concerns about fratricide that were justified on 26 November 2001, when a U.S. Navy F/A-18 Hornet strike fighter dropped a satellite-guided 500-pound bomb in the vicinity of Mazar-e-Sharif from 15,000 feet, wounding five American troops on the ground. The tragedy of fratricide was repeated less than two weeks later when a B-52 dropped a 2,000-pound "smart bomb" that exploded within 100 yards of American and Northern Alliance forces on 5 December 2001. The cost this time was three American and 23 Northern Alliance fatalities, and about 50 injuries (PPT:8).

The shift to bombing on coordinates as a primary means of CAS delivery was not formally adopted by the Services prior to use in Afghanistan. The process was largely untested by joint forces before combat began. Lack of joint tactics, techniques, and procedures (JTTP), interoperability issues, and communications problems plagued air-to-ground coordination until field expedient measures were designed and adopted by Service members forced into joint operations with little training.

USCENTCOM asked the U.S. Army Safety Center to conduct an investigation into the causes of the 5 December 2001 fratricide incident. The Safety Center concluded that the tactical

air control party supporting the ground operations, unfamiliar with the operation of a laser range finder, mistakenly transmitted his own coordinates as the target coordinates (PPT:61). The Army Safety Board identified several action items and requested increased Air Force efforts to resolve shortfalls in adapting training, doctrine, and acquisition strategy (PPT:61-73). The report does not mention the failure of the U.S. military to integrate Service systems. In effect, the U.S. Army Safety Center does not "action" any requirement to redress that part of the fratricide problem that "falls between the Services." Thus, the potential for recurrence of fratricide in Afghanistan remains high. Even worse, should the U.S. military engage in combat operations against an enemy that has the capacity to mount a credible air threat against U.S. assets, the resulting "fog of war" will dramatically increase the potential for high numbers of American casualties attributable to fratricide.

RECOMMENDED CHANGES

Current joint doctrine, JTTP, and training strategies do not adequately address the increased joint fire support complexity brought about by technological advances in weaponry. The Services do not share a common positional picture, but rather use Service-specific methods to identify both friendly and target combat positions. Finally, no agency has been singled out as the joint proponent for tying these elements together. Therefore, the Secretary of Defense should task USJFCOM to take the lead in resolving these shortfalls.

Establish Joint Doctrine, JTTP, and Realistic Training

Joint doctrine at present fails to treat fratricide directly. References to it are sprinkled throughout many documents, usually as reinforcement for a different point or issue. Joint Publi-

cation (JP) 3-09, *Doctrine for Joint Fire Support*, lists the causes of fratricide as "target misidentification, target location errors, target locations incorrectly transmitted or received, and loss of situational awareness by controllers or aircrew or requestor" (JP 3-09:IV-13). This list appears almost verbatim in JP 3-09.3, the JTTP for CAS, with the added requirement to make every effort possible at correct identification of friendly and enemy forces (JP 3-09.3:I-2). In past instances of eyes-on-target CAS, this made sense, and was often aided by target marking techniques. However, with CAS conducted from distances and altitudes that preclude visual target identification and confirmation by supporting aircrews, accurate target coordinates and their positional relation to friendly forces are now center stage.

The Joint Warfighting Center conducted an assessment of JP 3-09.3 in September 2000. They found in a report dated 01 December 1995 that JP 3-09.3 was in need of revision to accurately portray the current philosophy, terminology, capabilities and JTTP as they apply to CAS. The Joint Staff J-3 directorate was assigned as the Joint Staff doctrine sponsor with the U.S. Marine Corps as the lead agent for revision of JP 3-09.3 (MSG: 1). That revision continues, and a revised second draft dated 25 February 2002 is currently in circulation for review. This draft discusses GPS-guided weapons and their potential dangers to friendly forces more fully, yet does not call for a universal system of defining geographic positions or methods of communicating them from the requestor to the shooter. Instead, the requirement remains for CAS delivery platforms to use the systems and communications nets of the CAS requestor.

The two multiservice tactics, techniques, and procedures (MTTP) developed by the Air Land Sea Applications Center, *Joint Fire* and *Theater Air Ground System*, are useful and informative, yet they too suffer from failing to keep up with technological change. These MTTP, coordinated at Service level, are hierarchically lower than JTTP and require less scrutiny and re-

view prior to publication. The most recent of these is now almost four years old, and contains no reference to GPS-aided weapons.

JTTP must often be developed by the warfighters "on the fly," without adequate doctrine, especially joint Service doctrine that aids warfighters seeking to overcome Service interoperability conflicts. Sufficient joint training is rarely accomplished to test new JTTP prior to real world deployment.

> While the use of precision-guided munitions is increasing, problems in close air support persist. Experienced pilots and ground controllers say this is largely due to insufficient training, inadequate communications and night vision gear, and outdated tactics and doctrine…. In an interim report in October 2000, the Joint Close Air Support Study reported that in 22 exercise battles involving 218 close air support missions, there were major problems in planning, coordination, training, and equipment…. Fewer than half of all ground-control teams conducted realistic training with ground troops present (Wood:18-19).

Joint training receives low priority, as Services tend to prefer training that emphasizes their core capabilities successfully. Thus, when bombs fall at the National Training Center, communications and other interoperability shortfalls have been resolved long before the pilots engage targets. This is not so in combat.

Establish a Common Positional Picture

Differing geographic coordinate datums, formats, and the transformations and conversions required to ensure that the shooter has the correct data are the primary contributors to the degradation of the accuracy of target-friendly positional picture. Each Service has acquired multiple systems for aiding the warfighter in describing and communicating geodetic positions, and interoperability of these systems is often lacking. USJFCOM must take the lead in encouraging the Services to commit to the establishment of a common positional picture to ensure that warfighters in the air and warfighters on the ground can communicate target information rapidly

and accurately. To achieve maximum accuracy, the Services must review both acquisition strategies and interoperability issues with a goal of establishing standard, National Imagery and Mapping Agency (NIMA) approved datum, coordinate format, and transformation algorithms.

The CJCS addressed the datum issue with CJCSI 3900.01A, Position Reference Procedures, specifying the World Geodetic System 1984 (WGS-84) as the standard for joint operations. However, this policy gives CINCs the flexibility to authorize use of other datums as circumstances dictate, as long as map users record and transmit the source datum for all coordinates (CJCSI 3900.1A:1-2). One reason for preserving the CINC's option to use nonstandard datums is that local maps are often the best available. Conversion of these maps to WGS-84 is costly and time consuming. In addition, multinational operation partners often are familiar with the local maps, and training in combat becomes a new issue (JP 2-03:II-3). The Secretary of Defense should task USJFCOM to identify potential interoperability issues now, and take the lead in resolving inter-Service issues.

Different Services, and even different weapons platforms within the same Service, use a variety of coordinate formats. A working knowledge of different formats is often lacking between Services, which may induce error and/or delays to mission accomplishment. Ground forces are most familiar with the Universal Transverse Mercator (UTM) projection as operationalized in the Military Grid Reference System (MGRS). Naval and air forces use geographic coordinates in latitude-longitude format. There is a wide difference in format between these systems (Table 1). A number of computer applications can convert between formats accurately. GPS receivers can also convert from one format to another, though most users do not train for such tasks and may be unaware of that capability (JP 3-09.3:IV-6).

Coordinate Type	Format
UTM/MGRS	11T AA12345678
Geographic	DD-MM-SS (degrees-minutes-seconds)
	DD-MM.DM (decimal seconds to 2 or 3 digits
	DD-DDD (decimal minutes to 2 or 3 digits

Table 1

JP 3-09.3 states, "[W]hen supplied with GPS coordinates by terminal controllers, computed deliveries can be extremely accurate" (JP 3-09-3:IV-8). This implies that GPS coordinates can always be trusted as accurate, which is not the case. There is no requirement stated in the doctrine for NIMA-approved conversion algorithms. Many units have acquired commercial off-the-shelf GPS receivers that have not been tested by NIMA for accuracy and, in fact, accuracies of commercial systems vary widely. Different weapons systems employ different transformation algorithms, which can induce degradation of accuracy due to rounding and approximations. Without standardization and a lead agent, America's warriors are not fighting with a common positional picture, despite technological advances.

The addition of new, high-technological systems in series also increases the potential for error. The primary means in use for determining CAS target location is the combination of a GPS receiver and a range finder (usually laser). The laser range finder determines azimuth, range and elevation of the target referenced to the viewer's position. That data is then fed into the GPS, which computes the target coordinates. Primary sources of error are obscurants (dust, smoke) between viewer and target, which spoof the range component, and azimuth errors produced by magnetic anomaly effects on the range finder's compass. While users can compensate for these errors to some degree, positional accuracy of both target and friendly forces cannot be guaranteed.

Some method of crosschecking the data should exist to compensate for questionable accuracy. Logically, crosschecking requires either a human or machine comparison of computed target coordinates to friendly coordinates. In this area, joint doctrine is silent. Existing formats for requesting CAS such as the CAS "nine line" request, the abbreviated nine line request, and the Joint Target Airstrike Request provide fields for target coordinates, but no field for own/friendly coordinates (ALSA:17, JP 3-09.3:C-1). USJFCOM should restudy these issues and establish such a requirement.

The introduction of armed unmanned aerial vehicles (UAV) during Operation ENDURING FREEDOM further exacerbates an already dangerous CAS climate. Future technological developments will most certainly lead to increased use of UAV in an offensive role in those situations where the risk of losing aircrew and expensive combat aircraft assets is great. The USAF is currently evaluating such technologies as three-dimensional imaging flash radar seekers, IFF algorithms, new and improved types of warheads, and mid-course guidance packages that integrate a GPS receiver with an inertial navigation system for use on armed unmanned combat vehicles (JIDR:6). In these CAS systems of the future, CAS developers must adapt current and future technologies so that friendly force position is determined accurately and transmitted real-time to the shooter. This becomes even more relevant without a human in the cockpit to add that all-important and final sanity check as to friendly positions on the ground before weapons are launched.

The USMC is planning to acquire another system that could prove to be an additional part of the answer in aiding the elimination of fratricide, the Combat Situational Awareness System (CSAS). CSAS uses radio frequencies, laser, ultra-wideband and digital Internet technologies to achieve battlefield situational awareness with global reach via satellite and ground

communications (Tiron:27). The USAF Modeling and Instrumentation Agency is conducting a separate research and development project to validate the compatibility of CSAS with airborne, ground vehicle, and dismounted soldier positioning systems currently in use.

Establish Responsibility

USJFCOM's mission statement asserts that the organization is the chief advocate for "jointness" and that, as such, USJFCOM maximizes the nation's future and present military capabilities through joint concept development and experimentation, recommending joint requirements, advancing interoperability, and conducting joint training. As the U.S. military's designated joint force trainer, it is imperative that it take the lead in all aspects of joint CAS, in order to adapt to ever-increasing technological advances while protecting friendly forces on the ground. Once the revision to JP 3-09.3 is published, USJFCOM should immediately take steps to implement these changes across all Service lines. Service parochialisms, which may have in the past exacerbated the confusion inherent in the chaos of CAS, must be eliminated so that a true joint CAS doctrine can be implemented.

CONCLUSION

USJFCOM should expand joint doctrine and JTTP to include more indepth coverage of fratricide-producing pitfalls. It should also restudy JP 3-09 to address the subject at a general level, directing readers to JP 3-09.1 and JP 3-09.3 for the indepth discussion. USJFCOM should implement modification of CAS request forms to standardize a target coordinate reporting format, include coordinate datum, and friendly location coordinates. Finally, USJFCOM should devise joint training that requires the Services to operate as they do in war.

The men and women on the ground who require CAS are owed every possible consideration for their survival, safety and peace of mind. CAS, by the very nature of the operations involved, will always subject friendly forces on the ground to some degree of risk. The management of that risk is the most important aspect that must be considered in all occasions in which a joint force commander chooses to employ CAS as an option.

All CAS participants must train under the same exacting guidelines to add the level of protection required for ground forces. Participants must know procedures cold…on that there can be no compromise. Precise determination of target location and friendly force positions is essential; there can be no doubt as to their validity prior to weapons release. USJFCOM must test, evaluate, and share new technologies across Service lines to ensure that CAS works to the fullest extent possible. Even one more friendly fire casualty due to faulty targeting is too high a price to pay when the solution to the problem appears to be readily at hand.

President Bush has repeatedly warned the American public that the war on terrorism has human costs. His steely visage and patriotic words televised during the State of the Union address encouraged Americans to bravely bear the small number of casualties experienced in Afghanistan to date. Undoubtedly, public support for the President remains high, which seems to indicate that the number of casualties is still bearable. Should the U.S. military continue to prosecute the Global War on Terrorism with existing CAS doctrine and JTTP, additional fratricide will have a negative impact on the American will to fight. To reduce that potential, USJFCOM must take action by expanding joint doctrine and JTTP.

Bibliography

Air Land Sea Application Center (ALSA). *J-Fire, Multi-Service Procedures for the Joint Application of Firepower*. Hampton, Virginia: ALSA, 1997.

CJCSI 3900.01A. *Position Reference Procedures*. Washington: GPO, 1998.

Demonte, V. "Avoiding Fratricide: Is the Endgame Solution the Answer?" *Journal of Electronic Defense*, No. 15, 1992.

Department of the Army Safety Center Power Point Briefing (PPT), "Command Briefing of the Events Surrounding the JDAM Fratricide Incident of 5 December 2001", 13 March 2001.

Doton, LTC Larry. "Technology and Fratricide." *Acquisition Quarterly Review*, Winter 1996.

Hewish, Mark. "US Air Force Eyes Next Revolution in Close Air Support." *Jane's International Defense Review (JIDR)*, October, 2000.

JP 2-03. *Joint Tactics, Techniques, and Procedures for Geospatial Information and Services Support to Joint Operations*. Washington: GPO, 1999.

JP 3-09. *Doctrine for Joint Fire Support*. Washington: GPO, 1998.

JP 3-09.3. *Joint Tactics, Techniques, and Procedures for Close Air Support (CAS)*. Washington: GPO, 1995.

Joint Staff. Joint Staff GENADMIN Message (MSG), DTG 281521Z MAR 01.

Morello, Carol and Vernon Loeb. "Bomb Kills Three U.S. Soldiers; 20 are Injured 'Friendly Fire.'" *The Washington Post*, 6 December 2001.

Ricks, Thomas E. "Bull's-Eye War: Pinpoint Bombing Shifts Role of GI Joe." *The Washington Post*, 2 December 2001.

Rivard, David T. *An Analysis of Operation Urgent Fury*. Defense Technical Information Center, 1985.

Tiron, Roxana. "Combat Identification System Contributes to Live Training." *National Defense Magazine*, April 2002.

Training and Doctrine Command (TRADOC). *TRADOC-AMC Combat Identification Interim Report*. TRADOC, 2000.

Wood, David. "Study: Lack of Training, Equipment Causes Errant Bombs." *Air Force Times*, 10 December 2001.

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