

**REPORT DOCUMENTATION PAGE**

*Form Approved*  
OMB No. 0704-0188

The public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing the burden, to the Department of Defense, Executive Service Directorate (0704-0188). Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.

**PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ORGANIZATION.**

<b>1. REPORT DATE (DD-MM-YYYY)</b> 29-02-2015			<b>2. REPORT TYPE</b> Future of War Paper		<b>3. DATES COVERED (From - To)</b> September 2015-April 2016	
<b>4. TITLE AND SUBTITLE</b> Long Live the King: Expeditionary Force 21's Call to Action for Marine Artillery					<b>5a. CONTRACT NUMBER</b> N/A	
					<b>5b. GRANT NUMBER</b> N/A	
					<b>5c. PROGRAM ELEMENT NUMBER</b> N/A	
<b>6. AUTHOR(S)</b> Del Mazo, Kenneth, Major, USMC Giorgis, Craig, Major, USMC					<b>5d. PROJECT NUMBER</b> N/A	
					<b>5e. TASK NUMBER</b> N/A	
					<b>5f. WORK UNIT NUMBER</b> N/A	
<b>7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)</b> N/A					<b>8. PERFORMING ORGANIZATION REPORT NUMBER</b> N/A	
<b>9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)</b> USMC School of Advanced Warfighting Marine Corps University 2076 South Street Quantico, VA 22134-5068					<b>10. SPONSOR/MONITOR'S ACRONYM(S)</b> N/A	
					<b>11. SPONSOR/MONITOR'S REPORT NUMBER(S)</b> N/A	
<b>12. DISTRIBUTION/AVAILABILITY STATEMENT</b> Approved for public release; distribution is unlimited						
<b>13. SUPPLEMENTARY NOTES</b> none						
<b>14. ABSTRACT</b> In early 2014, Headquarters Marine Corps published Expeditionary Force 21 (EF21), a concept paper that describes a near-term future operational environment and outlines a campaign plan to change the Marine Corps in response. EF21's vision of MAGTF fires supporting a distributed Ground Combat Element (GCE) while retaining the ability to mass creates a broad mission set for Marine artillery. Following a critical analysis of EF21 from an artilleryman's perspective, four critical characteristics emerge as priorities for artillery force development: versatility, mobility, simplicity, and distribution. Versatile artillery units are capable of aggregating and disaggregating in support of varied operational requirements. Mobility is the ability of artillery—including its required sustainment—to get to the fight. Simplicity implies systems that are only as complex as necessary. Although simple weapons may use new technology, they are not dependent upon them. Finally, future artillery must be capable of supporting a distributed GCE. Following these priorities, the paper offers specific recommendations necessary for Marine artillery to maximize its potential in 2030.						
<b>15. SUBJECT TERMS</b> Artillery; Fire Support; Fires; Ground Fires; Future of Artillery						
<b>16. SECURITY CLASSIFICATION OF:</b>			<b>17. LIMITATION OF ABSTRACT</b>  UU	<b>18. NUMBER OF PAGES</b>	<b>19a. NAME OF RESPONSIBLE PERSON</b> School of Advanced Warfighting	
<b>a. REPORT</b> Unclass	<b>b. ABSTRACT</b> Unclass	<b>c. THIS PAGE</b> Unclass			<b>19b. TELEPHONE NUMBER (Include area code)</b> (703) 432 - 5318	

## INSTRUCTIONS FOR COMPLETING SF 298

**1. REPORT DATE.** Full publication date, including day, month, if available. Must cite at least the year and be Year 2000 compliant, e.g. 30-06-1998; xx-06-1998; xx-xx-1998.

**2. REPORT TYPE.** State the type of report, such as final, technical, interim, memorandum, master's thesis, progress, quarterly, research, special, group study, etc.

**3. DATES COVERED.** Indicate the time during which the work was performed and the report was written, e.g., Jun 1997 - Jun 1998; 1-10 Jun 1996; May - Nov 1998; Nov 1998.

**4. TITLE.** Enter title and subtitle with volume number and part number, if applicable. On classified documents, enter the title classification in parentheses.

**5a. CONTRACT NUMBER.** Enter all contract numbers as they appear in the report, e.g. F33615-86-C-5169.

**5b. GRANT NUMBER.** Enter all grant numbers as they appear in the report, e.g. AFOSR-82-1234.

**5c. PROGRAM ELEMENT NUMBER.** Enter all program element numbers as they appear in the report, e.g. 61101A.

**5d. PROJECT NUMBER.** Enter all project numbers as they appear in the report, e.g. 1F665702D1257; ILIR.

**5e. TASK NUMBER.** Enter all task numbers as they appear in the report, e.g. 05; RF0330201; T4112.

**5f. WORK UNIT NUMBER.** Enter all work unit numbers as they appear in the report, e.g. 001; AFAPL30480105.

**6. AUTHOR(S).** Enter name(s) of person(s) responsible for writing the report, performing the research, or credited with the content of the report. The form of entry is the last name, first name, middle initial, and additional qualifiers separated by commas, e.g. Smith, Richard, J, Jr.

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES).** Self-explanatory.

**8. PERFORMING ORGANIZATION REPORT NUMBER.** Enter all unique alphanumeric report numbers assigned by the performing organization, e.g. BRL-1234; AFWL-TR-85-4017-Vol-21-PT-2.

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES).** Enter the name and address of the organization(s) financially responsible for and monitoring the work.

**10. SPONSOR/MONITOR'S ACRONYM(S).** Enter, if available, e.g. BRL, ARDEC, NADC.

**11. SPONSOR/MONITOR'S REPORT NUMBER(S).** Enter report number as assigned by the sponsoring/monitoring agency, if available, e.g. BRL-TR-829; -215.

**12. DISTRIBUTION/AVAILABILITY STATEMENT.** Use agency-mandated availability statements to indicate the public availability or distribution limitations of the report. If additional limitations/ restrictions or special markings are indicated, follow agency authorization procedures, e.g. RD/FRD, PROPIN, ITAR, etc. Include copyright information.

**13. SUPPLEMENTARY NOTES.** Enter information not included elsewhere such as: prepared in cooperation with; translation of; report supersedes; old edition number, etc.

**14. ABSTRACT.** A brief (approximately 200 words) factual summary of the most significant information.

**15. SUBJECT TERMS.** Key words or phrases identifying major concepts in the report.

**16. SECURITY CLASSIFICATION.** Enter security classification in accordance with security classification regulations, e.g. U, C, S, etc. If this form contains classified information, stamp classification level on the top and bottom of this page.

**17. LIMITATION OF ABSTRACT.** This block must be completed to assign a distribution limitation to the abstract. Enter UU (Unclassified Unlimited) or SAR (Same as Report). An entry in this block is necessary if the abstract is to be limited.

# *School of Advanced Warfighting*

*United States Marine Corps  
School of Advanced Warfighting  
Marine Corps University  
3070 Moreell Avenue  
Marine Corps Combat Development Command  
Quantico VA 22134*

## **FUTURE WAR PAPER**

### ***TITLE:***

**“Long Live the King: *Expeditionary Force 21*’s Call to Action for Marine Artillery”**

SUBMITTED IN PARTIAL FULFILLMENT  
OF THE REQUIREMENTS FOR THE DEGREE OF  
MASTER OF OPERATIONAL STUDIES

### **AUTHOR:**

Major Kenneth del Mazo, USMC  
Major Craig Giorgis, USMC

AY 2015-16

**Mentor:** Dr. Bradley Meyer

**Approved:** *Bradley J. Meyer*

**Date:** *23 May 2016*

# *School of Advanced Warfighting*

## DISCLAIMER

THE OPINIONS AND CONCLUSIONS EXPRESSED HEREIN ARE THOSE OF THE INDIVIDUAL STUDENT AUTHOR AND DO NOT NECESSARILY REPRESENT THE VIEWS OF EITHER THE SCHOOL OF ADVANCED WARFIGHTING OR ANY OTHER GOVERNMENTAL AGENCY. REFERENCES TO THIS STUDY SHOULD INCLUDE THE FOREGOING STATEMENT

## Executive Summary

**Title:** Long Live the King: *Expeditionary Force 21's Call to Action for Marine Artillery*

**Author:** Major Kenneth del Mazo, USMC and Major Craig Giorgis, USMC, SAW AY2015-16

**Thesis:** Marine artillery must adopt doctrine, organizational structure, and equipment that provides persistent, mobile, and versatile fires to support the distributed MAGTF of 2030.

**Discussion:** In early 2014, Headquarters Marine Corps published *Expeditionary Force 21 (EF21)*, a concept paper that describes a near-term future operational environment and outlines a campaign plan to change the Marine Corps in response. *EF21's* vision of MAGTF fires supporting a distributed Ground Combat Element (GCE) while retaining the ability to mass creates a broad mission set for Marine artillery. Following a critical analysis of *EF21* from an artilleryman's perspective, four critical characteristics emerge as priorities for artillery force development: versatility, mobility, simplicity, and distribution. Versatile artillery units are capable of aggregating and disaggregating in support of varied operational requirements. Mobility is the ability of artillery—including its required sustainment—to get to the fight. It includes strategic, operational, and tactical mobility. Simplicity implies systems that are only as complex as necessary. Although simple weapons may use new technology, they are not dependent upon them. Finally, future artillery must be capable of the range, mobility, and command and control required to support a distributed GCE.

**Conclusion:** Following these priorities, the paper offers specific recommendations necessary for Marine artillery to maximize its potential in 2030. First, artillery must integrate unmanned aerial systems (UAS) into the C2 structure of fire support systems. Second, acquisition efforts should prioritize target location aids to reduce target location error (TLE). Third, fire support and surveillance systems must reorganize to facilitate the rapid collection and dissemination of targeting information. Fourth, to survive in an electronically degraded environment, C2 systems should develop a two-tiered capability set: one to maximize networked technology and one that functions in a degraded network. Fifth, artillery should use simple, rugged computers to compute technical fire direction at the weapon system to free leadership and expertise in support of distributed operations. Sixth, acquisition should focus on two primary weapon systems: a simple, light, and mobile direct support (DS) weapon and a versatile, long-range general support (GS) weapon. To support distributed operations, the ratio of GS to DS weapons should be increased. Seventh, artillery munition development should focus on both mass and precision, neither exclusive of the other. Eighth, doctrine must adapt to recognize that in a geographically distributed battlefield, the battery is the "basic unit" of Marine artillery. Ninth, artillery must reorganize and assign its DS battalions to the infantry regiment while retaining GS, target acquisition, and training capacity at the artillery regiment. Finally, because US Army and Marine Corps artillery are designed to support similar but not identical missions, the Marine Corps should establish a "Marine Artillery School" adjacent to existing MAGTF fires organizations, such as the MAGTF Training Center.

In early 2014, Headquarters Marine Corps published *Expeditionary Force 21 (EF21)*, a concept paper that describes a near-term future operational environment and outlines a campaign plan to change the Marine Corps in response. Supporting the key concepts contained within will be especially challenging for artillerymen. The ability to fight in the urban littorals, to aggregate and disaggregate seamlessly, and to retain strategic and operational mobility given limited naval lift are substantial problems artillerymen must address. Marine artillery, as currently organized, trained, and equipped, may not be well suited to meet these challenges. Today's artillery community has prioritized regaining proficiency in core competencies following nearly 15 years of counterinsurgency in Iraq and Afghanistan. While this focus is necessary, the community lacks a unifying vision to meet the requirements of the Marine Air Ground Task Force (MAGTF) of 2030.<sup>1</sup> Marine artillery must adopt doctrine, organizational structure, and equipment that provides persistent, mobile, and versatile fires to support the distributed MAGTF of 2030.

This paper aims to set the priorities necessary to meet the demands of the future operating environment. We begin with a critical summary of *EF21* and discuss its implications for artillery. From these implications, we derive four critical characteristics to guide developmental priorities: versatility, mobility, simplicity, and distribution. We conclude with recommendations regarding necessary changes to fire support, Command and Control (C2), and weapon systems (“eyes, brains, and brawn”), as well as doctrine, training, and organization that will maximize artillery's potential in 2030.

Understanding the broad scope of the topic, we have developed a small framework and a few assumptions to limit the discussion accordingly. First, we accept the future as described by *EF21*. Although critics have rightly identified potential flaws,<sup>2</sup> its unifying vision of distributed MAGTFs capable of supporting a broad range of operational requirements is correct. Second,

this paper confines itself to the core missions of artillery only. “Non-lethal fires” and “in lieu of” missions are also important, but this paper is about cannon, rocket, and mortar fires. Third, we have adopted *EF21*'s explicit assumption that naval surface fires and amphibious shipping will remain insufficient to support littoral maneuver. Finally, we expect that adversaries will effectively contest US air supremacy in the near-term. Proliferation of sophisticated surface-to-air weapons and drone technology indicate that the MAGTF cannot continue to rely on unquestioned control of the air.<sup>3</sup>

### **I. *EF21*: A Critical Summary**<sup>4</sup>

At its essence, *Expeditionary Force 21 (EF21)*<sup>5</sup> is a description of how the Marine Corps envisions itself reconfiguring to meet emerging national requirements in a changing operating environment. It explains both the content of this reconfiguration and the steps necessary for its implementation. Although the document lists eight functions of the Marine Corps, it clearly emphasizes two as central: crisis response and security cooperation. Other important themes include an emphasis on the service's naval and expeditionary character, a strong forward presence, deploying scalable and composite forces, integration with domestic and foreign partners, and fiscal austerity. *EF21* frames these ideas within an operating environment described as politically complex, volatile, chaotic, and globally connected. Access to and maneuver within the littorals remain critical, as does a capability to operate effectively across the range of military operations.

*EF21* has a lengthy intellectual heritage. It nests well with two enduring concepts—*Operational Maneuver from the Sea (OMFTS)* and *Ship-to-Objective Maneuver (STOM)*—and it is a logical progression from more recent ideas such as *Distributed Operations (DO)* and *Enhanced Company Operations (ECO)*. Most recently, the Navy and Marine Corps jointly

published the *Disaggregated Amphibious Ready Group/Marine Expeditionary Unit Concept of Employment (Disaggregated ARG/MEU COE)*.<sup>6</sup> This concept of employment asserts that although the ARG/MEU is trained, organized, and equipped to perform a prescribed mission set as a unified whole, Geographic Combatant Commander (GCC) requirements often necessitate physical or command separation of its components. Dividing the ARG/MEU has proved problematic, largely because its subunits are not equilateral or easily scalable. Yet its continued practice is also an admission that GCC requirements exceed US naval forces' current amphibious capacity, and that the Marine Corps' concept of forward presence must expand beyond the MEU.

*EF21* acknowledges this fact through its vision for Special Purpose MAGTF (SPMAGTF) crisis response forces. These land-based SPMAGTFs are a response to GCC requirements in a politically and fiscally constrained environment—the key restraints being a lack of amphibious shipping and reduced international appetite for large (battalion-sized) US combat formations ashore. Smaller, company-sized formations may operate far outside the range of mutual support; access to persistent supporting arms will be a critical means of mitigating the risk associated with this fact.

## **II. Implications for Artillery: Priorities for Change**

The requirement to support a distributed Ground Combat Element (GCE) while retaining the ability to mass creates a broad mission set to which MAGTF fires must organize, train, and equip. *EF21* may be short on details for Marine artillery, but certain implications emerge from its vision of the future MAGTF. These implications can form, in turn, priorities and specific recommendations for the artillery community that revolve around four critical characteristics: *versatility, mobility, simplicity, and distribution*. The following section defines each term as they

apply to artillery fires and links them to key concepts contained in *EF21*. Table 1 expands upon the text below.

### ***Versatile***

Versatile artillery units are capable of aggregating and disaggregating in support of varied operational requirements. As there is no “right size” MAGTF, there is no right size of artillery unit. Marine artillery must therefore possess the capability and capacity to control fires scaled from the platoon (i.e., two sections) through the regiment. Command and control capabilities must also support a smooth aggregation into *ad hoc* task forces, often without the benefit of organic or habitual relationships. The variety of mission sets anticipated by *EF21*—from forcible entry, to small wars, to theater security cooperation—suggests that artillery must be capable of both mass and precision fires. Versatility is essential to *EF21* concepts such as the “Middleweight Force,” “Forcible Entry in Depth,” crisis response, and the company landing team.

### ***Mobile***

Mobility is the ability of artillery—including its required sustainment—to get to the fight. It includes strategic, operational, and tactical mobility.<sup>7</sup> *EF21*'s emphasis on crisis response and littoral maneuver present particular problems for artillery in that weapon systems, prime movers, and ammunition are bulky and heavy. One potential solution is increased range, implying that the weapon system need not move to support a distributed MAGTF. A second solution is increased mobility through acquisition of lighter, smaller systems. The MAGTF of 2030 will likely require both: a strategically mobile general support (GS) weapon system capable of extremely long ranges (300km+) and a tactically mobile direct support (DS) weapon system capable of moving with a helicopter/tilt-rotor assault force. These complementary systems would support *EF21*

concepts such as the “Middleweight Force,” crisis response, littoral maneuver, the company landing team, and expeditionary logistics.

### ***Simple***

Simplicity implies systems that are only as complex as necessary. Although simple weapons may use new technology, they are not dependent upon them. They are capable of operating in austere environments and require a minimum of mechanical and technical support. Traditionally, cannons and mortars have made simplicity a virtue—they are ready to fire when required. Accessories such as hydraulics and electronics may increase capability but also increase complexity; they are more expensive and require a greater sustainment effort. Thus, to ensure responsive and persistent fires regardless of weather or electronic network availability, future MAGTF artillery systems (weapons, trucks, and C2) must be simple. Simplicity facilitates responsiveness and persistence, and all three characteristics support *EF21* concepts such as “Expeditionary Force in Readiness,” expeditionary logistics, and operations in an electronically degraded environment.

### ***Distributed***

Distributed operations are the “physical dispersion of networked units over an extended battlespace.”<sup>8</sup> *EF21* envisions GCEs that can disperse and mass as required.<sup>9</sup> In addition to range and mobility, artillery must possess the C2 structure and systems to support such distribution. Three specific implications follow. First, fire support expertise must be readily accessible to the infantry squad, either through distribution of qualified personnel (e.g., Joint Fires Observers) or through access to networked sensors capable of accurate target location and discrimination. Second, artillery batteries must possess the C2 capacity to split into two-weapon platoons; this likely necessitates a new approach to technical fire direction. Third, artillery networks must

support reliable long-range communications. Distributed artillery capability is integral with *EF21* concepts such as littoral maneuver, the company landing team, and expeditionary logistics.

### **III. Lessons Learned and Recommendations: Eyes, Brains, Brawn, and Beyond**

*EF21* as described provides a vision of the future battlefield and an outline of how the Marine Corps will fight and win in that environment. We distilled this vision into four priorities for change for Marine artillery: *versatility, mobility, simplicity, and distribution*. Given these priorities and lessons learned from the contemporary operating environment, this section offers recommendations necessary for Marine artillery to maximize its potential in 2030.

#### ***Eyes: UAS Integration and Target Location Error Reduction***

The ongoing Russo-Ukrainian War demonstrates what is possible by integrating Unmanned Aerial Vehicles (UAVs) with ground fire support platforms across a dispersed battlefield. Eighty-five percent of all casualties in the Russo-Ukrainian War have resulted from artillery, and first-hand accounts describe Russian indirect fires destroying entire battalions in a solitary strike.<sup>10</sup> The Russians task organized UAV and artillery platforms, pairing complementary sensing and shooting range capabilities, then disseminated information over a flattened C2 structure.<sup>11</sup> This system has devastated Ukrainian mechanized formations through persistent forward observation, the ability to mass dispersed firing units, short acquisition to response times (10-15 minutes), and real-time battle damage assessment (BDA).<sup>12</sup> Aerial observation thus serves as an economy of fires: low-cost, high endurance aircraft observe high-volume, massed fires from numerous ground-based weapon systems. As organized, Russian artillery has proven dynamic, efficient, and lethal.

Airborne sensors also address a second requirement for future MAGTF target acquisition: reduction in target location error. Our ability to strike targets accurately has far outstripped our ability to locate them with comparable accuracy. The US Army field artillery branch recently established an aspirational goal of achieving precision target location 80% of the time.<sup>13</sup> Israeli experience with precision fires in dense, politically ambiguous urban areas such as Gaza indicate that this expectation is not only reasonable but required.<sup>14</sup> To achieve this degree of accuracy, an observer requires technological aids; airborne sensors address that requirement in part.

Achieving these two goals by 2030—integration of UAV observation capability and reduction of target location error (TLE)—requires three interrelated efforts. First, Marine artillery must integrate with the MAGTF’s UAV system to create a network of persistent aerial observers capable of precise, real-time target location and BDA. The most capable and versatile platforms can serve as “general support observers,” providing precision observation to fire supporters in the deep, close, and rear areas of the battlefield.<sup>15</sup> Networked Company Fire Support Teams (FiST) should have direct access to their capabilities, thus enhancing their ability to integrate intelligence, fires, and maneuver. Simple UAV platforms should become part of the standard table of equipment (T/E) for the Company FiST. This would both reduce the limitations of line-of-sight observation and provide additional target location capabilities.<sup>16</sup> Second, material acquisition efforts should prioritize target location aids. These aids must be versatile enough to function in a variety of suboptimal situations, e.g. without GPS or updated imagery, and mobile enough for use with a heliborne assault force. Third and most importantly, fire support C2 systems must facilitate the rapid collection and dissemination of targeting information.<sup>17</sup> Such changes to C2 systems are the focus of the next section.

### ***Brains: Command and Control***

Russia's use of UAVs for persistent forward observation is only part of what led to their success with indirect fires. More instructive to us is their C2 system. It effectively processed multiple sensor inputs and then quickly disseminated fire missions to distributed artillery platforms.<sup>18</sup> Likewise, for Marine artillery, developing the right C2 system for 2030 is a critical task. Given the likelihood of electronic degradation from electronic and/or cyber attacks, any increase in complexity (e.g., addition of a UAV network) is also an increase in vulnerability. Further, in contrast to the Russian experience, US fire support coordination was often embarrassingly slow on the dispersed battlefields of Iraq and Afghanistan. The combination of high trajectories, dense airspace, and counterinsurgency tactics severely hampered artillery responsiveness. These factors will remain and likely increase in complexity over the next 15 years. Thus, two C2 challenges in particular require prioritization: development of "all-network" capable artillery and "flattened" fire support coordination architecture.

As *EF21* describes, Marines must prepare to fight and win in an electronically degraded environment. For artillery, this means executing its core mission—providing responsive precision and mass fires—with or without a fully functional C2 network. Disruption of radio or GPS networks, for example, would cause serious problems for Marine artillery as currently organized and equipped. Thus, artillery C2 systems must be able to operate with a "degraded" capability. In this sense, simplicity and versatility conflict: simpler weapon systems are inherently less vulnerable yet also less capable. Nevertheless, artillerymen must use new technology without becoming dependent upon it.

We reconcile this conflict with a two-tiered approach to artillery C2 systems. The first tier exploits technological complexity, and the second relies on proven, simpler (if less capable)

technology. For example, communications architecture should be capable of video streaming UAV feeds under ideal circumstances while maintaining simple long-range voice/chat communications under all circumstances. Artillerymen must train to these standards, and establish a mission essential task (MET) for platoon through regiment to preserve operational capability in an electronically degraded environment.

The ability to calculate technical fire direction with simple, rugged computers is a technology not yet exploited. Much as ballistic computers facilitated distributed fire direction 60 years ago,<sup>19</sup> Marine artillery has the capability to take the next step and begin computing firing data at the weapon. Freeing the battery of this task facilitates distributed operations in two ways. First, it diminishes the C2 load inherent to battery operations, thus freeing capacity to direct distributed firing units. Second, it allows a supporting artillery unit to devote more of its expertise to support distributed maneuver units.<sup>20</sup> Determining the exact structure of fire support coordination that best serves distributed maneuver requires further research and experimentation; however, it will undoubtedly involve compositing and redefining the traditional functions of tactical fire direction, fire support coordination, and airspace coordination.

### ***Brawn: Weapon Systems***

Over the past decade, Marine artillery has updated its weapons systems to form the “triad of fires”: the Lightweight 155mm Howitzer (M777), the High Mobility Artillery Rocket System (HIMARS), and the 120mm mortar Expeditionary Fire Support System (EFSS). Designed to support concepts inherent to *OMFTS*, the triad appears well-suited to support *EF21*. However, by 2030 these systems will have exceeded their service life expectancy and the future operating environment will necessitate new weapon systems.

*EF21*'s vision of a light, distributed GCE demands an especially mobile artillery system. This kind of mobility requires light weapon systems and support equipment with small logistical footprints. Presently, Marine artillery has a mobility problem that will prevent it from supporting the *EF21* MAGTF. A review of recent Marine Expeditionary Units (MEU) after action reports revealed one-third did not embark any M777s, and only one embarked its full battery complement of six cannons. Trends revealed two-thirds of MEU ships were at max weight capacity for cargo, and reports described the M777's required prime mover, the 7-ton truck, as not conducive for loading aboard amphibious shipping. Moreover, aviation-dependent SPMAGTFs are deploying without any artillery force structure.<sup>21</sup> The deduced conclusion is that Marine artillery's premier weapons system, the 155mm towed howitzer, is not operationally mobile and must be replaced.

When considering new artillery weapons, two conflicts emerge: capability vs mobility and mass vs. precision. Accordingly, what is the best compromise between simplicity, versatility, and mobility? This paper proposes that the right answer lies in two weapon systems—one direct support (DS), one general support (GS)—and discusses a munition set appropriate to both.

### *Direct Support Artillery in 2030*

Given a choice between capability and mobility, the MAGTF of *EF21* must favor mobility: operational mobility to get to the fight, and tactical mobility to support distributed maneuver units.<sup>22</sup> Therefore, artillery must be as light as possible while still providing the mass necessary to be worth the lift assets required to move it across the battlespace. Mortars, while light and operationally/tactically mobile, lack the range, lethality, and direct fire capability to adequately support distributed maneuver units.

The Marine artillery direct support system of the future is a lightweight, extended range (40km+)<sup>23</sup> 105mm howitzer. The M777, with its prime mover and ammunition, is insufficiently mobile to support *EF21*'s MAGTF. In the 1980s, both the Army and Marine Corps conducted a series of tests and war games to assess potential direct support weapons for their light forces. Both concluded that the 105mm howitzer system—at approximately ½ the weight and volume of its 155mm counterpart—was the right compromise between firepower and mobility.<sup>24</sup> The mobility of the 105mm, coupled with a lightweight, easily transportable prime mover and decreased ammunition signature, will offset the loss in range and lethality provided by a less mobile 155mm.

#### *General Support Artillery in 2030*

Thus far in Ukraine, Russia's artillery employment has focused on mass and area fires instead of precision. They maintain a high proportion of rocket to cannon systems—three multiple launch rocket systems for every four cannons, enabling them to mass at varying ranges (6km to 90km) while providing constant fire support coverage across the battlefield.<sup>25</sup> Currently, the Marine Corps has seven active cannon battalions and one active rocket battalion. This seven to one ratio of cannons to rockets is not the right force structure for the MAGTF of 2030. Today's rocket systems can range approximately seven times further than cannons, can quickly shoot and move, and are strategically mobile. Furthermore, the Marine artillery rocket system of the future must be versatile enough to operate from navy ships and help offset the Anti Access, Aerial Denial (A2AD) threat. By 2030, the Marine Corps must close the rocket to cannon ratio by tripling the number of rocket systems. The increased ratio of GS weapons will further offset the shorter range of a DS 105mm howitzer as well as provide an alternative means of supporting

distributed GCEs. The combination of a howitzer that can get to the fight and increased rocket capacity will ultimately produce the operational reach envisioned by *EF21*.

### *Artillery Munitions of 2030*

The contemporary precision munitions infatuation amongst artillery and maneuver commanders is a direct consequence of 14 plus years of counterinsurgency (COIN) warfare. The operational requirement to prevent collateral damage in a COIN fight has obscured lessons learned from past conflicts. For example, massed fires in Operation DESERT STORM overwhelmed the enemy and provided critical, timely support to maneuver commanders.<sup>26</sup> Twenty-five years later, Russia is successfully massing a versatile munitions inventory that includes thermobaric, Dual Purpose Improved Conventional Munitions (DPICM), scatterable mines, and top attack munitions.<sup>27</sup> Massed area fire artillery has continued relevance. Even so, some have advocated for a complete reliance on precision munitions and a rewrite of doctrine to reflect artillery as a precision-only weapon system.<sup>28</sup> The correct approach, however, is a synthesis of mass and precision. Without the capability to do both well, artillery is simply less effective and less versatile. Therefore, development of a suitable replacement for DPICM should occupy the top munition development priority for Marine artillery.<sup>29</sup>

### ***Doctrine***

Changing artillery's doctrinal focus from the battalion to the battery will necessarily transform artillery into a more responsive, persistent force capable of supporting maneuver units throughout a distributed area. The battery must be organized, trained, and equipped to perform tasks currently doctrinally required at the battalion level. The battery must be capable of receiving tactical missions directly, and then oversee platoons operating independently across a

distributed battlefield. Finally, fire support personnel must be able to support disaggregated infantry battalions. In other words, the battery must perform tactical and technical fire direction, and have the expertise to integrate fire support coordinators at the company level.<sup>30</sup>

### ***Organization***

The future operating environment demands decentralized maneuver units with accompanying fire support assets as well as greater integration of maneuver and fires. The permanent organization of partial Regimental Combat Teams (RCT) will create a synergistic effect on the future battlefield and enable the modularity of MAGTF employment called for by *EF21*. In the Russo-Ukrainian War, Russia permanently assigned artillery batteries to maneuver battalions as “necessitated by the abnormal dispersed nature of combat where the battalions are operating on a much broader front.”<sup>31</sup> Such organization will facilitate the scalable requirement of the *EF21* MAGTF, and enhance fires cohesion with maneuver.

The recommendation to incorporate the artillery battalion under the infantry regiment is similar to the Army’s Brigade Combat Team (BCT) organization. While the incorporation of artillery battalions under the BCT commander gave him more flexibility and empowerment, unintended consequences ultimately persuaded the Army to return to the division artillery (DIVARTY), or separated artillery regiments, task organization. Concerns of the BCT concept centered on training and professional development of artillerymen, as well as roles and responsibilities of the artillery battalion commander and fire support coordinator on the BCT staff.<sup>32</sup> This proposal recognizes these challenges and thus seeks to retain the vital role of the artillery regimental headquarters. Marine artillery regiments would continue to provide fire support coordination staff to the division and retain C2 of general support fires and observation. Furthermore, regiment headquarters would direct artillery training at the division level, develop

and refine doctrine, and serve as the senior artillery headquarters in the division. Their role to resource and train artillery battalions would remain, as would their responsibility to direct regimental fires as required. Thus the Marine division's artillery must be able to task organize from the platoon and battery (most likely scenarios) through the battalion and regiment (most dangerous scenarios). Artillery battalions integrated permanently with the infantry regiments will increase the required synchronization, cooperation, versatility, and modularity needed to fight and win on the future battlefield.

### ***Training and Facilities***

Marine artillery is necessarily different from Army artillery. Exploring service differences is not the intent of this paper, but *EF21* specifies requirements unique to the character of the Marine Corps. Marine artillery requires a school that focuses on the uniqueness of expeditionary artillery fire support. This paper offers three options: first, move the "Marine Artillery School" (MAS) to Twentynine Palms, CA. Cooperation with the Marine Corps Tactics and Operations Group will prove beneficial to greater maneuver and artillery integration. A similar argument exists for a move to Yuma, AZ and cooperation with Marine Aviation Weapons and Tactics Squadron-1. Finally, moving MAS to Quantico, VA will enable fusion and experimentation with Infantry Officer's Course and enhance the combined arms infantry-artillery team. All three options presented are preferable to remaining stagnate at Ft Sill integrated with Army artillery and their very different mission requirements.

### **V. Conclusion**

The authors of *EF21*, in a prelude article to the capstone concept, stipulated it would necessarily stimulate organizational change across Marine Corps military operational specialties.

They wrote, “In this time of increased fiscal austerity and global crisis, we need to break old paradigms...It will require time, and will ultimately change joint and service doctrine, organization, training, material, logistics, personnel, and facilities.”<sup>33</sup> Furthermore, *EF21*’s authors make the point that “air support alone will not satisfy the fire support needs of the littoral maneuver force...Long-range multiple-launch rocket systems or other surface missiles could also be considered as a means to support maneuver...”<sup>34</sup> Some argue that aviation fires are sufficient to fight and win the dispersed, complex future operating environment. However, in order to meet the challenges of that environment, versatile and dispersed organic, 24/7, all-weather, all-network ground support fires are required.

*EF21* provides Marine artillery the conceptual catalyst to look inward at the way it organizes, equips, trains, and fights. This paper provided recommendations for change across Marine artillery to allow it to meet the demands of the future operating environment. These recommendations focused on enhanced observation capability by increased UAV utilization, “all-network” command and control infrastructure, lighter and longer-range weapon systems, and doctrinal change that focuses on the battery vice the battalion as the base artillery tactical unit. This paper did not specify all of the numerous details each proposal requires, but rather intended to underscore the urgent need for reform and provide a broad outline of what that reform should look like. Specific areas for further examination include relocation of Marine Artillery School, UAV incorporation at the Company FiST level (including airspace coordination), assignment of DS artillery to standing RCTs, and development of an MV-22 internally transportable, extended range 105mm howitzer and prime mover.

Table 1. *Critical Concepts of EF21 and Implications for Marine Artillery*

Category (Page ref)	Concepts	Implications: Marine Artillery must be . . .
<b>1. Over-arching EF21 Attributes</b> (7, 11, 33, 42)	1.1) “Expeditionary Force in Readiness”	a. Able to sustain with minimal logistical support and maintain maximum readiness ( <i>simple</i> )
	1.3) “Middleweight Force”	b. Highly strategically (C-130), operationally (ship-to-shore/objective), and tactically (prime mover) mobile ( <i>mobile</i> )
	1.4) “Forcible Entry in Depth”	c. Able to provide scalable precision and mass fires ( <i>versatile</i> )
	1.5) Forward Presence	d. Organized and equipped to support theater security cooperation ( <i>versatile</i> )
<b>2. Crisis Response</b> (6, 11, 17, 23, 32)	2.1) “Global Response Force”	a. Able to organize and direct fires of multiple weapon systems ( <i>versatile</i> )
	2.2) Composite ( <i>ad hoc</i> ) and scalable response	b. Able to rapidly deploy via strategic lift ( <i>mobile</i> )
	2.3) SPMAGTF-CR	c. Able to task organize from platoon (-) through battalion in support of <i>ad hoc</i> crisis response forces ( <i>versatile</i> )
<b>3. Maneuver</b> (11, 14, 31)	3.1) Distributed Battlefield	a. Able to support distributed units ( <i>versatile, distributed</i> )
	3.2) Company Landing Team	b. Able to move with distributed units ( <i>mobile</i> )
<b>4. Amphibious Fires</b> (33)	4.1) Provide all weather fire support to forces maneuvering from the sea in dispersed formations.	a. Able to range distributed landing forces ( <i>distributed</i> )
	4.2) Support multiple entry points.	b. Able to come ashore immediately behind assault forces ( <i>mobility</i> )
	4.3) Employ fires from distributed locations, including ships.	c. Able to fire from naval platforms and support counter A2AD operations ( <i>versatile</i> )
<b>5. Ground Fires</b> (33)	5.1) Provide long-range precision fires	d. Transportable on a variety of naval platforms; minimal logistics footprint on ships ( <i>mobile</i> )
	5.2) Locate targets with increased accuracy	a. Able to provide long-range (i.e., ISO MEF deep fight) and precise (CEP <10m) fires in austere, non-permissive environments ( <i>versatile, simple</i> )
	5.3) Employ UAS for target acquisition	b. Able to locate targets according to the “80-10-10” standard ( <i>versatile</i> )
	5.4) Integrate all systems to neutralize G-RAMM threats.	c. Able to integrate UAS of various capabilities into fire support planning and observation ( <i>versatile</i> )
<b>6. C2</b> (12, 34-35)	6.1) Improved C2 Capabilities	d. Able to integrate airspace and air defense C2 systems ( <i>versatile</i> )
	6.2) Increased challenges to electromagnetic spectrum access	e. Potentially, able to use common air defense and artillery platforms ( <i>versatile</i> )
		a. Able to organize <i>ad hoc</i> artillery units in support of SPMAGTF and MEB operations. ( <i>versatile</i> )
<b>7. Logistics</b> (38-40)	7.1) Expeditionary sustainment	b. Able to C2 distributed artillery units. ( <i>versatile</i> )
	7.2) Seabasing	c. Able to provide timely, accurate fires in an electronically degraded environment ( <i>simple</i> )
		a. Able to sustain distributed artillery positions ( <i>distributed</i> )
		b. Able to self-sustain in austere environments with a minimum of resupply, especially fuel and ammunition ( <i>simple, mobile</i> )
		c. Capable of providing the most artillery support for the least amount of deck space and cargo weight ( <i>mobile</i> )

---

<sup>1</sup> This was an issue recently identified by the Marine Corps' artillery leadership. See the Artillery Operational Advisory Group (AOAG), "AOAG Conference Minutes," unpublished report, October 26, 2015.

<sup>2</sup> See for example: Michael Orzetti, "Extinct Force 21: *EF21*'s existential threat to the Marine Corps," *Marine Corps Gazette*, December 2015, Vol 99 Issue 12; Sydney Freedberg Jr. and Colin Clark, "Hard Corps: Marine's 'Expeditionary Force 21' To Be 'Fast, Austere, & Lethal,' And Expensive," *Breaking Defense*, April 3, 2014, <http://breakingdefense.com/2014/04/hard-corps-marines-expeditionary-force-21-to-be-fast-austere-lethal-and-expensive/>.

<sup>3</sup> See for example: Jeremy Binne, "Grail quest: MANPADS proliferation in the wake of Lybia," *Jane's Defence Weekly*, June 12, 2014; Reuben Johnson, "MH017 mostly likely downed by Russian-backed separatists," *Jane's Defence Weekly*, July 18, 2014; Per Liljas, "Ukraine Separatists Had Surface-to-Air Missiles, Rebel Leader Admits," *Time.com*, July 25, 2014; Maxim Pyadushkin, "Tallying Ukraine's Aircraft Losses," *Aviation Week and Space Technology* 176, no. 21 (June 2014).

<sup>4</sup> This section is an adaptation from a paper the co-author wrote while a student at the USMC Command and Staff College in 2014.

<sup>5</sup> Headquarters United States Marine Corps, *Expeditionary Force 21* (Washington, DC: HQMC, 2014).

<sup>6</sup> Headquarters United States Marine Corps, *Operational Maneuver from the Sea* (Washington DC: HQMC, 1996); Michael Haggee, "A Concept for Distributed Operations," (Washington, DC: HQMC, April 2005); James Conway, "A Concept for Enhanced Company Operations," *Marine Corps Gazette*, December 2008, Vol. 92 Issue 12, 57-61; N. W. Tyson and K. J. Glueck, "Disaggregated Amphibious Ready Group/Marine Expeditionary Unit Concept of Employment," US Fleet Forces Command and Combat Development and Integration: Norfolk and Quantico, 2014.

<sup>7</sup> The authors use the following rough definitions: "strategic mobility" includes lift via aircraft (C-130 and larger) and amphibious or merchant shipping; "operational mobility" includes lift via amphibious shipping, amphibious, connectors, helicopters, and tilt-rotor aircraft; and "tactical mobility" includes movement via helicopters, tilt-rotor aircraft, and prime movers (i.e., trucks).

<sup>8</sup> Robert Schmidle, "Distributed Operations: From the Sea", *Leatherneck Magazine*, July 2004.

<sup>9</sup> *Expeditionary Force 21*, 31.

<sup>10</sup> Mary Ellen Connell and Ryan Evans, "Russia's 'Ambiguous Warfare' and Implications for the U.S. Marine Corps," Center for Naval Analysis, May 2015, 11.

<sup>11</sup> Phillip Karber "Lessons Learned" from the Russo-Ukrainian War (Personal Observations)," The Potomac Foundation, July 6, 2015, 10-15.

<sup>12</sup> Connell and Evans "Russia," 12, 16.

<sup>13</sup> In this sense, "precision" is a target location error (TLE) of 10m or less; "near-precision" is a TLE between 10 and 50m; and "area" or "non-precision" is a TLE of greater than 50m. The authors apply the same terms and standards to weapon system accuracy and circular error probable (CEP). See William Turner, "State of the Field Artillery," *Fires*, January-February 2015.

<sup>14</sup> Israel's creative use of ground and aviation fires in Gaza is worth additional research. The Israeli Defense Force is also expanding its precision artillery capabilities in response to lessons learned. See David Johnson, *Hard Fighting: Israel in Lebanon and Gaza*, Santa Monica: RAND Corporation, 2011: 132; Sachar Helwig, "The Return of Israeli Artillery," *Fires* (March-April 2009); Katz Yaakov, "Israel draws up plans for a future imperfect," *Jane's Defence Weekly*, December 20, 2010, and "IDF aims for precision guided mortar system," *Jane's International Defence Review*, August 8, 2011; Geo-Strategy Direct, "Israel preparing next-generation artillery platform with 40-km range," *Geo-Strategy Direct*, September 5, 2012.

<sup>15</sup> Deep, close, and rear areas of the battlefield are fundamental elements of battlespace framework described in multiple doctrinal publications, to include MCDP 1-0 *Marine Corps Operations*.

<sup>16</sup> For a historical analysis of aerial observation in the U.S. Army field artillery, see Boyd Dastrup, "Aerial observation gives 'new eyes' to target acquisition," *Fires* (Nov-Dec 2015): 31-45.

<sup>17</sup> For example, see Capt Courtney Boston, "Creating Ground Strike Sections: An *EF21* Imperative," *The Marine Corps Gazette*, Vol. 99 No. 12, 31.

<sup>18</sup> Karber, "Russo-Ukrainian War," 12-13, 19.

<sup>19</sup> E. J. Rowse and L. S. Bethards, "FDC Needs Modernization," *Marine Corps Gazette* 39, no. 4 (April 1955): 12.

<sup>20</sup> Jonathan Dunne, "Enhanced Artillery Battery Operations," *Marine Corps Gazette* 94, no. 2 (2010): 36.

<sup>21</sup> Information supporting this analysis derived from a review of after-action reports, load plans, and lessons learned analyses from the Marine Corps Center for Lessons Learned.

---

<sup>22</sup> *Expeditionary Force 21*, 5.

<sup>23</sup> One arms manufacturer is currently testing a 105mm howitzer with a range of 36km. *IHS Jane's* "Denel Land Systems 105 mm Light Experimental Ordnance (LEO)," Sep 10, 2014, <https://janes-ihs-com.lomc.idm.oclc.org/Janes/Display/1501501>.

<sup>24</sup> Boyd L. Dastrup, *Modernizing the King of Battle, 1973-1991* (Fort Sill, Oklahoma and Washington, DC: The U.S. Army Center of Military History, 2003), 47; Phillip Hughes, *The Marine Corps Artillery Regiment: A Structure for the 1990s* (Maxwell, AL: Air War College, 1988).

<sup>25</sup> Karber, "Russo-Ukrainian War," 12-13, 16-17.

<sup>26</sup> Dastrup, *Modernizing the King of Battle*, 57.

<sup>27</sup> Karber, "Russo-Ukrainian War," 12-13, 16-17.

<sup>28</sup> Michael Forsyth, "Averting a Disaster," *Fires* (Nov-Dec 2012), 10-12.

<sup>29</sup> U.S. policy makers have opted to eliminate the primary anti-armor munition—DPICM—from its inventory due to a propensity to produce duds. This dud rate has led to unintended collateral damage and political consequences in recent COIN environments. However, its elimination without a replacement severely reduces U.S. anti-armor capability in future wars. The authors assume that DPICM will remain a political non-starter for the foreseeable future.

<sup>30</sup> Dunne, "Enhanced Artillery Battery Operations," 33-39.

<sup>31</sup> Karber, "Russo-Ukrainian War," 19.

<sup>32</sup> Peter Vangjell, "Green Tab to Green Tab Fire Support: The BCT Commander's Best Fire Support Asset," *Infantry* 97, Issue 3 (May/June 2008), 18-20.

<sup>33</sup> Doug King, *et al*, "Forward and Ready for Crisis," *Proceedings* 139, Issue 11 (Nov 2013): 27-29.

<sup>34</sup> *Ibid*, 28.

## BIBLIOGRAPHY

- Benson, Ryan P. "The Expeditionary Fire Support System." *Marine Corps Gazette* 93, no. 11 (2009): 90.
- Dastrup, Boyd. "Aerial observation gives 'new eyes' to target acquisition." *Fires* (Nov-Dec 2015): 31-45.
- Dastrup, Boyd. *Modernizing the King of Battle, 1973-1991*. Fort Sill, OK and Washington, DC: U.S. Army Center of Military History, 2003.
- Dastrup, Boyd. *The Field Artillery: History and Sourcebook*. Westport, CT: Greenwood, 1994.
- Dunne, Jonathan P. "Enhanced Artillery Battery Operations" *Marine Corps Gazette* 94, no. 2 (2010): 33.
- Connell, Mary Ellen and Ryan Evans. "Russia's 'Ambiguous Warfare' and Implications for the U.S. Marine Corps." *Center for Naval Analysis*, May 2015, 11.
- Echevarria II, Antulio J. *After Clausewitz: German Military Thinkers Before the Great War*. Lawrence, Kansas: University Press of Kansas, 2000.
- Emmanuel, Gordon; Gray, Justin. "The MAGTF: A Continuing Dialogue" *Marine Corps Gazette* 98, no. 8 (2014): 66.
- Field, Walker. "Marine Artillery in the Battle of an Nasiriyah." *Marine Corps Gazette* 88, no 6 (2004).
- Friedman, B. A. "Evolving Marine Artillery: Utilizing the Triad of Fires in the 21st Century." *Fires* (Jan-Feb 2012): 52-57.
- Forsyth, Michael. "Averting a Disaster," *Fires* (Nov/Dec 2012): 10-12.
- Grice, Michael D. "Resuscitating the King." *Marine Corps Gazette* 92, no. 10 (2008): 20.
- Gudmundsson, Bruce. *On Artillery*. Westport, CT: Praeger, 1993.
- Headquarters, U.S. Army. *The United States Army Functional Concept for Fires: 2016-2028*. TRADOC PAM 525-3-4. Ft. Monroe, VA: Training and Doctrine Command, 2010.
- Headquarters, U.S. Army. *The U.S. Army Operating Concept: Win in a Complex World*. TRADOC PAM 525-3-1. Ft. Eustis, VA: Training and Doctrine Command, 2014.
- Headquarters U.S. Marine Corps. *Operational Maneuver From the Sea*. M CCP 1. Washington, DC: HQMC, 1996.
- Headquarters U.S. Marine Corps. *Expeditionary Force 21*. Washington, DC: HQMC, 2014.
- Heinl Jr., R. D. "Naval Gunfire Support in Landings." *Marine Corps Gazette* 97, no. 4 (2013): 37.
- Hoerster, Frank, and Boulet, Jeffrey. "M777 Lightweight Howitzer Gives the Marine Corps a True Expeditionary Fire Support System." *Marine Corps Gazette* 88, no. 6 (2004): 39.
- Hollis, Patricia Slayden. "Fixing the Marine Artillery." *FA Journal* 5, no. 5 (Sep- Oct 2000): 3.

- HT Media Ltd. "Expeditionary Fire Support System Teams Conduct Amphibious Assaults, Aerial Raid Training." (Aug 16, 2014). *US Fed News Service*. ProQuest.
- Hughes, Phillip. *The Marine Corps Artillery Regiment: A Structure for the 1990s*. Maxwell, AL: Air War College, 1988.
- Johnson, Anthony J.; Mogensen, Kurt; Peery, Todd; Fears, Chris; and Tate, Andrew. "Marine Artillery." *Marine Corps Gazette* 95, no. 10 (2011): 51.
- Karber, Phillip. "Lessons Learned from the Russo-Ukrainian War (Personal Observations)." *The Potomac Foundation*. July 6, 2015: 10-15.
- King, Doug, Colonel; Phillips, Ford, Lieutenant Colonels; Filson, Sean; Clark, Robert; Adams, John K; Wardman, Gregory; McHaty, Rodrick; Kamb, Timothy, Major. "Forward and Ready for Crisis". *Proceedings* Volume 139, issue 11 (Nov 2013): 24.
- Knox, Macgregor and Murray, Williamson, eds. *The Dynamics of Military Revolution 1300-2050*. Cambridge: University Press, 2001.
- Lasswell, James A. "What is the fire support answer to OMFTS?" *Marine Corps Gazette* 83, no. 7 (July 1999): 31.
- Lewis, James C. "Is the King Dead?" *Marine Corps Gazette* 94, no. 2 (2010): 41.
- Lindsey, Forrest R. "Focus on Expeditionary Fire Support." *Marine Corps Gazette* 82, no. 7 (1998):18.
- Marine Corps Warfighting Lab and Marine Corps Artillery Detachment, US Army Field Artillery School. *Enhanced Battery Operations*. Quantico, VA: Marine Corps Warfighting Laboratory, 2009.
- Mazzara, Joseph N. "Artillery in the Foothills." *Marine Corps Gazette* 97, no. 12 (2013): 62.
- McConachy, Bruce. "The Roots of Artillery Doctrine: Napoleonic Artillery Tactics Reconsidered." *The Journal of Military History*, Vol. 65, No. 3 (Jul., 2001): 617-640. *Society for Military History Stable*. <http://www.jstor.org/stable/2677528>.
- McDaniel, Lance. "The Challenge of Artillery Reset." *Marine Corps Gazette* 94, no. 5 (2010): 74.
- McFadden, Jennifer. "Fires in the United Kingdom: an Overview of the Presentation by Brigadier Richard Haldenby." *Fires* (Jul-Aug 2012): 46-49.
- Melillo, Michael R. "Cannon Cockers at War: The 11th Marines in Operation Iraqi Freedom." *FA Journal* 8, no. 5 (2003): 28-32.
- Nitchenske, Stefan. "Technology Enablers of the U.S. Marine Corps." *Naval Forces*, V/2013: 20. *Monch Publishing Group*, ProQuest.
- Norris, Mark. "Capstone Concept for Joint Operations Joint Force 2020: An overview of the presentation by U.S. Marine Corps Lt. Gen. George Flynn." *Fires* (Jul-Aug 2012): 25-27.
- Officers of Golf Company, 2nd Battalion, 5th Marines. "It's Not the Artillery's Fault." *Marine Corps Gazette* 97, no. 3 (2013): 40.
- Officers of Battery R. 5th Bn 11th Marines. "Advanced Force HIMARS: An amphibious solution to antiaccess/area denial." *Marine Corps Gazette* 99, no. 3 (2015).

- Oppenheimer, Andy. "Artillery Systems-Faster, Lighter, Stronger." *Military Technology-MILTECH*, 7/2013: 12. Monch Publishing Group. ProQuest.
- Pengelly, Rupert. "Firing for effect - modern artillery strives to deliver." *Jane's International Defense Review* 36, no. 10 (2003): 26.
- Rowse, E. J. and L. S. Bethards. "FDC Needs Modernization." *Marine Corps Gazette*, 39, no. 4, (April 1955): 12-13.
- Russo, Joseph J. "3 x 2 Distributed Rocket Artillery Operations." *Fires* (Mar-Apr 2010): 48-51.
- Shimko, Keith L. *The Iraq Wars and America's Military Revolution*. Cambridge: Cambridge University Press, 2010.
- Turner, William. "State of the Field Artillery." *Fires* (Jan-Feb 2014): 3-4.
- Tyson, N. W. and K. J. Glueck. *Disaggregated Amphibious Ready Group/Marine Expeditionary Unit Concept of Employment*. Norfolk and Quantico: United States Fleet Forces Command, Headquarters Marine Corps Combat Development and Integration, 2014.
- Vangjell, Peter. "Green Tab to Green Tab Fire Support: The BCT Commander's Best Fire Support Asset." *Infantry* 97, no. 3 (May/June 2008), 18-20.
- Waller Jr., Thomas G. "The Field Artillery Battery." *FA Journal* 6, no. 1 (2001): 8.
- Wilson, P. E. "An Unexpected Force of Artillery." *Marine Corps Gazette* 44, no. 7 (1960): 36-39.