REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From - To)*
05/23/2019	Master's of Operational Studies	JUN 2018 - JUN 2019

4. TITLE AND SUBTITLE
Setting Conditions to Solve Problems: Making a Marine Corps that Can Build Resilient Energy Chains

5a. CONTRACT NUMBER
N/A

5b. GRANT NUMBER
N/A

5c. PROGRAM ELEMENT NUMBER
N/A

6. AUTHOR(S)
Eckert, Andrew, C, Major, USMC

5d. PROJECT NUMBER
N/A

5e. TASK NUMBER
N/A

5f. WORK UNIT NUMBER
N/A

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
USMC School of Advanced Warfighting
Marine Corps University
2044South Street
Quantico, VA 22134

8. PERFORMING ORGANIZATION REPORT NUMBER
N/A

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

10. SPONSOR/MONITOR'S ACRONYM(S)
Dr. Michael Baskin

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

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release, distribution unlimited.

13. SUPPLEMENTARY NOTES

14. ABSTRACT
The future operating environment proposed in the 2016 Marine Operating Concept (MOC), which includes a contested maritime domain, presents considerable challenges to the survivability of the ACE's energy chain. The energy chain is more than the supply chain. It incorporates all aspects of energy, such as engine efficiency or transmission methodology. In order to ensure that material, organizational, and conceptual solutions are created and implemented to address energy chain vulnerabilities, the Marine Corps must integrate holistic energy planning into operational planning teams, establish dedicated energy assurance officers, and incorporate energy planning considerations into its planning schools.

15. SUBJECT TERMS
Energy; Aviation; Organizational Culture; MCPP; Contested Maritime Environment;

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			USMC School of Advanced Warfighting
					19b. TELEPHONE NUMBER *(Include area code)*
Unclass	Unclass	Unclass	UU	31	(703) 432-5420 (Admin Office)

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

Setting Conditions to Solve Problems:

Making a Marine Corps that Can Build Resilient Energy Chains

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

AUTHOR:

Major Andrew C. Eckert, USMC

AY 2018-2019

Mentor: Dr. Michael Baskin, Professor of Energy Studies

Approved: Michael Baskin

Date: 20 May 2019

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.

Introduction

The Marine Expeditionary Unit of 2025 is estimated to consume over one million gallons of fuel over five days of combat operations.[i] That is the same amount of energy consumed by an American city of 500,000 residents during the same amount of time.[1] Energy is a driving force behind the Marine Air Ground Task Force's (MAGTF) speed, range, and lethality. This fact is the most evident in the Aviation Combat Element (ACE), which consumes the largest amount of energy in the MAGTF.[2] The ACE's capabilities are necessary to support the MAGTF across the spectrum of military operations, and the availability of energy is necessary to support the ACE. The future operating environment proposed in the 2016 Marine Operating Concept (MOC), which includes a contested maritime domain, presents considerable challenges to the survivability of the ACE's energy chain.[3] In order to ensure that material, organizational, and conceptual solutions are created and implemented to address energy chain vulnerabilities, the Marine Corps must integrate holistic energy planning into operational planning teams, establish dedicated energy assurance officers, and incorporate energy planning considerations into its planning schools.

The energy chain is more than the supply chain. It incorporates all aspects of energy, such as engine efficiency or transmission methodology. The energy chain should be understood as the interrelation of generation, transmission, transport, storage, and usage of energy in any form. Disruption of the energy chain can prevent the effective employment of any Marine capabilities at the required time and place, especially aviation related capabilities.

The current concept for energy chain maintenance has evolved in a manner that makes it especially vulnerable to interruption. Additionally, energy requirements for the ACE are unique,

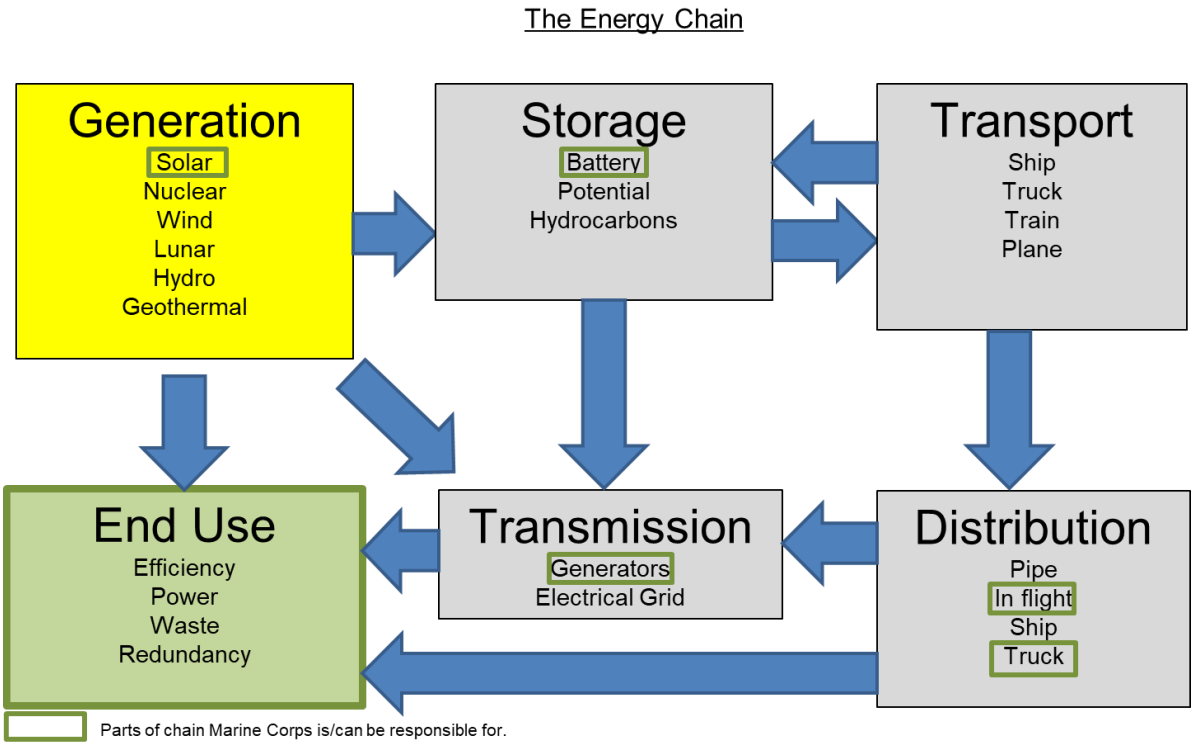
[i] Calculations made using updated MAGTF Power and Energy Model v5.0.1 Beta with Maritime Expeditionary Warfare Integration Division's original 2024 MEU 24 January 2019.

are expected to rise over the course of the next fifteen years, and are more complex than those for the rest of the MAGTF. Since disruption of the energy chain will decrease Marine Corps' utility to the Joint Force as an expeditionary force in readiness, it is paramount the service is prepared to mitigate the risk in contested maritime environments.

Energy Chain Vulnerability Background

The energy chain can be described as the uninterrupted flow of energy from its point of origin, such as solar, lunar, nuclear, or geothermal, to the platform that ultimately uses it. While every segment of the energy chain affects the others, military planners typically focus on those components which are most malleable when analyzing effectiveness, efficiency, and resiliency. Changing oil drilling policies in Texas, for example, are most likely outside the scope of military planning. For plans involving the ACE, the energy chain segments of concern begin with procurement of petroleum from commercial vendors, which is currently done by the Defense Logistics Agency (DLA). The DLA is the Department of Defense's assigned organization for obtaining petroleum from the private sector to meet operational requirements.[4] Once purchased, the petroleum is transported to the requisite theater, typically by commercial merchantmen, railroads, and trucking. Once in theater, it is turned over to either the Army, Air Force, or Navy, who will then take care of theater level long haul transportation and bulk storage.[5] Finally, the petroleum is transferred to the tactical unit, in this case the Marine Corps, where it is temporarily stored, transported short distances for distribution, and then used for either electrical generation or for internal combustion engines. This conceptual energy chain takes different forms in different environments, but all of these components are present (Figure 1).

Figure 1: The Energy Chain



The contested maritime environment brings multiple new threats to this energy chain. These threats are especially notable because of adversaries' ability to interrupt the chain at a time and place of their choosing, from procurement all the way through tactical movement and storage. Technological advancement and propagation have allowed the adversary to contest locations that the United States had previously considered permissive with a precision and persistence that the US military has not recently planned for.[6] Additionally, the networked nature of civilian petroleum infrastructure and transportation makes them especially vulnerable to cyber warfare, thus bringing the possibility of interruption even prior to procurement.[7] The future environment that the MOC portrays gives an adversary a significant number of options to interrupt the energy requirement for the ACE, and the method of maintaining this requirement has evolved to be especially vulnerable.

The evolution of global supply chain management--which includes part of the energy chain--has been about efficiency since World War II. The establishment of the Munitions Board in 1947 was the Department of Defense's first attempt to centralize and standardize supply chain practices.[8] This process, which eventually culminated in the founding of the DLA in 1961, sought to eliminate waste and effort duplication. Up through 1991, DLA's efforts continued to account for adversaries' abilities to interrupt the supply chain, thus balancing efficiency with resiliency. However, since then, repeated conflicts in localized theaters have allowed the supply chain to achieve exceptional efficiency, but with the requirement of a permissive environment up to the point where DLA connected to theater level logistics. Even after entry into the theater, an adversaries' ability to disrupt the supply chain has been transitory, and typically only along ground transportation routes. While this ability may have cost lives and equipment previously, the ability to completely interrupt the operational flow for a long duration was non-existent. Therefore, the concept for supply chain management that was successful in recent military operations, such as Iraq or Afghanistan, will not necessarily be successful at preventing interruption in the future operating environment.

Though energy chain interruptions affects the entire MAGTF, the ACE is at even greater risk for four reasons. First, aviation is most dependent on energy and has the greatest concern with potential energy chain interruption since it requires seventy-eight percent of the MAGTF's operational energy.[ii] Second, fuel needs for the ACE are projected to increase in the future.[iii] Third, aviation has a much greater reliance on energy chain resiliency through chain

[ii] Operational energy is defined as "the energy required for training, moving, and sustaining military forces and weapons platforms for military operations… (including) energy used by tactical power systems and generators and weapons platforms." Marine Corps Expeditionary Energy Office. *Marine Corps Expeditionary Energy Strategy and Implementation Plan*. Headquarters, US Marine Corps. 2009, 18 and 71.

[iii] F-35 burns 52% more fuel than the platform it replaces as per G. T. Zerr, Capt USMC. *USMC Expeditionary Energy Officer: Energy Analysis Quick Guide 2018.1.1*. (Expeditionary Energy Office, Quantico, VA, January 12, 2018), PowerPoint presentation. Slide 7.

management because of the unique requirements for aviation fuel. This requirement means that methods for addressing energy chain vulnerabilities in support of ground units are not necessarily replicable for the ACE. For example, a ground combat element (GCE) unit may be able to replace a generator with solar panels, or could forage for local diesel, if necessary, to fuel its trucks. These options are not available to the ACE because the energy requirements for aircraft necessitate a high density energy storage in the form of specific petroleum products.[9] Lastly, the large number of fuel distribution methods, from air bases to Navy ships to Air Force tankers, requires greater consideration and coordination than for any other part of the MAGTF.[iv] This is why the problem of energy chain resiliency is most acute and most complex in the context of the ACE's requirements.

The problem is that, because of years of optimizing energy chain efficiency, the current concept for fulfilling the ACE's energy needs was not developed to mitigate the vulnerabilities inherent in the contested maritime environment. Adversaries have a greater ability to interrupt the flow of energy from origination to usage. The concept for ensuring energy chain integrity, specifically through global supply chain management, has not been designed for the future operating environment. Marine Corps aviation's energy chain is especially vulnerable to interruption, will be even more so in the future, has unique energy requirements that cannot be adequately filled by primary energy sources, and is the most complex in the MAGTF. Therefore, it is especially in need of tailored material, organizational, and conceptual solutions to the energy chain vulnerabilities in order to win in the future contested maritime environment.

[iv] The ACE energy chain includes multiple avenues for aircraft to get fuel. Inside of the MAGTF, the Marine Wing Support Squadron runs storage and distribution locations, but on any given mission an aircraft may receive fuel from any number of distributers. This is contrasted with the other parts of the MAGTF, where the preponderance of their fuel is controlled by Marines, predominantly in the Logistic Combat Element, for distribution. Information is based on Energy and Innovation Scholars Seminar curriculum.

To facilitate its ability to identify and mitigate a problem, an organization should optimize its planning, personnel, and training processes to account for the specific nature of the problem. The challenge of identifying energy chain vulnerabilities and developing mitigations will not have a single or simple solution. Nor will any solution guarantee that the Marine Corps will be prepared to address additional adversarial advancement in the future.

Instead of focusing on individual technical or conceptual changes in an attempt to solve specific energy chain vulnerabilities, the Marine Corps needs to focus on making targeted modifications within the organization that will facilitate planners and leaders identifying and overcoming the problems. The following sections will demonstrate why similar modifications in different situations and for different problems have been successful, and then how they could be applied to energy chain planning. Additions to the format and execution of the planning process offer the greatest opportunity to reduce energy chain risk for the ACE and Marine Corps in the future contested maritime environment.

Consider the Energy Chain Up Front

Targeting specific aspects of a problem, like energy, from the beginning of planning increases the likelihood of developing holistic solutions. It ensures that the problem is incorporated into each step, from conceptual to detailed planning.[v] Capable planners will eventually account for most problems and considerations, but studying issues from the outset affords the greatest amount of latitude for solutions. The further into the planning process a problem is introduced, the more a planner is subconsciously affected by cognitive biases and the fewer options available to them without completely rewriting the plan.[10] Therefore, planners

[v] The Marine Corps Planning Process includes six steps, but these steps are iterative and done at various levels of the planning hierarchy. MCWP 5-1 *Marine Corps Planning Process* defines the differences between conceptual, functional, and detailed planning.

who account for specific issues of the operation or campaign up front are more likely to adequately address them, and, if the topics are critical, avoid defeat. Conversely, failure to account early on for requirements and capabilities will most likely lead to inadequate plans that do not address the problems. Contrasting the planners' approaches to different planning situations demonstrates the difference between early and late focus on specific planning challenges in the planning process.

When American forces started planning for the Tinian invasion in the Pacific in 1944, concerns about opposition for the landing beaches were top priority.[11] Experiences at Tarawa were still fresh in the minds of planners, and they wished to avoid a significant enemy presence in the vicinity of the landing.[12] This meant that concerns about landing beach characteristics and location relative to enemy troop concentrations were essential, at times trumping other considerations. The overall objectives on the island could have convinced the planners to instead land on the southern coast closer to Tinian Town.[13] Instead, the northern coast was chosen because its beaches were lightly defended. Focusing on the beaches early in the planning process also meant that careful study of each beach identified shortcomings. The planners were able to effectively develop mitigating actions and concepts.[14] In some cases, this actually resulted in actions that were contrary to previous experience with amphibious landings in the Pacific. The planners were ultimately able to adapt effectively only because they considered the problem at the beginning of planning process.

Contrast this previous experience with the experience of US Army VI Corps during Operation Dragoon in Southern France in 1944. As General Truscott, Commander of VI Corps, explained in planning the landings, initial considerations for overcoming beach obstacles, specifically underwater mined obstacles, had not been thoroughly examined early on in the

planning process.[15] The commanding admiral for the amphibious task force, in fact, thought the entire problem "somewhat exaggerated."[16] Though the planners eventually developed solutions, considering the problems late in the planning process meant that the operational plan was not seriously changed to overcome concerns of an opposed landing. On the day of execution, unexpectedly heavy opposition and problems clearing obstacles contributed to one of his regiments being put ashore at a different beach than planned.[17] Unlike at Tinian, the operational approach and objectives were of primary concern. The beach selection was secondary and considered later in the process, meaning the problems associated with them needed to be mitigated rather than avoided. Otherwise, as eventually happened, the forces would be unable to land in their assigned areas. This example does not prove that the beaches should always be focused on early in the planning, but instead it demonstrates the different results when planners focus on an aspect of an operation, such as landing beaches, early on and when they do not.

A more contemporary planning process example can be found in the evolution of civil-military operations and post conflict planning in the first decade of the twenty-first century. As the United States military planned for the invasion of Iraq from 2002 through to the actual commencement of hostilities, very little focus was applied to planning for post-conflict stabilization or how U.S. Armed Forces' actions during execution of Phase I, "deter", through III, "dominate", would affect Phase IV, "stabilize."[18] A small group of planners were set aside to think about the problem, but it was not a focus for overall planning.[19] This was different than planning that had been conducted before 2002, especially when General Anthony Zinni, USMC, had been the Commander of Central Commander (CENTCOM).[20] Part of the difference was that General Zinni had experience in conflicts requiring civil-military operations, while the then current CENTCOM Commander, General Franks, had not.[21] This difference meant that post

conflict stabilization was de-emphasized in early planning, and the eventual direction of the CENTCOM staff to plan for stability and reconstruction efforts came too late in the planning process to allow for thorough solutions to the multitude of issues.[22]

Following the failure of the plan, known as Cobra II, to effectively solve problems associated with civil-military operations and post conflict resolution, the military services, and specifically the Marine Corps, focused on ensuring future planning efforts would be more successful. One action taken by the service was the institutionalizing of the Green Cell in the Marine Corps Planning Process in 2010.[23] Currently from the outset of planning, every operational planning team (OPT) is expected to consider appointing an individual to research, articulate, and integrate all issues and considerations associated with the civilian population and how military actions would be influenced by it.[24] This is not to say that planning for civil-military operations had never been done before formalizing the Green Cell. From as far back as the 1990s, General Zinni had already spoken at length about why leaders need to incorporate civilian issues into their plans.[25] But as Cobra II demonstrated, incorporating civil-military operations and civilian considerations was overly dependent on the personal experiences of the commander and staff. By making the Green Cell a doctrinal tool, it increased the likelihood that civil military operations would be included in the plan as opposed to its inclusion being based on personal experience.

Using a model similar to the Green Cell, the Marine Corps needs to establish an Energy Assurance Cell within the Marine Corps Planning Process in order to provide a doctrinally reinforced structure and model to ensure the energy chain is prioritized from the outset. Currently, the planning process fails to focus on energy chain vulnerabilities at the beginning of problem framing and lacks the tools to holistically analyze and communicate risk to

commanders.[26] This cell would be established inside of the OPT, and would be required to holistically address the energy chain for all of the various parts of the MAGTF, then integrate these considerations through conceptual, functional, and detailed planning. As opposed to simply considering supply chain management and planning to meet requirements generated after the establishment of the concept of operations, the Energy Assurance Cell would view the problems up front from multiple perspectives.

During initial design and problem framing, the cell would identify the unique contextual considerations, how different operational approaches may impact expected energy requirements, and capabilities within the allocated forces. The cell would identify vulnerabilities in the entire energy chain and present efficiency and effectiveness considerations as part of course of action generation, war gaming, comparison and decision (Figure 2). Through risk analysis methodology, the Energy Assurance Cell would look across all echelons within the energy chain, from end usage through theater logistics to DLA support, in order to understand how those aspects of the chain affect the situation.[vi] By focusing on energy chain related information, the cell increases the commander's awareness of decision points and risk connecting energy and mission accomplishment.

[vi] For risk analysis methodology, see CJCSM 3105.01 *Joint Risk Analysis*.

Figure 2: Proposed Energy Assurance Cell actions during Marine Corp Planning Process

MCPP Step	Energy Assurance Cell Action
Problem Framing	The purpose of the Energy Assurance Cell is to consider the entire energy chain in order to promote a better understanding of how the problem and courses of action influence and are influenced by the energy context of the environment. This may include friendly, enemy, and civilian capabilities and limitations. At a minimum, the Energy Assurance Cell estimates the vulnerabilities and possible conceptual or technical solutions to energy problems in the courses of action.
Course of Action Development	Energy Assurance Cell integrates Blue, Red, and Green energy chain considerations, advising all three about opportunities, vulnerabilities, and mitigations that can be incorporated into the courses of action.
Course of Action Wargaming	Energy Assurance Cell provides an assessment on each turn as to whether Blue and Red actions are feasible given the energy chain considerations or if additional mitigations are necessary.
Course of Action Comparison and Decision	Energy Assurance Cell provides input as to the opportunities, vulnerabilities, and risks associated with each course of action as it relates to the energy chain.
Orders Development	Energy Assurance Cell provides input to Annexes B, C, D, G, V, and W to ensure energy chain concept is integrated across all warfighting functions.
Transition	Energy Assurance Cell liaisons with higher, adjacent, and subordinate headquarters for purposes of integrating energy chain planning.

The Energy Assurance Cell could be as robust or lean as necessary based on the given situation (Figure 3). Not every situation would require significant investment of personnel and resources, but simply making it a doctrinal tool, like the Green Cell, increases the likelihood that even a single planner assigned the billet will identify energy chain vulnerabilities early in the planning process and more effectively mitigated.

Figure 3: Proposed Energy Assurance Cell Organization

Energy Assurance Cell Organization	Energy Assurance Cell Outputs
Temporary or Permanent Scalable Reach back ability Optimal Membership - Energy Assurance Officer - G-2 Representative - G-4 Representative - GCE Representative - LCE Representative - ACE Representative - Army Liaison - Navy Liaison - Airforce Liaison - DLA Liaison	Energy Chain Vulnerability Assessment Energy Chain Shortfalls and Limitations COA Energy Comparison Concept for Energy Assurance

Opponents to adding an Energy Assurance Cell to the OPT would argue that the current OPT construction is sufficient to identify and mitigate energy chain concerns. While every aspect of the energy chain is considered by various members of the OPT, these considerations are initially done in isolation of one another. For example, a maneuver representative may consider the platform requirements, while the logistics representative thinks about storage and distribution, and the force protection representative is thinking about protecting fuel dumps and lines of communication. There is not, however, any codified part of the OPT structure that thinks about all of these aspects holistically from the beginning of planning and investigates their interrelated nature as they affect the plan. Much like civilian considerations needed replacement of ad-hoc attention with doctrinally support tools within the OPT to ensure a complete appreciation of the problem from the beginning, so the energy chain needs dedicated structure within the planning process to avoid planners failing to anticipate issues in respect to energy.

The Right People in the Room

Making the energy chain an added focus in the planning process will only be partially successful in mitigating vulnerabilities if the necessary personnel with the appropriate characteristics are not part of the team. In Jim Collins' book *Good to Great,* the author talks about getting the right people on the bus in order to ensure that an organization is more capable of adapting and innovating.[27] The natural inverse of this argument is that lacking the correct people decreases the organization's likelihood of successfully addressing changing circumstances. Getting the right people is more than just including high quality professionals. It necessitates having representatives with appropriate experience and standing within the organization that can effectively advocate for a particular issue within the planning effort and help develop solutions.

People experienced in a subject are more likely to be able to successfully innovate and adapt to problems having to do with that subject. While this may seem common sense, it has important implications for planning team composition. Keith Sawyer's book *Group Genius* highlighted how psychologist, Dr. Mihaly Csikszentmihalyi's, research in professional creativity demonstrated that the most important factor connected to problem solving was the link between the challenge and the person's expertise.[28] When you force someone to solve a problem outside of their experience, they are less successful. Additionally, solutions are typically developed in the framework of the problem solver's understanding of the interrelated nature of the world, or schema.[29] In order to optimize a planning team to address a certain problem, it is imperative that the team includes a person highly experienced with similar problems.

This experience brings the information to the table, but in order to ensure it is incorporated, the person with the experience must have high enough standing within the group. Research done by psychologists at the University of Neuchatel, Switzerland, suggests that even in non-military groups attempting to execute a task, an informal hierarchy emerges automatically. More importantly, they were able to demonstrate that the stronger the link between the perceived power of the task-competence individuals in the group and the task to be completed, the better the group's performance.[30] Within the United States military, this human propensity to form hierarchies is further reinforced by the rank structure. This means that the level of positive influence a planning team member has is related to their rank relative to the other members of the team. Therefore, to ensure the planning member who has experience with tackling a particular problem is appropriately influential within the group, they must hold the appropriate rank.

To address the energy chain problem, given the necessity of experience and appropriate rank, the Marine Corps must establish energy assurance limited duty officers. These officers would commission from the chief warrant officers within the bulk fuel military occupational specialty (MOS). Though other MOSs such as supply and logistics are tangentially related to the energy chain, no other group focuses more on understanding the entirety of the energy chain than bulk fuel officers. They are required to comprehend both the technical requirements as well as the conceptual strengths and weaknesses of procurement, transportation, storage, and usage. The issue is that, though these subject matter experts already exist, there are not enough to ensure their upfront and in-depth involvement in all MAGTF operational planning at all levels; when they are involved, their standing within the operational planning teams is potentially compromised by their position in the group hierarchy due to their low rank.[31] In most cases,

plans have already been built before the bulk fuel officer is brought in to flush out the energy chain coordination.[32] It is important to note that the Marine Corps has established limited duty company and field grade officers in other communities, like combat cargo, to guarantee considerations related to their field are appropriately advocated for.[33] Energy assurance officers would provide that same advocacy for energy chain concerns, leaving bulk fuel officers to primarily focus on the technical planning and coordination.[vii] Some additional training would be necessary to round out the complete energy chain understanding, such as more thorough comprehension of non-petroleum based energy generation and storage, but this training would be additive to the expertise they already possess.[viii]

A counter-argument to adding an energy assurance officer is that the Marine Corps already has the right people at the right rank to plan for energy. However, this argument is invalid because these two characteristics do not exist in a single person. Bulk fuel officers, who already have the technical expertise, are too low in rank to guarantee that their advocacy is effective in OPTs, or when advocating for material and conceptual changes to the Marine Corps. Logisticians, who have the rank, lack the same holistic experience and training that would make them most effective. Additionally, logisticians are generalists, changing their focus multiple times over the course of their careers, from motor transport to maintenance to medical planning.[34] The broad array of different functions they are required to know does not lend itself

---

[vii] There are 41 CWO Fuels Officers in the Marine Corps at any given time. In order to support the proposed concept, the MOS would require an expansion, ensuring availability of enough CWOs to become LDOs. There should be sufficient LDOs to fill billets on all MEF, MEB, and MEU staffs, at planning schools, and at headquarters Marine Corps. Due to the low density of bulk fuel enlisted Marines, the MOS could be combined with the utilities occupational field in order to increase the staff non-commissioned officer ranks before accession into the CWO and LDO ranks. Like bulk fuel Marines, the utilities occupational field is more involved in energy chain planning than any other part of the Marine Corps, and could augment energy assurance officer's expertise.

[viii] Using a similar model as the civil affairs officers, three to four weeks of additional training would be necessary to ensure any gaps in experience are filled, as well as introducing current technological and conceptual operational energy initiatives that were not directly relate to the bulk fuels MOS.

to the same depth of knowledge and focus as an energy assurance officer would have about nuances and requirements of the entire energy chain. The contested maritime environment demands that energy assurance officers are Marines with expertise in energy chain components as well as career-length experience in planning energy chain operations, from concept through detailed planning, and the necessary rank to appropriately influence the planning process.

Getting Sets and Repetitions

Planning process changes and subject matter experts are not enough to ensure future energy chain vulnerabilities are mitigated. How officers are trained and educated is directly connected to their ability to solve problems. If the desire is to impart planners with the ability to apply different concepts to different situations, then the curriculum during their education must reinforce this ability by giving them multiple opportunities to practice.

An effective model for imparting desirable problem solving tools onto officers can be drawn from examining the changing approach to mathematics education in the United States. At the end of the 1990s, there was considerable concern about the growing deficit between American and foreign students in mathematics. Studies seemed to suggest that the method of education did not facilitate students' abilities to apply mathematical concepts in changing situations and circumstances, instead focusing on rote memorization and procedural mimicry that was only narrowly useful. It was identified that when teachers provided context, tools, and a problem that the student needed to solve on their own, the student's ability to successfully solve follow-up problems was greatly enhanced. This method allowed the student to build their own concept of interrelation in the context of a given scenario, effectively establishing the ability to transfer skills and experience. In *Adding it Up: Helping Children Learn Mathematics*, the authors stated that this was necessary because, "How learners represent and connect pieces of

knowledge is a key factor in whether they will understand it deeply and can use it in problem solving."[35] Thus, this example demonstrates that to increase a learner's expertise at using a tool or concept in problem solving, it must be included in the repetitions of problem solving the learner is required to perform while being taught.

Effectively leveraging the Energy Assurance Cell and officers against the energy chain vulnerabilities requires the Marine Corps to incorporate energy chain considerations into its planning schools, specifically Expeditionary Warfare School (EWS), Command and Staff College (CSC), and MAGTF Staff Training Program (MSTP). As the principal institutions within the Marine Corps that teach and educate on Marine Corps planning methodology, they are natural hubs for investing in subjects the service wishes to tackle, and historically the service has done such.[ix] The Marine Corps has used its officer schools in the past to grapple with emerging problems and concepts. In the 1920s and 1930s, as the service attempted to work through problems like amphibious operations and small wars, one of its primary actions was to include the subjects into the Marine Corps Schools. This was for two reasons: First, it allowed the infusion of organizational lessons learned to the leaders and planners that were to return to the operating forces. Secondly, and more importantly, it familiarized the officers with the unique concerns associated with the matter and afforded them opportunities to attempt to solve problems that potentially had not yet been solved. In 1940, before the Marine Corps had any combat experience in fighting forces ashore against a peer adversary to draw upon, it already devoted 635 hours of instruction to amphibious operations.[36] When the War in the Pacific commenced a year later, the officers were more familiar with the concepts and considerations associated with amphibious operations, even if they were not necessarily masters yet, and thus more capable of

[ix] As will be mentioned later in the paper, the Marine Corps approach to amphibious operations in the 1920s and 1930s started in the planning schools. Krulak, Victor General USMC. *First to Fight.* 36.

solving specific problems as they arose. The Marine Corps takes similar steps today. When the institution desires its planners to have increased familiarity with such things as civil-military planning or operations in the information environment, it includes them as items of focus during planning exercises, or even as more detailed periods of instruction.[37]

The same concept should be applied to energy chain planning, including it within the programs of instruction for the planning schools. The current curricula at EWS and CSC include over ten planning exercises where students are expected to develop solutions to real world scenarios.[38] Students are exposed to various capabilities and considerations so that they are afforded multiple opportunities to explore different ways to adapt to problems. Yet nowhere in the programs of instruction are students exposed to the energy chain or forced to think holistically about the trade-offs necessary in energy planning. These students, captain and majors, will become the primary problem solvers in operational planning teams in the operational forces after graduation, and the best way to prepare them to identify and mitigate energy chain concerns is to expose them to these considerations while at school. After graduation, the reinforcement through MSTP planning exercises will ensure even greater familiarity, and ensure that staffs are capable of mitigating future energy chain vulnerabilities.[x]

Not every consideration can be covered in great detail at the planning schools, and so opponents to dedicating any focus at the schools would argue that this is just one more distraction from the primary mission of developing general MAGTF planners. However, that

[x] The addition of energy chain considerations to the planning schools needs to be centralized to ensure that the changing nature of energy chains are incorporated. The Energy and Innovation Chair for Marine Corps University should be the central point for coordination of curriculum development, with the Bulk Fuels School director and the Expeditionary Energy Officer having responsibility over content across the three planning institutions. Subject matter experts will need to build the information packages, much like the civil affairs school does currently for civil considerations, and one instructor within each institution would need to be the point of contact for ensuring the inclusion of energy in the planning exercises. A period of instruction, of similar length to Green Cell instruction, will need to be included into each curriculum, but the real experience will come during the planning exercises.

does not account for the fact that the steps of MCPP are never applied context-free. Every planning exercise has a context, and inclusion of one focus area or another does not detract from the overall execution of the steps within the process. Even if the previous two recommendations are not implemented, even limited inclusion within the planning schools means that MAGTF officers will have had some previous experience addressing vulnerabilities to the energy chain in the planning process, which will make them more capable of developing solutions. The risk to mission failure for the Marine Corps in contested maritime environments is too great not to include energy planning considerations within planner education.

Conclusion

The loss of any component of the MAGTF would make a mission difficult, but even more so with the loss of any of the ACE's capabilities. Whether providing close air support, assault support, or any other function of Marine Corps aviation, the ACE is going to need a resilient energy chain. In order to ensure its resiliency, the Marine Corps must integrate holistic energy planning into operational planning teams, establish dedicated energy assurance officers, and incorporate energy planning curricula into its planning schools. Though any of the above recommendations in isolation have potential in ensuring leaders and planners are capable of identifying vulnerabilities in the energy chain and developing mitigations, they are most effective when taken all together. The doctrinal formation of Energy Assurance Cells within OPTs will need to be taught at the planning school, and will thus increase other officers' awareness of energy chain considerations. With the creation of energy assurance officers, the MAGTF will have experts who can advocate for material or conceptual solutions both within the OPTs, in the schools as either instructors or adjacent students, and across the organization as a whole. In this way, each recommendation reinforces the contributions of the others and leads to

better organizational conditions for adapting and overcoming energy chain issues. By implementing these recommendations, the Marine Corps ensures its leaders and planners will be capable of identifying vulnerabilities and developing mitigations as adversary capabilities propagate, and the energy needs of Marine Corps aviation expands. When the MOC's future contested maritime environment becomes a reality, Marine Corps aviation must not find itself in the next conflict dependent on an energy chain forged during a time of relative supremacy, only to have it snap when the MAGTF needs it most.

[1] U.S. Energy Information Administration, "Frequently Asked Questions," accessed 28 February 2019, https://www.eia.gov/tools/faqs/faq.php?id=97&t=3.
[2] Marine Corps Expeditionary Energy Office. *Marine Corps Expeditionary Energy Strategy and Implementation Plan*. (Quantico, VA: Headquarters, US Marine Corps, 2009), 70.
[3] Headquarters US Marine Corps, *Marine Corps Operating Concept: How an Expeditionary Force Operates in the 21st Century*, September 2016.
https://www.mcwl.marines.mil/Portals/34/Images/MarineCorpsOperatingConceptSept2016.pdf
[4] U.S Department of Defense. Joint Bulk Petroleum and Water Doctrine. JP 4-03 (Washington, DS: US Department of Defense, January, 11 2016), x.
[5] Ibid.
[6] U.S. Department of Defense, Summary of the 2018 National Defense Strategy, January 2018.
[7] Cyber Conflict Documentation Project, *Russian Navigation Warfare: Understanding Hostile Intentions and Recent Incidents.* November 2017. 9. Report provided to students of School of Advanced Warfighting, Marine Corps University AY 2019.
[8] Defense Logistics Agency, "History," accessed November 11, 2018, http://www.dla.mil/AboutDLA/History/.
[9] Thomas Hornigold, "Are Electric Planes the Future of Aviation?" Singularityhub, June 28 2018. https://singularityhub.com/2018/06/28/are-electric-planes-the-future-of-aviation/.
[10] Allison, Graham and Philip Zelikow. *Essence of Decision: Explaining the Cuban Missile Crisis* (New York: Longman, 1999), 147-163.
[11] Philip A. Crowl, *Campaign in the Marianas*. (Center of Military History United States Army: Washington D.C., 1993), 271-275.
[12] Ibid.
[13] Ibid.
[14] Ibid.
[15] Lucian Truscott. *Command Missions: A Personal Story.* (New York: E.P Dutton and Company Inc., 1954), 431-432.
[16] Ibid.
[17] Jeffrey J. Clarke and Robert Ross Smith, *Riviera to the Rhine*. (Center of Military History United States Army: Washington D.C., 1993), 115-117.
[18] Gordon and General Trainor. *Cobra II (*New York: Pantheon Books), 138 – 140.
[19] Ibid.
[20] Ibid.
[21] Ibid.
[22] Ibid.
[23] Anthony Terlizzi (retired Marine involved with establishment of Marine Corp Civil-Military School), discussion with author, December, 2018.
[24] U.S. Marine Corps. Marine Corps Planning Process. MCWP 5-1 (Washington, DC: Department of the Navy, Headquarters Marine Corps, 2016, 2-6, Accessed April 18, 2019. https://www.mca-marines.org/files/MCWP%205-1%2018 Marine Aviation Plan20MCPP.pdf.
[25] Joe Strange and Anthony C. Zinni, General USMC, *Capital "W" War A Case for Strategic Principles of War*, (Quantico, VA: Marine Corps University, 1998), 274.
[26] Deputy Commandant, Combat Development and Integration, *Initial Capabilities Document for United States Marine Corps: Expeditionary Energy, Water and Waste*, Initial Capabilities Document, 1 August 2011.
[27] Jim Collins, *Good to Great: Why Some Companies Make the Leap and Other Don't.* (New York: HarperBusiness, 2001), 41-46.
[28] Keith Sawyer, *Group Genius*, (New York, Basic Books. 2007), 41-42.
[29] Dr. Paul DiMaggio, "Culture and cognition," Annual Review of Sociology. vol. 23 (August 1997): 269.
[30] D. Frauendofer, M. Schmid Mast, D. Sanchez- Cortez, and D. Gatica-Perez, "Emergent power hierarchies and group performance." *International Journal of Psychology*, 50. (October 2015): 392-396. 10.1002/ijop.12102.
[31]Danilo A McCabe, CWO 04 USMC, Bulk Fuel School Director discussion with author, December, 2018.
[32] Ibid.

[33] Secretary of the Navy, *Marine Corps Limited Duty Officer and Warrant Officer Programs, Promotions and Continuation Procedures*, SECNAVINST 1412.9B, February 7, 2006. https://www.marines.mil/Portals/59/Publications/SECNAVINST%201412.9B.pdf?ver=2012-10-11-164116-653.
[34]Interview with various logisticians during Marine Corps University (MCU) Energy & Innovation Scholars Program, November 2019.
[35] Jeremy Kilpatrick, Jane Swafford, and Bradford Fidell, *Adding It Up: Helping Children Learn Mathematics.* (Washington D.C.: National Academy Press), 11.
[36] Victor H. Krulak, LtGen. USMC (Ret.), *First to Fight: An Inside View of the U.S. Marine Corps*, (Annapolis: Bluejacket Books, 1999), 36.
[37] Anthony Terlizzi (retired Marine involved with establishment of Marine Corp Civil-Military School), discussion with author, December 12, 2018.
[38] Dennis Katolin, Maj USMC (former instructor, Expeditionary Warfare School and student, Command and Staff College), discussion with author, December 10, 2018.

Bibliography

Allison, Graham and Philip Zelikow. *Essence of Decision: Explaining the Cuban Missile Crisis.* 2nd ed. New York: Longman, 1999.

Amos, Gen. James, Commandant of the Marine Corps. Memorandum 11/09, November 19, 2009.

Carey, Seam B Capt. "Increasing the Endurance and Payload Capacity of Unmanned Aerial Vehicles with Thin-Film Photovoltaics.*"* Master's thesis, Naval Postgraduate School, 2014.

Clarke, Jeffrey J. and Robert Ross Smith. *Riviera to the Rhine*. Center of Military History United States Army: Washington D.C., 1993.

Collins, Jim. *Good to Great: Why Some Companies Make the Leap and Others Don't.* New York: HarperBusiness, 2001.

Cooper, Belle Beth. "The Secret to Creativity, Intelligence, and Scientific Thinking." *Fast Company, June 2014.* https://www.fastcompany.com/3031994/the-secret-to-creativity-intelligence-and-scientificthinking.

Crowl, Philip A. *Campaign in the Marianas*. Center of Military History United States Army: Washington D.C., 1993.

Commandant of the Marine Corps. *Applying Energy Performance Metrics and Measures in Requirements Development and Acquisition Decision-Making*. MCO 3900.19, May 23 2013. https://www.marines.mil/News/Publications/MCPEL/Electronic-Library-Display/Article/900243/mco-390019/.

Cyber Conflict Documentation Project. *Russian Navigation Warfare: Understanding Hostile Intentions and Recent Incidents.* November 2017. Report provided to students of School of Advanced Warfighting, Marine Corps University AY 2019.

DiMaggio, Paul Dr. "Culture and cognition". *Annual Review of Sociology*. vol. 23 (August 1997): 26-287.

Defense Logistics Agency, "History," accessed November 11, 2018. https://www.dla.mil/AboutDLA/History/.

Department of Defense. *2016 Operational Energy Strategy*. Office of the Assistant Secretary of Defense for Energy, Installations and Environment. 2016. https://www.acq.osd.mil/eie/Downloads/OE/2016%20DoD%20Operational%20Energy%20Strategy%20WEBc.pdf.

Secretary of the Navy, *Marine Corps Limited Duty Officer and Warrant Officer Programs, Promotions and Continuation Procedures.* SECNAVINST 1412.9B, February 7, 2006. https://www.marines.mil/Portals/59/Publications/SECNAVINST%201412.9B.pdf?ver=2012-10-11-164116-653.

Deputy Commandant for Aviation, United States Marine Corps. *2018 Marine Aviation Plan*. Presentation. May 1, 2018. https://www.aviation.marines.mil/Portals/11/2018%20AvPlan%20FINAL.pdf.

Dyes Jr. MajGen. Robert. *Demand Reduction: Setting Conditions to Enable Multi-Domain Battle.* White Paper, February 21 2018.

Elert, Glenn, "Energy Density of Aviation Fuel." *The Physics Factbook*. Accessed on August 24, 2018. https://hypertextbook.com/facts/2003/EvelynGofman.shtml.

Frauendofer, D., Schmid Mast, M., Sanchez- Cortez, D., & Gatica-Perez, D. "Emergent power hierarchies and group performance." International Journal of Psychology, 50. (October 2015): 392-396. 10.1002/ijop.12102.

Gordon, Michael and Bernard E. Trainor, General. *Cobra II: The Inside Story of the Invasion and Occupation of Iraq.* New York: Pantheon Books. 2006.

Hammond III, LtCol. James. "The ACE That Ate the Marine Corps." *Marine Corps Gazette*, January 2014.

Headquarters US Marine Corps. *Marine Corps Operating Concept: How an Expeditionary Force Operates in the 21st Century.* September 2016. https://www.mcwl.marines.mil/Portals/34/Images/MarineCorpsOperatingConceptSept2016.pdf

Hoffler, Robert E., LtCol USMC. *Developing A Bulk Fuel Strategy to Support Distributed Operations in a Contested Environment.* FY18 Naval Innovation Advisory Council Report. July 13, 2018.

Hornigold, Thomas. "Are Electric Planes the Future of Aviation?" *Singularityhub*, June 28 2018. https://singularity hub.com/2018/06/28/are-electric-planes-the-future-of-aviation/.

Jones, Gen. James, Commandant of the Marine Corps. Policy Memorandum 2-02, 15 August 2002.

Kilpatrick, Jeremy, Swafford, Jane, Fidell, Bradford. *Adding It Up: Helping Children Learn Mathematics.* Washington D. C.: National Academy Press, 2001.

Marine Aviation Weapons and Tactics Squadron One. *UAS Groups 1 and 5 Employment*. After Action Report. April 28, 2018.

Marine Corps Expeditionary Energy Office. *Marine Corps Expeditionary Energy Strategy and Implementation Plan*. Headquarters, US Marine Corps. 2009.

McCauley, Kevin. "China's Military Reforms and Modernization: Implications for the United States." *Testimony before the U.S.-China Economic and Security Review Commission*. February 15, 2018.

Olsen, Johan P. "The Ups and Downs of Bureaucratic Organization." Annual Review of Political Science, vol. 11 (June 2008): 13-37. https://www.annualreviews.org/doi/abs/10.1146/annurev.polisci.11.060106.101806.

Riel, Jennifer and Roder L. Martin. *Creating Great Choices: A Leader's Guide to Integrative Thinking*. Boston: Harvard Business Review Press, 2017.

Sawyer, Keith. *Group Genius: The Creative Power of Collaboration*. New York: Basic Books, 2007.

Strange, Joe Dr. and Anthony C. Zinni, General. *Capital "W" War: A Case for Strategic Principles of War (Because Wars Are Conflicts of Societies, Not Tactical Exercises Writ Large).* Marine Corps University. 1998.

Truscott, Lucian. *Command Missions: A Personal Story*. New York: E.P Dutton and Company Inc., 1954.

U.S. Department of Defense. *Summary of the 2018 National Defense Strategy*. January 2018. https://dod.defense.gov/Portals/1/Documents/pubs/2018-National-Defense-Strategy-Summary.pdf.

U.S Department of Defense. *Joint Bulk Petroleum and Water Doctrine*. JP 4-03. Washington, DS: US Department of Defense, January, 11 2016. https://www.jcs.mil/Portals/36/Documents/Doctrine/pubs/jp4_03pa.pdf?ver=2018-02-08-091424-107.

U.S. Marine Corps. *Green Cell*. MCCMOS Circular 3.1. Washington, DC: Department of the Navy, Headquarters Marine Corps. September 2017.

U.S. Marine Corps. *Warfighting*. MCDP1. Washington, DC: Department of the Navy, Headquarters Marine Corps. 1997.

U.S. Marine Corps. *Marine Corps Planning Process.* MCWP 5-1 Washington, DC: Department of the Navy, Headquarters Marine Corps, 2016. Accessed April 18, 2019.

VornDick, Wilson. *Renewable Energy and the PLA's Next Generation of Self-Sufficiency (Part1)*. The Jamestown Foundation. 2 March, 2017. https://jamestown.org/progarm/renewable-energy-plas-next-generation-self-sufficiency-part-1/.

VornDick, Wilson. *Renewable Energy and the PLA's Next Generation of Self-Sufficiency (Part2)*. The Jamestown Foundation. 2 March, 2017. https://jamestown.org/progarm/renewable-energy-plas-next-generation-self-sufficiency-part-2/.

Zerr, G. T. Capt USMC. *USMC Expeditionary Energy Office: Energy Analysis Quick Guide 2018.1.1*. PowerPoint presentation. Expeditionary Energy Office, Quantico, VA, January 12, 2018.