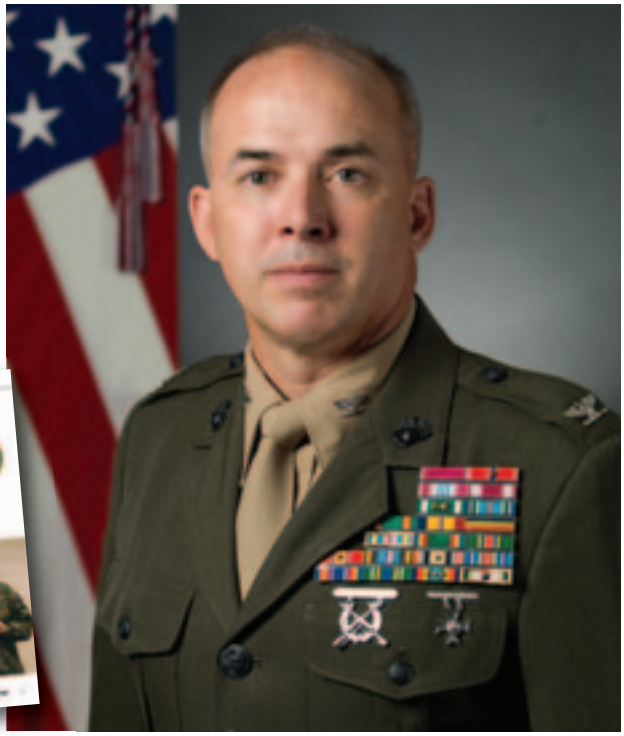
Marine Corps Sponsors Study to Better Understand Energy Use

Naval Postgraduate School Recommends Changes in Practices to Promote Energy Efficiency

RECENT RESEARCH INITIATED by the Marine Corps Expeditionary Energy Office (E2O) has shed some light on how fuel and energy are used in the field. A series of studies conducted by a team at the Naval Postgraduate School (NPS) have contributed to a number of initiatives including procedural changes and a war games exercise.

The E2O was formed in 2009 to address energy-related vulnerabilities within the Marine Corps. The then-director of E2O, Colonel James C. Caley, asked NPS researchers to create a framework with which to assess the human factors impacting the adoption of new energy policies and technologies. (Note: For more information about E2O, see the summer 2014 *Currents* interview with Col. Caley at http://greenfleet.dodlive.mil/currents-magazine/currents-magazine-2014/currents-summer-2014.)

According to Col. Caley, the NPS team's research has changed his thinking about energy problems in the Marine Corps, shifting his thinking to a greater emphasis on behavior. "The Marine Corps has thousands of pieces of equipment. Do you know what the most common piece of equipment is? The Marine," he said. In trying to further understand the impact of a Marine's energy use, Caley recently set up a seminar war game using computer tools and models to project how today's energy policies and usage patterns could backfire down the road.



Colonel James C. Caley

The end product of this study was a behavioral framework that explains how Marines' personal knowledge, attitudes, values, and motivations vary by each scenario.

Operational Reach 2015

In June 2015, 75 individuals from the Marines, Air Force, Army, Navy, the Office of the Secretary of Defense, and Allied Nations met in Quantico, Virginia for Operational Reach 2015, a war game about energy and fuel set in 2030. This marked the first time that energy was included in an operational planning exercise. The exercise identified issues concerning new naval concepts and weapons systems such as fuel storage, load measurement, vehicle travel, equipment distribution, follow-on operations and energy implications.

"Units cover more battle space than they used to, they have more fire power and they're better protected," says Caley. "But that increase in capability has come with a cost on the energy side of the house that we haven't entirely kept up with."

The results of Operational Reach 2015 uncovered risks and vulnerabilities for the Marine Corps, especially when Marines need to operate deep in country untethered from energy resupply, and highlighted the system-wide need for change.

Old Habits Die Hard

Col. Caley remembers when he first joined the Marine Corps, "We had trucks called 813's. If you didn't start your vehicle 45 minutes before operations, or jump start the ones that wouldn't start, you were going to feel the pain of that decision. Today, M2VR trucks start in two to three seconds, but we still start our engines 20-30 minutes early. And no one knows why."

"We are prone to wasting our fuel—idling trucks, running generators at 35 percent of their load," Caley continued. "So I turned to the NPS researchers because I wanted a multi-disciplinary approach to energy consumption, to look from the perspective of psychology, sociology, and business development. Now we are getting a fresh set of eyes on Marine Corps behaviors and our standard operating procedures."

The Study

The Study of Human Behavior and Operational Energy looked at the ways in which situational and personal factors routinely impact how energy is used. The report is the most recent output from a stream of studies conducted by a team of NPS researchers including Kathryn Aten, Anita Salem and Ann Gallenson. This study is based on interviews and observations of over 60 Marines in three training exercises and a deployed expeditionary command environment. The end product of this study was a behavioral framework

The Marines & the Naval Postgraduate School

PROFESSOR ALEJANDRO (ANDY) Hernandez, Col. (retired), program manager at NPS for E2O, says that Col. Caley has partnered with NPS for the past three years to get a new and comprehensive perspective on the E2O mission. According to Col. Hernandez, NPS supports E2O in four areas:

1. New innovations in processes and systems
2. Untethering from major resupply bases
3. Challenges in delivery and storage capacity
4. Organizational adaptation which includes decision-making, improved command and control, and education and training.

NPS uses teams that combine faculty expertise and student operational experience to deliver research and theses that address behavioral, organizational, and technical challenges in effective energy use. Current behavioral and organizational research includes the modeling and simulation of energy use in the field, industry recommendations on the use of vehicle telematics, and Commander-designed fuel information systems. Technical solutions include new technologies such as solar drones and robots to carry 100-pound backpacks for Marines.

Marine Corps Captain Brandon Newell shows Secretary of the Navy Ray Mabus how Sailors and Marines are using the GREENS equipment at Boldak Expeditionary Energy Patrol Base in Helmand Province, Afghanistan.

CMC Sam Shavers

that explains how Marines' personal knowledge, attitudes, values, and motivations vary by each scenario. The report had immediate impact and sets out the behavioral basis for continuing research.

The Marines were observed and interviewed during and after integrated training exercises, during Weapons and Tactics Instructor exercises and while embarked on a Landing Helicopter Deck amphibious assault ship with a deployed Marine Expeditionary Unit.

Personal Factors

A key finding of the research was that energy behaviors and key influencers varied by community and activity. In general, researchers found that Marines' willingness to be energy efficient is impacted by the following factors.

NPS is developing a new energy efficiency course that integrates energy concepts into operational planning and wargaming.

Awareness

The researchers concluded that many Marines are not aware of fuel use and its impact on the mission. For example, Humvee drivers idle their engines in order to be ready to move the vehicle quickly when attacking or being attacked. They also idle engines to recharge batteries for artillery and to maintain vital communications with fellow Marines. However, previous to this study, there was no policy or standard regarding how much time should be spent idling a Humvee. When drivers were asked how long they should idle to charge batteries, some Marines said five minutes, while others gave answers ranging up to 30 minutes. Even though the Marine Corps has been looking at energy as a force multiplier, there was very little discussion in the exercise about the human costs of using so much fuel, such as the number of casualties from enemy attacks on fuel convoys. These costs are significant. A report issued by General James Amos in 2010 found that during one three-month period in Afghanistan, one out of every 50 fuel and water convoys resulted in a Marine being wounded in action.

Little Accountability for Fuel Use

The study also revealed gaps in individual awareness of financial impacts. A common attitude seemed to be that fuel is not a top concern—"We always have what we need" and "It's not coming out of our wallets." There was minimal awareness of fuel use and no observed unit accountability for expenditures. Mechanisms for tracking and managing finances were also lacking.

Motivation

As in many large organizations, there is general resistance to change in the Marine Corps. Adding new energy policies is seen as "just one more thing to do." The burden of paperwork and the perceived tendency for the Department of Defense to overreact to problems were cited as causes of resistance. At the same time, the researchers saw indications that Marine Corps values such as professionalism, resilience, resourcefulness, and pride of work could serve as strong motivators.

The researchers concluded that a combination of strategic, operational and tactical practices can effectively reduce energy use in the Marine Corps.

New fact sheets were created describing improved procedures for tanks, motor transport and amphibious assault vehicles.

Effectiveness Trumps Efficiency

The prevailing attitude was that nothing should adversely affect operations and training. While some interviewees recognized the efficiency of making fuel last as long as possible, many enlisted Marines had no concept of extending reach through energy efficiency. Safety and well-maintained equipment were of more concern.

Knowledge

Researchers identified a lack of energy planning and management at the senior levels. In one case, a utilities engineer developed a plan which would conserve energy use that was overridden by his superiors. In addition, the ranks of utility engineers (most often responsible for energy planning) are shrinking.

Leadership

Direction and support from top leadership can be an important part of changing the focus to an energy conscious force. Junior ranks are looking to senior leadership to set the example: "Energy? That's for other people to think about—those above me." Some senior leadership recognized this important role—"I'm a steward. It's my job to pay attention to money and efficiency and effectiveness."

The researchers concluded that a combination of strategic, operational and tactical practices can effectively reduce energy use in the Marine Corps. They created a five-factor model for effecting change.

Five Steps Toward Changing the Culture

1. Improve Specific Procedure

Researchers found that energy requirements are often based on worst case scenarios, and don't account for the ebb and flow of combat operations. Changes were recommended in areas ranging from idling policies (no more than five minutes) and battery charging procedures to logistical planning for Marine training exercises, optimizing flight paths for pilots, and installing driver fuel meters.

New fact sheets were created describing improved procedures for tanks, motor transport and amphibious assault vehicles. These were created for Military Occupational Specialty (MOS) schools, and include information about smart driving techniques, preventive maintenance checks, starting and shutting down engines, and the use of personal heaters. MOS fact sheets can be found at www.hqmc.marines.mil/e2o/E2OHome.aspx.

2. Revise Policies

Many of the current structures of the Marine Corps are at odds with reducing energy use. The study cited the length and design of exercises, coordination between the Ground Forces and Logistics, and the availability of utility engineers as factors that affect energy use. Various tactical and operational strategies could be revisited regarding their energy impact. For instance, a tactical strategy might include looking at new ways to transport goods while an operational strategy might revisit the role of the Medical Corps in refrigeration planning.

Other policy recommendations in the study focus on the length, tempo, and time of day of training exercises. One Marine interviewed mentioned a training exercise that was expected to last three days, and turned into thirty days with ten times the amount of fuel burned. This may well have been an appropriate use of time and energy, but the use of energy should have been a formal consideration.

U.S. Marine Corps

U.S. Marine Corps

Sgt. Christopher Q. Stone

U.S. Navy

Master Sgt. William Price

U.S. Marine Corps

MCS2 Christopher Lindahl

A convoy of Amphibious Assault Vehicles assigned to 3rd Amphibious Assault Battalion, line the shores of Oahu, ready to make their way back aboard the amphibious assault ship USS Peleliu (LHA 5) after combat training exercises.

PM2 Prince A. Hughes III

A revision in financial and incentive policies was also recommended. One key policy shift would be to make each unit accountable for their energy use, and to provide incentives for energy-efficient behaviors. For example, the study revealed gaps in individual awareness of financial impacts, in tracking and managing finances, and in unit accountability for expenditures. There was a sense of abundance among many of the Marines interviewed, and a disconnect between using energy and paying the energy bills. One way to incentivize Marines to be energy-efficient is to reward and recognize units that are more efficient by providing additional educational benefits, more liberty, and/or more pay. Another way is to build on collective values that align with the desired culture change such as resourcefulness, resilience, adaptability, and pride.

OPPOSITE PAGE, CLOCKWISE FROM TOP:

Solar photovoltaic panels demonstrated at the 2013 ExFOB (now E2C) technology demonstration, held 6–10 May 2013 at Marine Corps Air Ground Combat Center Twentynine Palms, CA.

Materials Requirements Analyst Major Sean Sadlier, energy officer for Marine Corps Pentagon Headquarters, demonstrates Ground Renewable Expeditionary Energy (GREENS) apparatus at the Naval Surface Warfare Center, Carderock Division. The GREENS program is sponsored by the Office of Naval Research.

Marines with the Communications Section, Combat Logistics Battalion 24, 24th Marine Expeditionary Unit train on GREENS on the flight deck of USS Gunston Hall. Marines use the system, which generates electricity through solar power, to power command operation centers.

The NPS behavioral study initiated the first-ever guidance regarding idling vehicles such as Humvees.

The Ground Renewable Expeditionary Energy Network System.

Lance Cpl. Dakota Hicks connects a radio battery to a Solar Portable Alternative Communication Energy System (SPACES) at Patrol Base Gumbatty in Sangin District. SPACES is a flexible solar panel that can be carried by a Marine and is used for recharging radio batteries. With more room in their packs from fewer batteries, the coalition forces can pack more essentials, like ammunition.

Hybrid power systems.

Sgt. Christopher Q. Stone transmits imagery using a Broadband Global Area Network powered by SPACES from King Faisal Air Base in Jordan to the USS Kearsarge (LHD 3) at sea.

3. Integrate Enhanced Technology

Integrating appropriate and usable technology was also identified as key. A Marine in Afghanistan or Iraq routinely carries between 60 and 100 pounds in gear including batteries and possibly solar cells to recharge communication devices and artillery. Therefore, battery efficiency and solar reliability is key to greater agility. According to one Howitzer operator, "Battery life is short, batteries are heavy, batteries don't last to spec, they're not durable, you can't carry large batteries, and large batteries decrease capability and maneuverability."

> Because of this study, we changed our approach from a focus on equipment to what motivates commanders to make decisions.
>
> *—Col. James C. Caley*

4. Improve Education.

The study recommends a three-pronged approach to training. Hands-on training should be provided to key personnel. For instance, convoy drivers need to understand the charging requirements of different equipment. Secondly, there is a need for formal training, through MOS schools and continuing education. The third recommendation is to establish methods by which skilled personnel such as utility engineers teach or mentor junior and senior leadership in power planning. The mentoring solution, in particular, might be a cost-effective and efficient way to educate Marines on the benefits of energy efficiency.

5. Use Cultural Levers.

Such qualities as persuasion, influence and leadership are vitally important for changing day-to-day behaviors, particularly in the lower and mid-levels of command. Persuasive communications are most successful (and most influential) when they address the underlying values and motivations of the audience. For example, communicating the personal benefit of carrying lighter weight batteries is likely to persuade soldiers to support solar power.

The Latest Efforts

One direct result of NPS research is the E2O's new Energy Command and Control initiative. Through this program, sensors are being placed in all vehicles, generators, logistics equipment, and airfields so that commanders can tell Marine Corps leadership what makes them more effective in combat. Current research by Aten, Salem and Gallenson is focusing on how the data drawn from these systems can be targeted to the appropriate stakeholders and used to improve situational awareness and operational decision-making.

On the technology side, the Marine Corps hosts an annual event known as Expeditionary Energy Concepts (E2C), formerly known as Experimental Forward Operating Base (ExFOB), where businesses present innovations in energy technologies and Marines try them out and give feedback. So far, Marines have tested hundreds of technologies and adopted five, including GREENS (a solar-hybrid power systems that can power a battalion combat operations center), SPACES (flexible solar panels to recharge batteries for communications equipment), radiant barriers (shelter liners that resist heat), light emitting diode (LED) lights for tents, and Mobile Electric Hybrid Power Sources (combining batteries, solar, and diesel generators with up to 50 percent fuel savings).

Marines are also implementing changes in driving and vehicle maintenance procedures as outlined on the MOS fact sheets mentioned above. These fact sheets are distributed not only in MOS training, but on the web and in the field. Other education and training efforts have also been impacted by this research. Currently, NPS is developing a new energy efficiency course that integrates energy concepts into operational planning and wargaming and is including behavioral factors in their existing energy seminars for Flag officers, junior and mid-level officers and non-commissioned officers.

U.S. Marines from 1st Platoon, Alpha Company, 1st Battalion, 7th Marine Regiment, patrol from Expeditionary Patrol Base Dulab to a ridge along the outskirts of the city in Dulab, Iraq.
Cpl. Shane S. Keller

Marines from 13th Marine Expeditionary Unit provide security for a CH-46E Sea Knight helicopter during a joint mass casualty training exercise in Grand Bara, Djibouti, near Camp Lemonier.

PO2 Jesse B. Awalt

The Basics About the Marine Corps Expeditionary Energy Office

THE E2O WAS formed in 2009 to address energy-related vulnerabilities within the Marine Corps Expeditionary Forces. E2O focuses on increasing the operational reach of the forces that operate in harm's way through more efficient energy use. Its mission states that "by 2025…the only liquid fuel needed will be for mobility systems which will be more efficient than systems are today."

The E2O also helps other forces that are training in garrison to get more readiness out of their training dollars. E2O hosts an annual E2C conference that focuses on emerging energy technologies. E2C 2016 is scheduled for 2-6 May 2016. For more about E2O and E2C, see www.hqmc.marines.mil/e2o/E2OHome.aspx.

Looking Ahead

The NPS researchers feel that Integrated Training Exercises (ITX) are an excellent space for exploring new energy-efficient technologies and for instilling the value of energy conservation in recruits. More than one study participant stated that "ITX is where a Marine learns to be a Marine."

The team suggests that ITX is a place where the design of the FOB should be re-examined "to assess the lifecycle impacts of Marine Corps policies and procedures, to analyze the return on investment of energy-hungry technologies and polices that are ill suited for expeditionary conditions."

"The analysis that we're doing is not strictly focused on the expeditionary force," Caley emphasizes. "It's focused on the naval force. We are looking at capabilities that may mitigate some of these increased energy requirements in the expeditionary brigade and across the naval force."

"Because of this study, we changed our approach from a focus on equipment to what motivates commanders to make decisions. We are giving commanders information so they can tell us what makes them more effective in combat. It's a paradigm shift," Caley concluded. ⚓

Kathryn Aten
Naval Postgraduate School
831-656-2644
kjaten@nps.edu

Anita Salem
Naval Postgraduate School
831-277-6616
amsalem@nps.edu