Fuel Distribution

Today's plan to use yesterday's technology tomorrow

by LtCol Brad Klusmann

The *Commandant's Planning Guidance* frames the Marine Corps as a legacy force both inhibited and unable to move past 20th century technology, doctrine, and organization. It demands that the Service assess how it organizes, trains, and equips to execute its core competencies. The resultant formations must enable self-sufficient units that can operate in and seamlessly transition between the contact, blunt, and surge layers to increase the lethality, protection, and operational reach of the MAGTF while retaining the ability to mass.[1]

This statement from the *Marine Corps Functional Concept for MAGTF Engineering* captures the spirit of *combat credibility* and is explicit in the fundamental transformation required of capabilities spanning the range of military operations to achieve alignment to the 2018 *National Defense Strategy* and *Defense Planning Guidance*.

In its current configuration, the joint force and Marine Corps' bulk fuel distribution capability will not enable the naval force to achieve combat credibility because of the combined effects of the ever-increasing speed of conflict and the five drivers-for-change that define the future operating environment: complex terrain, technology proliferation, information as a weapon, battle of signatures, and an increasingly contested maritime domain.[2] These factors will negatively impact the deployment, employment, and redeployment cycles of bulk fuel delivery networks within contested environments against peer competitors. In this article, the doctrine of bulk petroleum operations—*providing the right fuel, in the right place, and at the right time*[3]—will be presented through historical context and current application so gaps can be identified. This approach links institutional reliance on historical precedence for perspective to validation through commercial industry metrics for efficacy.

Hose reel system (HRS) employment, Operation Iraqi Freedom I (OIF I). ***(Photo courtesy of CWO5 Luc Brennan.)***

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Velocity, agility, and *accuracy* are the three measures of effectiveness (MOE) that will be utilized to analyze the application of bulk petroleum operations spanning 75 years—we will first review the past, then address contemporary utilization, and finally address the future. Petroleum industry companies like XRI Holdings, LLC, utilize these MOEs (or what they refer to as key performance indicators) to adjust plans, resource allocations, and influence advancement toward defined end states.[4] While it is recognized that commercial sector standards of competition are market forces, not enemies attempting to destroy them, the MOE definitions are flexible enough to reveal the glaring capability gaps with bulk fuel distribution and detect opportunities to inform gaps' solutions. Ultimately, filling the bulk fuel distribution capability gap must become an institutional objective to enable naval force combat credibility. To make this happen, the Service will need to divest from efficiency, invest into resilience, or combine solutions where it makes sense.

MOE

Velocity is efficiency, capacity, and speed moving toward an objective (or objectives) within a system. Velocity works best in linear, relatively static, and predictable environments associated to phase IV and V operations in the joint operations phasing model. Achieving velocity implies an ability for the force to sufficiently control interior lines. Velocity's correlative effectiveness will diminish as relative compounding effects of the five drivers-for-change appear within an operating environment, as unpredictability and friction intensify during contact to blunt layer transitions and phase II and III operations, and where resilience is not a constraint.

Agility is resilience of a distribution network and can be applied to models of responsiveness, modularity, and adaptability. Agility is best associated to a distribution network's ability to rapidly deploy, employ, respond, and adjust to its operating environment to achieve maximum effectiveness. Agility implies continuous and timely delivery—regardless of environment—and not just a single rapid transfer that degrades over time. It is a desirable metric in operating environments characterized by uncertainty and where control of interior lines cannot be assured.

The final MOE, accuracy, is the precise delivery of wholesale, retail, or kiosk capabilities and capacities to an organization at a specified time and place. Accuracy must always be achieved to ensure tempo is maintained relative to the speed of conflict. For a capability to be effective, accuracy must be combined with velocity or agility.

The Past

World War II marked the beginning of modern theater bulk fuel distribution as it developed as a critical requirement to maintain tempo. Emerging technologies spanning the domains of land, air, and sea created a tremendous demand for fuel in both the Asiatic-Pacific and African-European theaters. As such, bulk fuel accounted for over half of the tonnage delivered during the war.[5] Military and industrial partnerships filled both theaters' capability gaps through the creation of a pipeline distribution solution called the invasion-weight pipe, which was later designated lightweight steel tubing (LWST).[6] This solution combined the capabilities of ship-to-shore and inland-from-shore technologies to achieve both accuracy and velocity in the distribution of bulk fuel. Slow system deployment, employment, and long decision cycle timelines contributed to the system's failure to achieve overall agility. Within the African-European Theater, fuel distribution networks, which spanned from ports to refineries to airfields, were prevalent. Combined fuel distribution network distances aggregated from short-, medium-, and long-range pipeline construction were well over 1,000 miles.[7] While this system was revolutionary for the time, its linearity, signature, and multiple single points of failure created an exploitable culmination mechanism because of its inherent lack of redundancy. In both the Asiatic-Pacific and African-European theaters, distribution networks achieved velocity and accuracy, and they were largely successful because of allied controlled interior lines and absence of the five drivers, which effectually averted the need for agility.

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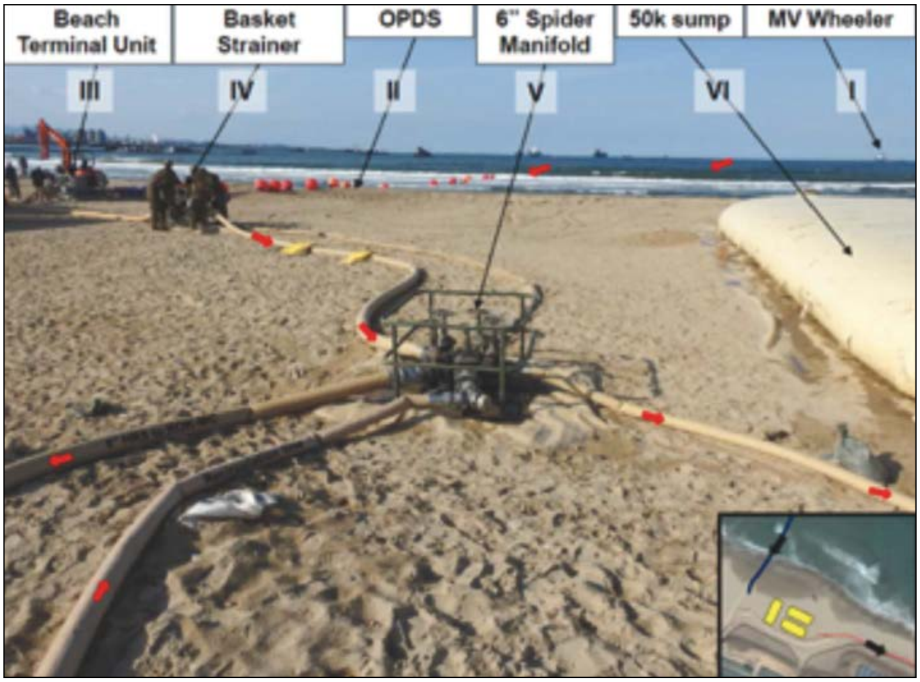
During the Vietnam War, the employment of fuel distribution networks initially befuddled engineer planners because of the *complex terrain* in which it was employed. Bulk fuel distribution started off as a complicated network of tanker ships, barges, and aircraft wholesale delivering 55-gallon drums of fuel for retail distribution by both military and host-nation commercial trucking.[8] This distribution method achieved accuracy and moderate levels of agility but lacked velocity. The system struggled to maintain the tempo of a force, and agility was irrelevant because of the relatively static nature of phase IV and V operations. Ultimately, the complex terrain—both human and environmental—undermined the resilience of the network. Eventually, commanders were no longer willing to expose the force to risk for negligible gains in agility. Consequently, they adjusted their bulk fuel distribution network to resemble a capability comparable to solutions utilized during World War II. Predictably, this solution was able to meet demand at

MV* Wheeler *Offshore Petroleum Distribution System (OPDS) connection to the Beach Terminal Unit (MV* Wheeler *in the background). (Photo by 3D MEB COMSTRAT.)

both wholesale and retail levels and reduced reliance on trucking and aircraft resupply. The solution "utilized legacy LWST pipelines for both ship-to-shore and inland-from-shore methods of delivery, and distributed fuel directly to areas of high demand."[9] These pipelines ran through semi-permissive environments to airfields in spans of 25 miles or less, and "losses due to spills, pilferage, and contamination were estimated at 2.5 million gallons a month."[10] Regardless, the refined solution was able to achieve accuracy and velocity but unsurprisingly lost agility. While strategic victory was not achieved during Vietnam, operational- and tactical-level objectives were attained with consistent regularity, due in part because of the velocity and accuracy of the bulk fuel distribution solutions.

Following the Vietnam War and prior to the Persian Gulf War, the LWST was no longer a viable solution for both ship-to-shore and inland-from-shore wholesale distribution. The system was not functional, as remaining components were not mission capable.[11] A capability gap formed based on concerns about its enormous signature, which led to the development of the Army's Inland Petroleum Distribution System (IPDS) and the Navy's OPDS. Both systems were improved solutions over the LWST and were interoperable in the transportation of wholesale bulk fuel from ships to the high-water mark, then from the high-water mark to inland distribution points. The Persian Gulf War marked the first time that IPDS was employed within a combat theater.[12] The utilization of the system proved to be a challenge for engineers, as the system's enormous logistical footprint delayed its deployment and subsequent employment. Alternative methods for fuel distribution had to be identified and executed to support the Coalition Joint Task Force Commander's main effort—advancing combat power forward. Delays in employment were caused by complex terrain and the inherent friction and uncertainty associated with phase III operations. While the pipeline was deployed in a permissive environment, host-nation governments stalled the employment of the IPDS over concerns regarding impacts to both the environment and pattern of life of its citizens. At the conclusion of the war, 260 miles of pipeline had been employed, but they were never utilized.[13] While this system increased velocity relative to its predecessor's capabilities, its drawback was that the concept of employment remained the same. Exacerbating its diminishing relevance was its adaptability to complex terrain and employment in support of phase II and III operations. This system's linearity, enormous signature, and long decision



Bulk Fuel Company, 9th Engineer Support Battalion, 3D MLG Beach Terminal Unit, from the OPDS MV* Wheeler *to the amphibious assault fuel system, beach unloading assembly, in the Republic of Korea during Exercise SSang Yong 16. *(Photo by 3D MEB COMSTRAT, identification graphics by CWO2 Kyle Babka.)*

Marines employ the Hose Reel System during OIF I, somewhere in Iraq. *(Photo courtesy of CWO5 Luc Brennan.)*

HRS emplacement during OIF I, Iraq. *(Photo courtesy of CWO5 Luc Brennan.)*

cycle never achieved agility, and its ability to influence the outcome of the war never came to fruition.

The War in Iraq was supported with the same bulk fuel capability solutions as previous wars; the Army and Marine Corps ran parallel bulk distribution systems but at longer ranges. The Army employed the IPDS, and the Marine Corps employed the HRS.[14] The Marine Corps' HRS was doctrinally intended to be employed as a retail system but was utilized in wholesale distribution. The relatively static operating environment determined by phase IV and V operations facilitated the concept of employment of both systems. Both the Army and Marine Corps were able to achieve velocity and accuracy. At the conclusion of the war, the Army had employed and utilized 182 miles of the IPDS, and the Marine Corps had employed and utilized 90 miles of the HRS.[15] Relative to the irregular threat, both bulk fuel distribution systems were able to maintain tempo but did so within the context of relatively static phase IV and V operations. The Army registered significant fuel losses from the employment of the IPDS because of pilferage.[16] This fuel loss was largely indicative of the longer distance between pumping stations with the IPDS as compared to the HRS. Complex terrain, coupled with the moderate control of interior lines, created a semipermissive environment that ultimately impacted the IPDS's velocity. While the solution that filled this capability gap was sufficient to maintain the tempo, it was largely enabled through the static precepts of phase IV and V operations. Similar concepts of employment utilizing these solutions, because of their inherent lack of agility, would become increasingly ineffective as operating environments became more fluid.

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Current

The United States is still using mid-20th century capability solutions to distribute fuel in the current operating environment. Bulk fuel distribution systems remain linear and adhere to wholesale and retail distribution models, which are adequate in the static predictability of post-phase III operations or when the control of interior lines can be assured. These systems, the organizations that employ them, and their associated doctrine were never fully adapted for fluid operating environments. Under the current approach, the compounding effects of increasing speed of conflict and the drivers-for-change will continue to degrade the effectiveness of legacy bulk fuel distribution. This observation is built on the belief that current capability solutions will continue to be employed in fluid uncertainty—because there is no alternative.

As the Marine Corps endeavors to become an adaptive force designed to seamlessly transition between the contact, blunt, and surge layers, bulk fuel distribution capability gaps will require solutions optimized to provision forces across range of military operations. The divergent MOEs of agility and velocity will always be necessary to support accuracy, but these metrics need to be balanced by risk against a peer competitor. As previously demonstrated, and throughout history, agility was never consistently achieved above the tactical level and still does not appear to be an institutional objective. Precedence shows agility is not only a gap but a constraint to attain combat credibility. In order to address solutions, a quick look at the historical examples reveal the current distribution capability has

Dracone attached to hydraulic pump, Bishop's Point, Hickam Field, HI (April 2015). *(Photo by CWO5 Michael Neill, USMC[Ret].)*

an enormous signature, is linear, and has long associated decision cycles. This establishes that correlative solutions influenced by deception, economy of scale, and global logistics awareness will be required to inform and modernize capability solutions.

Future

The *fait accompli* of a fluid operational environment controlled by the five drivers, multi-domain transitions, and an institutional aversion to change has forced the Marine Corps into an inextricable dilemma: evolve or be dominated by peer competition. Over the past 75 years, the lack of operational need to achieve agility has generated institutional apathy, which led to the obsolescence of bulk fuel distribution solutions. To achieve agility in bulk fuel transfer and gain combat credibility in the future operating environment, the following three opportunities—derived from historic deficiencies—must inform gap solutions: deception, economy of scale, and global logistics awareness. Solutions informed by these opportunities, coupled with legacy bulk fuel distribution solutions, could evolve the capability into a hybrid bulk fuel distribution solution optimized to support an adaptive force. In other words, hybrid solutions would maintain velocity and accuracy through legacy bulk fuel distribution solutions in static operational environments and attain agility and accuracy with innovative fuel distribution solutions amidst fluid unpredictability.

The first opportunity, economy of scale, creates the virtues of mass without the vulnerabilities of concentration.[17] In this context, solutions that support the agility gap would be focused on the employment and control of multiple mobile fuel delivery systems that operate dispersed and provide riskworthy platforms that enhance the mobility and transportability of bulk fuel. Instead of concentrated stocks of wholesale bulk fuel within ship stores and fuel farms ashore, low-cost mobile platforms—able to receive transferred fuel stocks—would move to and reside in shallow water harbors, rivers, deltas, and coastal waters.[18] These solutions would support maneuver units

One million–gallon fuel farm, 9th Engineer Support Battalion, Bulk Fuel Co, Central Training Area, Okinawa, Japan (January 2017). *(Photo by LCpl Roland James.)*

that possess limited abilities to receive and distribute fuel. Standards informing these solutions would be inexpensive, mobile, remote, and autonomous systems capable of multiple domain transitions and massing and disaggregating based on operational demand. The utility this provides would enable naval force lethality through responsive flexibility in multiple domains and reduce the need for secured interior lines. The non-linearity of the system would remove the legacy systems' exploitable culmination mechanism and amplify resilience.

The second opportunity, deception, informs standards of signature obscuration and the utilization of decoys. Specific solutions to the agility gap would include construction scale additive manufacturing, which creates decoy refueling points; user-defined signature amplification and masking capabilities, which create minimal or increased optical, infrared, and electromagnetic signatures; hide in plain sight platforms, which saturate an operational environment that have the same visual and electromagnetic signature as commercial vessels;[19] and subterranean or subsurface employment to reduce signature. Deception is dependent on original concepts of deployment and tactical-level innovation informed by operational-level guidance. Certain aspects of deception, like decoys, reduce efficiency, but the resilience attained would be through the uncertainty achieved.

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The third and final opportunity, global logistics awareness, informs reduction in decision cycles, enables network degraded environment operations, and facilitates responsive delivery across multiple domains. Possible solutions would be decision support tools to generate predictive demands based on minimal information from the joint integrated data network; enhanced information management processes; and user-defined situational awareness tools that enable faster decision timelines and ensure responsive air, land, and surface delivered supplies from wholesale distributed fuel warehouses to kiosk-level end-users.[20] These solutions would achieve resilience by outcycling a competitor's decision cycle, reducing the joint force and Marine Corps' decision cycle, and eliminating the petroleum lake ashore by removing the middleman.

Bulk fuel distribution solutions informed by the stated opportunities would achieve the compounding effects of agility and accuracy in the future operating environment. More importantly, solutions informed by these opportunities, and combined with legacy fuel distribution solutions, would be employed as a hybrid capability to give the naval force both the resilience and efficiency necessary to support accuracy—and enable it to achieve combat credibility.

Conclusion

In order to be able to compete in the future operating environment, the Marine Corps must move past its obsession with 20th century technology, doctrine, and organization and must align to the 2018 *National Defense Strategy* and *Defense Planning Guidance*. This fact is clear as bulk fuel distribution has not changed much over the past 75 years and has not been forced to change by operational need. Throughout the historical examples, no precedence was ever established of velocity and agility existing concurrently to support accuracy within the same operating environment. More importantly, agility was never achieved in any of the examples above the tactical level for any measurable amount of time. This highlights a capability gap that detracts from force resilience.

As the Marine Corps endeavors to adapt to the changing character of war, the increasing speed of conflict, and the five drivers-for-change, a hybrid bulk fuel distribution capability that is flexible enough to achieve all three MOEs will become necessary to enable the naval force to gain and maintain combat credibility through contact, blunt, and surge layer transitions. If nothing is done, legacy bulk fuel distribution solutions will culminate early or be dominated by peer competitors due to systemic inflexibility. As demonstrated through historical context, a hybrid bulk fuel distribution solution with legacy systems continuing to support in static operational environments to gain efficiency and modernized solutions—informed by the opportunities of deception, economy of scale, and global logistics awareness—and continuing to be employed in fluid operating environments to gain resilience will fundamentally transform this capability and enable an adaptive force. Ultimately, bulk fuel distribution will enable naval force combat credibility—but only if filling the gap of agility becomes an institutional objective.

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Notes

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