Solving the Class IX Riddle

A better way to plan intermediary supply and maintenance sustainment

by Maj Jonathan B. Bong

>Maj Bong is a Internal Logistics (Coyote 40) OIC in Tactical Training Exercise Control Group (TTECG), stationed aboard Marine Corps Air Ground Combat Center Twentynine Palms. He is a 3002 (Ground Supply Officer) and 0477 (Expeditionary Logistics Instructor).

Correlating Material Readiness, Class IX, and Financial Resources

In 1976 and 1977, the Air Force Logistics Command (AFLC) was tasked by then-BGen Mullins (the Deputy Chief of Staff for Plans and Programs at ALFC) to determine how a method of proactive analysis could impact potential wartime operational effectiveness. At the time, this represented a significant departure from previous Air Force operational planning practice in which individual combatant commanders planned operations in relative vacuum (without the AFLC capabilities and restraints factored in). The result was that planning operations were being constructed without considering competing requirements and may not have been supportable from a global logistics/industrial output point of view.[1]

By 1980, Congress and the Government Accountability Office (GAO) acknowledged that the existing metrics tying logistics resources to readiness were insufficient, stating that the "DOD spends billions each year to maintain the readiness of its weapon systems but cannot accurately project how much readiness a dollar will buy or determine how much readiness is needed."[2] Forty years later, little has changed. The GAO this year highlighted the issue that monitoring readiness issues at the Service level exclusively misses key readiness issues in the capabilities of the joint force.[3] More specifically, the balancing of two competing costs when referring to Class IX from a supplier/consumer perspective.

- The first cost is the potential cost (in adverse effect) to mission or potential opportunity cost due to stock age levels of zero. The DOD generally reflects this as material readiness and principal end items that are dead line and currently within the maintenance cycle.
- The second is the cost of providing sufficient on hand inventory to prevent adequate protection against inventory depletion. As weapon systems become increasingly complex and expensive, their accompanying maintenance tail likewise increases in cost proportionately.

Over stockage bears its own opportunity cost in terms of money that could otherwise be spent on force structure, modernization, and new capabilities necessary for maintaining a competitive edge against our adversaries. Comparable to the Air Force over four decades ago, the Marine Corps is lacking a more analytical, centralized approach to Class IX planning and tracking across the Service writ large. Addressing this gap will better utilize our limited financial resources, maximize material readiness, and identify Class IX gaps that do not currently exist during steady state/garrison tempo but will exist during the increased tempo generated by wartime requirements.

Class IX Planning at the MEF level

The specific service issue with Class IX is actually part and parcel of a greater MLG problem in that the MLGs do not have a standardized framework for measuring excess capability and capacity in terms of filling unforeseen operational requirements.[4] Within each MEF, a supply battalion supports all ground equipment Class IX requirements for both steady-state garrison requirements as well as expeditionary units such as MEUs or Special Purpose MAGTFs. Requisitions that cannot be filled are filled directly by the Defense Logistics Agency. The target metric that supply management units (SMU) aim to increase is fill rate. Thus, the most highly ordered items are the ones stocked to the highest levels in order to maximize SMU shelf space. Each SMU, under the cognizance of each supply battalion commander, stocks in accordance to the MLG/MEF commanders priorities. This current construct, while adequate for garrison needs, is generally reactive and any forward planning is based on analysis of historical demand. Additionally, any operational planning decisions (in terms of specific parts blocks) are made entirely on the experience and knowledge of the SMU staff in conjunction with inputs from maintenance officers within requesting units. The quality and analytical rigor behind each analysis is as variable as the Marines who happen to be behind the wheel, and total Service stockage levels are not analyzed—let alone total DOD inventory levels for joint weapon systems or industry constraints taken into account.

Cold War Solution: Dyna-METRIC

Shortly after identifying these issues, the Air Force began working on a solution in conjunction with the RAND Corporation in the late 1970s and 1980s. Based primarily on Palm's theory,[5] RAND developed METRIC (Multi-Echelon Technique for Recoverable Item Control), a mathematical technique for forecasting peacetime demands for spare parts and determining optimal inventory levels at various consumer levels.[6] However, METRIC was not fully mature until dynamic scenarios were added to its otherwise steady-state approach that allowed the system to evaluate the variable of changing wartime demands and their effect on logistics resourcing on projected aircraft sortie rates. Termed Dyna-METRIC, and continuously updated throughout the 1980s and 1990s, it would become the key analytic tool utilized by AFLC until the end of the Cold War. What made Dyna-METRIC such a quantum leap in the supply and repair parts analysis process was its ability to precisely calculate the distribution of a number of parts in a repair pipeline taking into account evolving and non-steady state environments; including scenarios in which abrupt transitions would occur (i.e. rapid escalations to conflict). This ability is absolutely critical for maintenance and supply planners for the reason that transitions from peace to wartime may occur abruptly without sufficient lead time to increase stock of critical Class IX inventory. Material readiness, as a metric, can be misleading as it provides a commanders a snapshot in time of current equipment posture. What often gets overlooked is the issue of *sustainment*. The critical difference being that an adequate sustainment metric tells the commander for how long and at what cost maintaining variable operational tempos will have on his equipment. Dyna-METRIC's capability to model equipment failure rates and assess the distribution of parts within a given repair pipeline will be critical information needed during the early stages of conflict in which initial successes or failures may be irreversible.[7]

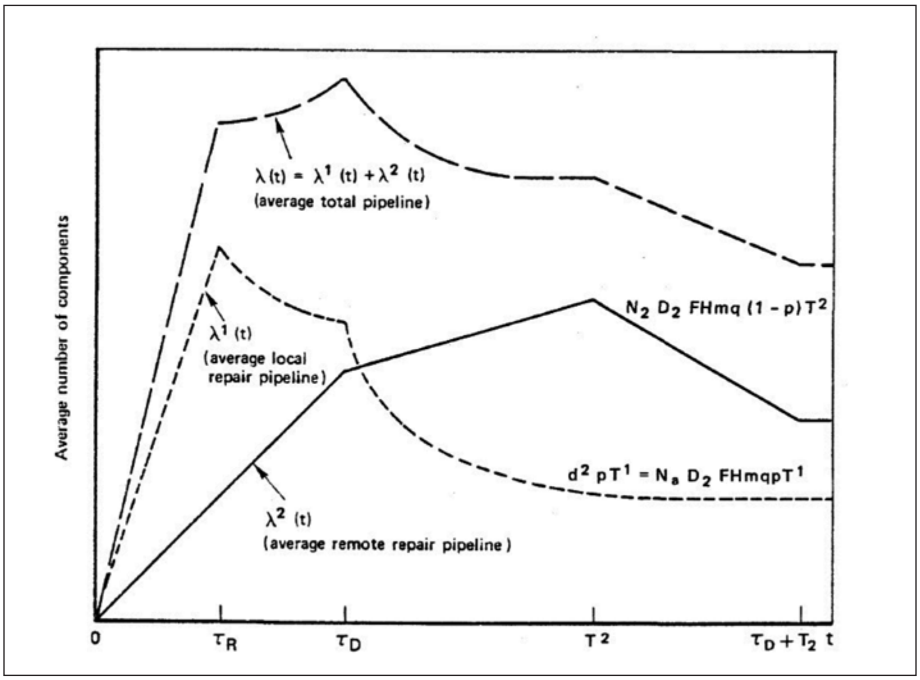

Figure 2. Illustration of average calculations. ***(Figure provided by author.)***

The End of the Cold War & the Adoption of VISION by the Army

Throughout the 1980s, the base models of Dyna-METRIC would be expanded and enhanced to branch and form various specialized sub-systems for better control and tracking of specific aspects of the logistics process. Some of these programs are still in use by the Air Force to this day (i.e. WSMIS). However, by 1992, the end of the Cold War caused cross-service military drawdowns with an emphasis shift away from wartime support systems and towards cost savings through more efficient logistics processes.[8] In 1992, the Army took interest in developing the Dyna-METRIC model as a Class IX oriented decision support system designed to improve equipment sustainability of high-end ground platforms.[9] Some of this interest was a result from experience gained in Operation DESERT SHIELD; at the time, the Chief of Staff of the Army tasked the Major Subordinate Command and Army Material Command to project future readiness of key weapon systems based on a number of different operational requirements. At the time, the Chief of Staff's task could not be answered adequately for the following reasons:

1. Projections were focused on historical trends moderated by subjective factors.
2. Overemphasis on quantitative analysis on current problems and not projected problems.
3. Lack of integration with other Major Subordinate Commands, injecting degrees of variability that made consistency problematic.[10]

The original Air Force officer who was part of the design team that pioneered Dyna-METRIC (in conjunction with RAND), Col Robert Tripp (Ret) developed a prototype (again with RAND) for the Army called the VISION Assessment System (VAS). The prototype and concept were tested in 1992 and jointly sponsored by the Assistant Deputy for Material Readiness of Army Material Command, the Commanding General of Combined Arms Support Command, and the Strategic Logistics Agency. Under the suggestion of Tank Automotive Command, the M1 Abrams tank was utilized as the test vehicle for this initial prototype because of it being both logistically burdensome as well as a critical weapons platform. The results of the test were mixed: on the one hand, the suitability of the Dyna-METRIC model included in VAS was more than capable of being adapted to ground equipment and was able to represent Army support structures, policies, and current resource allocation at the time. However, the Army's STRATIS (Standard Army Management Information Systems) supply and maintenance data system was insufficient in supplying the requisite data needed to operate VAS under deliberate and time-sensitive planning contingencies. Much of the root of the data availability issues stemmed from the constraints of programming limitations at the time.

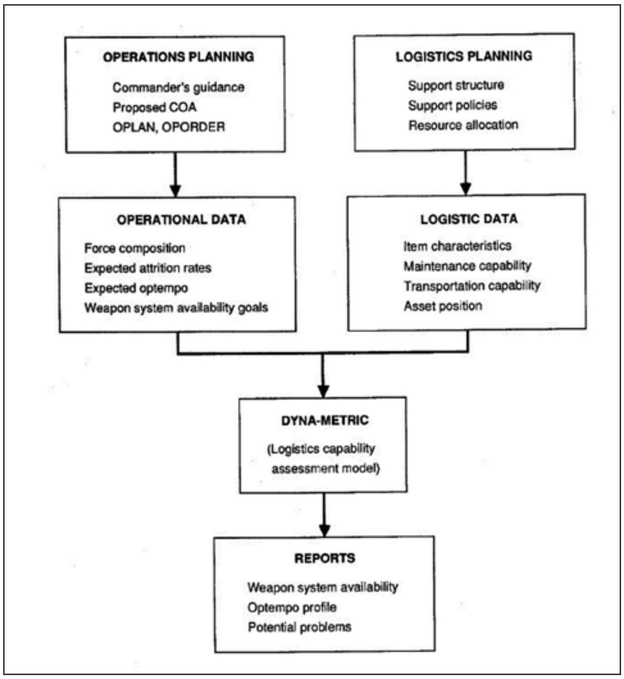

Figure 3.1. Basic structure of VAS. *(Figure provided by author.)*

Post Operation IRAQI FREEDOM/Operation ENDURING FREEDOM and the Return to Great Power Competition

On its face, the idea of utilizing Dyna-METRIC seems ridiculous. What relevance could a computer program written over four decades ago for the Air Force have with modern Marine Corps requirements against peer adversaries within a future EABO construct? I argue that it has great relevance. First, the Cold War was the last time the United States was faced with a peer adversary. Maintaining high operational tempo was seen as critical to a conflict that could escalate with little to no warning and would require rapid regeneration of manpower and equipment as a result of the high projected casualties. The organizations and departments tasked to manage this level of conflict (such as Requirements and Capabilities Directorate, ALFC/XRP) spent decades developing tools and techniques to assess readiness and support wartime activities. I consider it premature to automatically discard any work from this area as irrelevant due simply to age.

Second, while the computer programming is obsolete due to the age of the original platforms when it was developed, the mathematics behind the programming is still as relevant today as any of the laws of classical mechanics originally published in 1687. The mathematics behind Dyna-METRIC are founded in probability theory and statistics, primarily that of Poisson distribution and Palm's Theory.[11] Palm's Theory is useful in modeling inventory problems in METRIC because of the theorem's limited domain of applicability, time dependent customer arrival rates approximated by constant rates, and arrivals with large variability by Poisson arrivals.[12] Poisson distribution theory is still mathematically relevant and used in commercial applications for modeling discrete probability distributions. The original programming used in Dyna-METRIC was based on the functions and equations developed by Simeon Denis Poisson in 1823 and used to model equipment failure rate and inventory stock levels.

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What I am proposing is a complete overhaul of the way the Marine Corps currently executes Class IX stock and planning. Its current decentralized construct over relies on the subjective expertise of the Supply Management Units. Installations & Logistics should centrally manage Class IX stock through the entire Enterprise via the

THEOREM 1 (Palm 1943, Takács 1962, p. 160—Palm's Theorem). *Consider the $M/G/\infty$ queue with homogeneous Poisson input at rate $\bar{\lambda} > 0$ and a stationary service distribution F with mean $1/\mu$. Then, as $t \to \infty$, the limiting (steady state) distribution of the number of arrivals still in service is Poisson with mean $\bar{\lambda}/\mu$.*

THEOREM 2 (Takács 1962, p. 160, Feller 1968, p. 460). *For the $M/G/\infty$ queue, let the arrival intensity $\lambda(t) = \bar{\lambda} > 0$ for $t \geq 0$, and $\lambda(t) = 0$ otherwise. If the service distribution is stationary, the number of arrivals still in service at time t has a Poisson distribution with mean*

$$\Lambda(t) = \int_0^t \bar{\lambda}[1 - F(s)]ds.$$

THEOREM 3 (Hillestad and Carrillo 1980, Crawford 1981). *Suppose we have nonhomogeneous Poisson input with intensity function $\lambda(t) \geq 0$ for $t \geq 0$, $\lambda(t) = 0$ otherwise, and nonstationary service distribution G. Then the number of arrivals undergoing service at time t has a Poisson distribution with mean*

$$\Lambda(t) = \int_0^t [1 - G(s, t)]\lambda(s)ds.$$

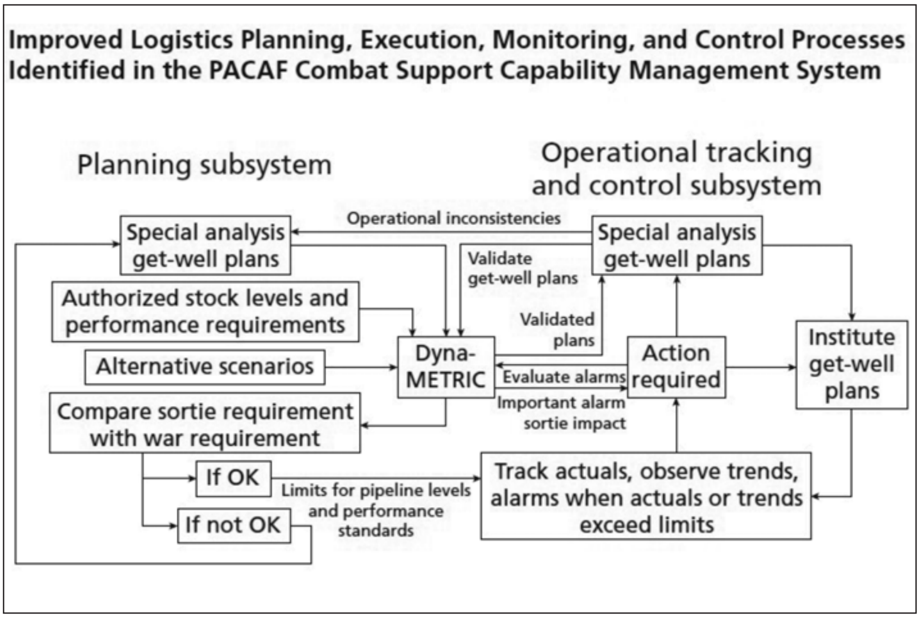

Figure 4. ***(Figure provided by author.)***

$$P(k \text{ in pipeline}) = \frac{\lambda_{ss}^{k} e^{-\lambda_{ss}}}{k!}$$

Figure 5. Palms Theory–Applied in Dyna-METRIC. ***(Figure provided by author.)***

Dyna-METRIC model. Quantum leaps in computing power since the 1980s means we are able to model with more detail and over a larger number of critical weapons platforms. Eventually, the goal should be total asset visibility with the other DOD components as well as the industries currently supporting us. With this tool, operational planners will have to ability project material readiness based on multiple courses of action and factor that data into their decision making as well as explore cost reduction and resource optimization at the points of assumed risk. If we continue to utilize the current method of intermediary supply and maintenance, we will continue to suffer a sustainment blind spot that will likely only be exposed during a high-tempo conflict when we can least afford it.

Notes

1. Robert Tripp, *The Line Between Order and Disorder*, (Santa Monica, CA: RAND, 2020).

2. Staff, The DOD Material Readiness Report, (Washington, DC: Government Accountability Office, 1980).

3. Staff, "Report to Congressional Committees–Military Readiness," (Washington, DC: Government Accountability Office, 2021).

4. Wong Hemler and Lewis Perry, *Developing a Capacity Assessment Framework for Marine Logistics Groups*, (Santa Monica, CA: RAND, 2017).

5. Manuel J. Carrilo, "Note-Extensions of Palms Theorem: A Review," *Management Science*, (Catonsville, MD: Institute for Operations Research and the Management Science, 1991)

6. *The Line Between Order and Disorder*.

7. G.B. Crawford, *Palms Theorem for Nonstationary Processes*, (Santa Monica, CA: RAND, 1981)

8. *The Line Between Order and Disorder*.

9. Robert Tripp, Christopher Tsai, Patricia Boren, *An Initial Evaluation of the VISION Assessment System*, (Santa Monica, CA: RAND, 1992)

10. Ibid.

11. *Palms Theorem for Nonstationary Processes*.

12. "Note–Extensions of Palm's Theorem: A Review."