Logistics and Analysis in the Science of War

by James A. Harvey III

Studies conducted by the Army Materiel Systems Analysis Activity are making significant contributions to improving logistics operations.

The analysis of warfare is not new and in fact has been occurring for centuries. More than 2,000 years ago, the Chinese military theorist Sun Tzu took analysis of war seriously enough to put his thoughts down in writing. In the 19th century, two great military theorists, the Swiss-born Antoine-Henri Jomini and the Prussian Carl von Clausewitz, also analyzed war, including the question of whether war was more of an art or a science.

Clausewitz, in the end, determined that war was a gamble and that factors like the "fog of war" and "friction" do not allow war to be completely driven by science. (Friction is what Soldiers today call "Murphy.") Jomini originally thought that the practice of war, like other disciplines, could be broken down into solid, rational principles that, if followed, would produce success on the battlefield. Ultimately, Jomini seemed to realize that such analysis was not very realistic and that war was both science and art.

However, this article is not meant to reignite the Clausewitz versus Jomini or the warfare art versus science debates. My real purpose is to demonstrate that by using some of the Army's current analytical capabilities, scientific principles can be applied to the study of battlefield and peacetime logistics. The use of these objective methods would have been appreciated by Jomini because he was one of the first great theorists to actively consider logistics while developing his theories.

I would argue that the logistics aspects of warfare are in fact more open to scientific analysis than other aspects. I think this can be demonstrated by reviewing several examples of the logistics analysis performed by the Field Studies Branch (FSB) of the Army Materiel Systems Analysis Activity (AMSAA).

AMSAA's Mission

AMSAA, located at Aberdeen Proving Ground, Maryland, is the Army's materiel analysis organization. Although other analytic organizations focus on tactics, strategy, and lessons learned outside of the materiel realm, examining the materiel aspect of the Army's functions is the driving force behind AMSAA's mission.

FSB focuses on the analysis of logistics systems, processes, and materiel. This analysis is conducted by engineers, operations research analysts, mathematicians, and other personnel in objective disciplines. FSB supports the logistics aspects of Army warfighting by providing the types of scientific analysis that Jomini could only dream of.

The Office of Personnel Management classifies operations research and systems analysis (ORSA) as career series 1515 and states, "The primary requirement of operations research work is competence in the rigorous methods of scientific inquiry and analysis rather than in the subject matter of the problem." The military officer equivalent to the civilian 1515 series is functional area 49. The entire AMSAA workforce, other than the deputy director, who is a colonel, consists of Department of the Army (DA) civilians and contractors.

Deployment of Analysts in Southwest Asia

One use of analysis in logistics has been AMSAA FSB's deployment of analysts to Iraq, Kuwait, and Afghanistan. These analysts provide logistics analysis support while deployed in support of Army field support brigades (AFSBs). AFSBs provide the critical interface between the materiel enterprise and the warfighter. Currently, the 401st AFSB is in Afghanistan and the 402d AFSB is in Kuwait after leaving Iraq. However, the 402d does continue to support the Department of State mission in Iraq. The FSB deployed analysts to Iraq in September 2006 and to Afghanistan in August 2008 on a rotational basis.

FSB analytic capabilities have led to logistics improvements through studies such as the following.

Fire suppression systems. During 2007 and 2008, fire suppression systems in combat vehicles in Iraq were experiencing premature discharges that made vehicles not mission capable, which in turn degraded combat power. FSB's Steve Webb was attached to the 402d AFSB and conducted an analysis that helped to resolve this problem. For his efforts in this and other studies while he was deployed, Webb received one of the Army Materiel Command's 2009 Louis Dellamonica Outstanding Personnel of the Year Awards.

Tactical wheeled vehicle power draw. A tactical wheeled vehicle (TWV) power draw study was used to determine if the electrical load on various TWVs was too

A deployed AMSAA analyst installs devices to gather data on a tactical wheeled vehicle during the AMSAA power draw study.

large for their design specifications and, if not, how much "head room" remained for potential future items to be installed with an additional increase in power draw.

Stryker temperatures. Temperature data collection and analysis of Stryker armored vehicles in Iraq helped lead to the installation of air-conditioning. The data were collected by AMSAA analysts and compared to Army Public Health Command data showing that temperatures in Strykers could exceed those the human body could withstand. Using a $45 sensor to collect temperature data yielded more than $20 million in funding to support compartment cooling redesigns in Strykers and tracked vehicles.

These analyses, backed up by data, helped to provide solutions that prevented the degradation of combat power. Such degradation affects lives and resources. As the Army moves into an era of scarcer resources, resource conservation will become even more important, and data-driven analysis should lead the way. The emphasis given to managing financial resources in current operations, as demonstrated by the Commander's Guide to Money as a Weapons System (Center for Army Lessons Learned Handbook 09–27), testifies to the important role money plays in combat power and sustainment.

Sample Data Collection

Sample data collection (SDC) is an Army G–4 maintenance program that involves the worldwide collection of maintenance data from a sample of Army combat vehicles, TWVs, artillery systems, and aviation assets (including unmanned aerial vehicles and rotary-wing airframes). As the responsible office for executing the SDC program, AMSAA FSB maintains a presence at most Army locations worldwide and uses contractor personnel to collect data. FSB DA civilians and contractors analyze the data for presentation to senior leaders as required. This in turn helps senior leaders to make Army fleet-wide decisions in such areas as new acquisitions, capitalization, and reset.

Unit maintenance personnel and other vested parties outside of the Army's senior leadership also can request and use the collected maintenance data. Such analytical capabilities allow leaders to make tactical-, operational-, and strategic-level decisions that affect logistics operations on the battlefield supported by actual data. Sample maintenance data can be used to make better informed decisions.

An example of how SDC data help leaders make informed decisions is manpower requirements criteria (MARC), which are used when building or updating Army unit modified tables of organization and equipment (MTOEs) or tables of distribution and allowances (TDAs). An accurate, data-driven analysis of the true labor hours needed to perform maintenance will result in a more realistic MTOE or TDA. Data can also help illustrate the impacts of any maintenance actions, whether scheduled or unscheduled, on vehicle downtime.

Condition-Based Maintenance

Another analysis program under the SDC program that enhances Army combat power is the AMSAA condition-based maintenance (CBM) program. This program grew out of the larger Department of Defense CBM initiative, which was designed to make maintenance practices more prognosis-driven. Ultimately, CBM's goal is to focus maintenance more on responding to the actual condition of equipment than on simply performing services at fixed intervals. The result will be more maintenance dollars saved and fewer mission failures caused by equipment breakdowns.

In 2006, AMSAA FSB began installing instrumentation devices on most TWV variants throughout the world; these TWVs operate in different climates and terrain and with different usage profiles. The instrumentation devices collect critical data points for analysis from the vehicles' J1939/J1708 sensor network. Additional data are received from other instruments feeding into the data recorder, such as accelerometers and global positioning system devices installed on the vehicles. The data are then collected and analyzed to look for any outcomes that can help to support CBM goals.

One such analysis matches the SDC maintenance records with a CBM-instrumented vehicle. Provided a mechanical failure occurs during the data collection period, analysts try to determine predictive algorithms that match the maintenance records with the sensor data on that particular failure event recorded from the instrumentation devices. The goal is to use any developed algorithms to predict the future better and thus prevent mechanical failures before they happen. The hope is that this will mitigate mission failures caused by mechanical issues.

While much work remains to be done in this area, the usage data analysis has already provided returns. One such area is in reducing the fuel consumption caused by high idling rates among TWVs operating in Iraq and Afghanistan. The high idling rates have interested senior leaders as a potentially easy target for cutting fuel costs in a resource-conscious Army. For example, as a result of the CBM analysis, Product Manager Heavy Tactical Vehicles will soon refit some line-haul trucks with tactical idle-reduction systems.

Like SDC itself, the CBM data analysis has numerous other benefits. These examples serve as a demonstration of the usefulness of CBM data analysis in making better-informed logistics decisions for the Army's vehicle fleets and equipment.

AMSAA Materiel Lessons Learned Analysis

Another subcomponent of the SDC program is AMSAA Materiel Lessons Learned Analysis (AMLLA). This is a program that identifies systemic maintenance issues that can be resolved at the lowest level possible. The AMLLA program uses SDC contractor personnel to gather data "on the ground" and research systemic failures firsthand. Using reach-back capabilities, FSB analysts then can apply the full range of AMSAA capabilities to the problem, such as using modeling and simulation to conduct physics-of-failure analysis and determine how failures are occurring.

These three examples resulted from analysis of Stryker platforms:

A coolant hose ruptured, spraying hot coolant on the vehicle's gunner. As a result of the analysis, General Dynamics Land Systems agreed with AMLLA's recommendations to install additional covers and add the item to the preventive maintenance checks and services table.

The telescoping steering column mechanism of the Stryker vehicle was seizing. After AMLLA analysis, General Dynamics Land Systems recommended implementing short-term changes suggested by the steering manufacturer (TRW Automotive) as a high-priority way to improve durability.

The bolts on the mounting for the Stryker driver's hatch were gouging supplemental armor and would not allow the hatch to open all the way. After AMLLA analysis, General Dynamics Land Systems implemented engineering design changes.

Given the high pace of current operations, the absence of the AMLLA program would likely have left these types of systemic failures in the "just deal with it" category. However, that approach would have affected missions because the failures could have adversely affected safety, morale, or lives.

After serving in Afghanistan as a deployed AMSAA representative from August 2010 to February 2011, I appreciated the role played by analysts in trying to affect the warfight. Most noticeable was the use of ORSA analysts in combat support roles, such as countering improvised explosive devices, and in social demographic work, like determining election results. Surprisingly, I found that very few ORSA analysts knew much about theater logistics or what an AFSB was. Very little rigorous analytical support such as ORSA was evident in addressing logistics concerns.

The logistics aspects of current operations offer no shortage of work for analysis. Based on my experience, some logistics areas that I believe are candidates for further analysis include new equipment fielding processes, Afghanistan intratheater aviation transportation, dining facility efficiency (including the convoys that supply them), forward operating base traffic patterns, and noncombat unit utilization and workload ratios.

It is rather easy to demonstrate the need for analysis and the use of science applications in warfare. In particular, given modern advances in technology and the logistics tail needed to support them in an increasingly budget-constrained environment, logistics is an area in which analysis can pay huge dividends. It appears that now is the time to focus more of our analysis capabilities on logistics to preserve combat power in the future Army.

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