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Understanding Gaps Between Doctrinal and Operational Behavior

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Author Note: The authors participated in a year-long senior research project in the Department of Systems Engineering at the United States Military Academy under the advisement of Paul Evangelista. Paul Evangelista is a Colonel in the US Army and currently serves as an Academy Professor.

Abstract: The US Army needs to improve its consistency in measuring small unit behavior in order to understand the gap between doctrinal capabilities and operational behavior. The presented methodology identifies key factors that determine operational effectiveness by exploring position-location data and mission context for small units conducting training missions at Ft. Benning, GA. Systematic analysis of this data led to the creation of a consistent quantitative method for measuring small unit performance. The quantitative method can then be paired with qualitative analysis to provide a holistic evaluation of the unit's performance. This work provides two contributions. First, the methodology can be used by commanders to measure the effectiveness of their formations and identify gaps between operational behavior and doctrine. Second, the work provides a foundation for future research in this underdeveloped field of small-unit analysis.

Keywords: Operational Behavior, Doctrine, Evaluation Tool, Operational Effectiveness, Small Units, US Army, Gaps

1. Introduction and Background

Ranger Hall of Fame member Colonel (Retired) Keith Nightingale states that "the squad is the most important and most neglected of all military organizations." (Nightingale, 2018). While the squad's level of importance can be debated, it is undeniable that the squad represents a complex system of interactions that impact the success of the larger military organization. In theory, the US Army utilizes doctrine to control the actions of a squad. However, many military commanders and leaders acknowledge that soldier and small unit behavior does not always match doctrine, especially when soldiers are placed in a combat-simulated environment. In 2013, a report from the National Research Council recommended that the Army should develop a method for measuring small unit performance (National Research Council, 2013). This acknowledgement raises the question of how to measure and assess the gaps between operational behavior and doctrine. Since the 1950's, the US Army has conducted qualitative studies aimed at answering this question (Barber et al., 1991). Previous research identifies three main categories of factors that determine operational effectiveness: physical, cognitive, and social. Physical factors involve easily observable characteristics such as fitness or shooting accuracy (Dupuy & Hammerman, 1980). These components provide the foundation for many activities, but current analysis methods treat them as isolated entities and do not holistically measure their interactions. Cognitive factors involve matters such as mental state and cognitive overload (Laird & Wray, 2003). Most research in this area theorizes that these concepts play a significant role in operational effectiveness, but no numerical method exists to quantify their impacts on a small unit level. Social factors encompass interpersonal interactions such as leadership, motivation, and cohesion (Mael, 1989). Each of these three areas could be improved be providing a consistent method that measures more than just the individual soldier. Currently, the Army provides this feedback by utilizing experienced soldiers to grade small unit operations. While this method has benefits, it can fail to provide a holistic view and is prone to subjectivity. In the past decade, the Army has employed methods such as placing GPS trackers on soldiers to collect raw location data during training events. This represents movement in the right direction, but the data collection lacks consistency, and the methods of analyzing that data remain underdeveloped. According to the National Research Council, the need to address this area of research that "has always been insufficiently resourced" exists and demands more attention (National Research Council, 2013). The key to addressing this issue is understanding how the squad, as an integrated system of soldiers, interacts in an operational environment. Once the Army's understanding of interdependencies among Soldier's behavior becomes clear, the squad's behavior can be assessed against doctrine to provide a more accurate assessment of military performance. The potential to analyze small unit behavior through data analysis already exists in the form of GPS-based trackers. However, no major effort to streamline data collection has been made, and no methodology or proven metrics exist for the interactions of the Soldier

(National Research Council, 2013). The following work provides a consistent measurement model to address the issues raised above and highlights a streamlined framework for data collection that is necessary to achieve effective analysis.

2. Methodology

A classic systems engineering process using a V-Model approach was employed (shown below in Figure 1), beginning with problem definition. The main problem centers on the need to improve the Army's ability to measure soldier behavior to identify and understand gaps between doctrine and behavior. The work focuses on dismounted soldiers in small unit missions. Four main lines of effort support the goal of understanding small unit behavior. These lines of effort included the visualization of position-location data, the measurement of speed and distance, the measurement of soldier location relative to each other, and the understanding of operational context to provide greater insight. To develop each of these concepts, we analyzed data and action reports from small unit missions at Fort Benning, GA. Using this data, we created general quantitative methods that produce numerical output. Combined with visual aids, the output from these models provide the core of our research effort. These models include maps of soldier position over time, graphs of soldier speed over time, and graphs of key leader distance relative to other soldiers. After extensive efforts to verify the code and validate the results with actual field reports, we compared the output of our models with current Army doctrine.

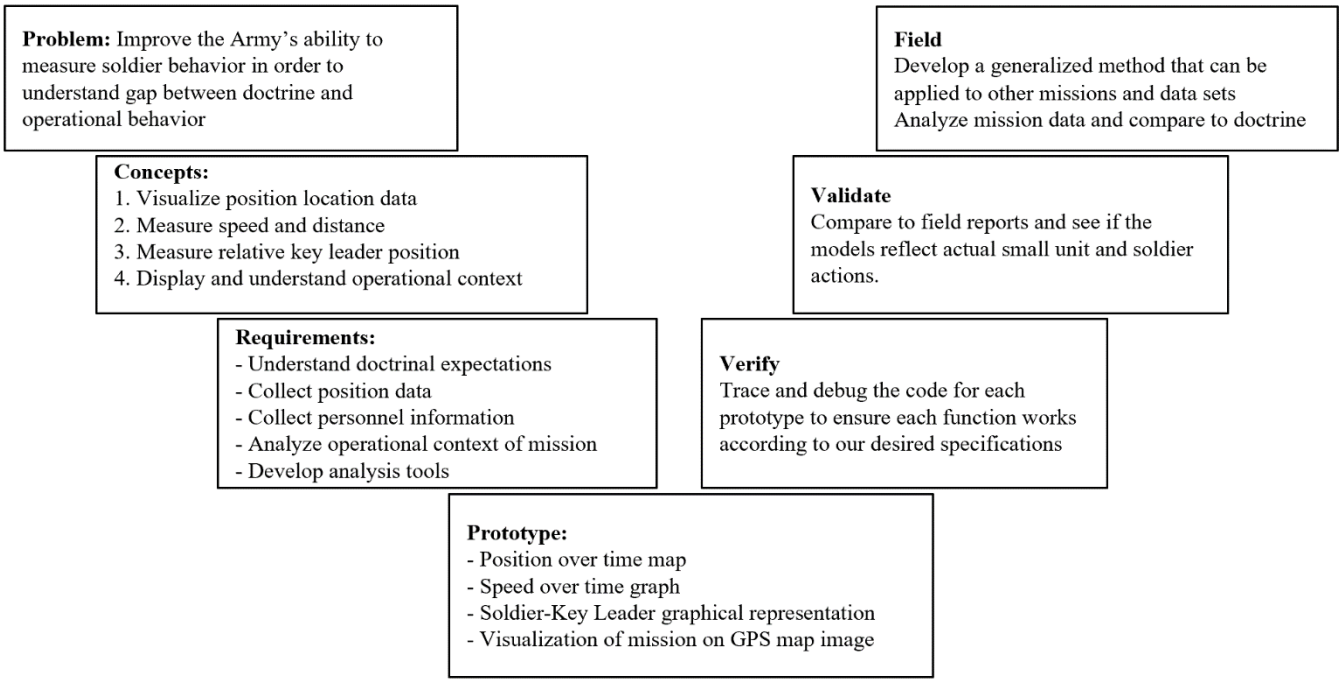

Figure 1. Systems Vee Diagram

3. Results

3.1 Visualize Position Location Data

The goal of the first concept is to analyze position location data for soldiers and display the data on a map of a designated mission area. Necessary components for this process include a latitude, longitude, and timestamp for each data point representing soldier location. For all the analysis that will be discussed, the data sets used contain a soldier identification tag, latitude, longitude, and timestamp for each data point. The data represents a training unit at Fort Benning in March of 2009.

The latitude and longitude in the original data do not need to be manipulated, but the timestamps need to be cleaned before applying them in a script. An R script was used to create graphics of the data points on a map of the mission area. The timestamps are first manipulated using general expression substitution so that it is in the form of "H/M/S" which gives the hour, minute, and second of the data point This is an automated process. The latitude, longitude, and timestamp are then read into the script, which plots the points on an image of the training area. Here, creating the image of the training area is an analog process done using Google Earth, but once the image is created, the script which plots the points is automated. An example graphic depicting the position of the platoon sergeant throughout an ambush mission is shown on the left in Figure 2.

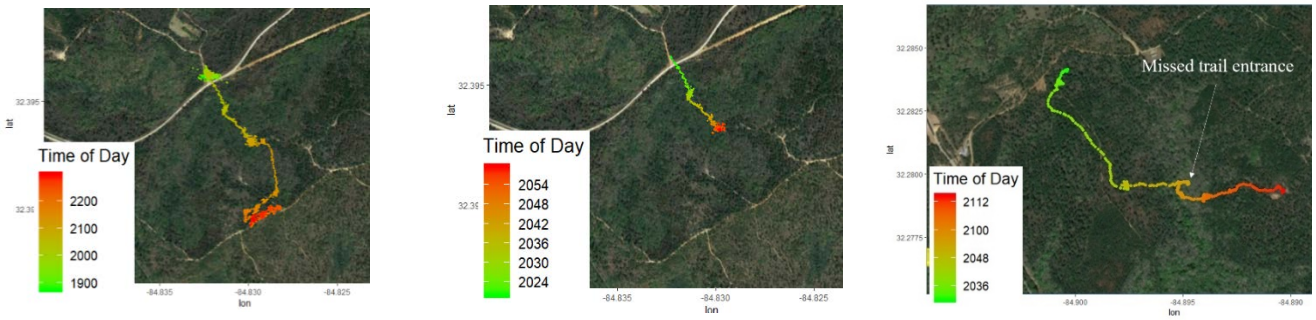

Figure 2. Soldier Movement Patterns: Analysis of Efficiency

Qualitative analysis can be used in conjunction with concept 1 to assess operational behavior. First, the user should analyze the efficiency of movement to determine if the major movements are efficient and follow a tactical route, or if the movement meanders inefficiently. These questions, in conjunction with knowledge of the terrain, can demonstrate whether the movement is effective or sloppy. In Figure 2, the image in the middle displays highly efficient movement while the image on the right displays meandering, inefficient movement.

Next, the user can assess various tactical distances against doctrine. For example, doctrine specifies that a security halt should occur 100-200 meters from the objective rally point (ORP) during low visibility (Ranger Handbook, 2017). Using point clusters in concept 1 to identify halts and ORPs, the user can measure distance and compare operational behavior to doctrine (analog). This was accomplished by noting the times at each point cluster (analog) and finding the distance between a soldier's location at both times. The first image in Figure 3 provides an example of a security halt that is too far from the ORP, given the parameters of the mission. The user can also measure the distance of the ORP to the mission objective. According to doctrine, the ORP should be out of sight, sound, and small arms range of the objective (Ranger Handbook, 2017). Our analysis gives insight into the distance in meters, but no insight into the sight aspect of ORP selection. The second image in Figure 3 provides an example of this type of assessment.

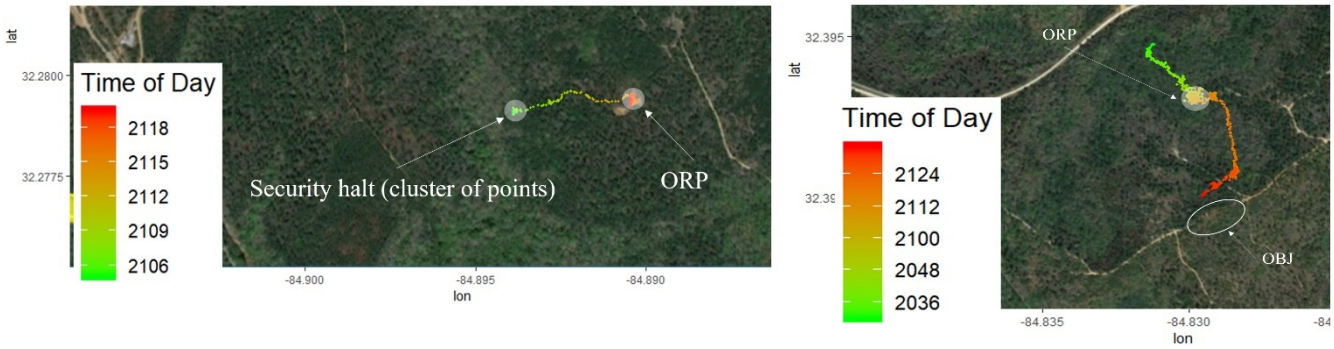

Figure 3. ORP Location Analysis: Security Halts, ORPs, & Distance to the OBJ

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3.2 Measure Speed and Distance

The second concept analyzes speed and distance traveled for soldiers throughout the course of a mission. The goal of this concept is to understand the rate at which soldiers are moving during different parts of a mission. In order to collect this information, a script would measure the distance of each data point from the last. Using the distance, the script would calculate the speed at which the soldier traveled from the last point by dividing the distance traveled by the time elapsed. Next, the speed values were averaged over the previous 25 data points to create a speed range. This also smooths the curve which gives a better visual representation of speed over time without jumps in the data. An example of a speed measurement plot is below in Figure 4. The plot shows platoon sergeant's speed throughout the duration of an entire mission from start to finish.

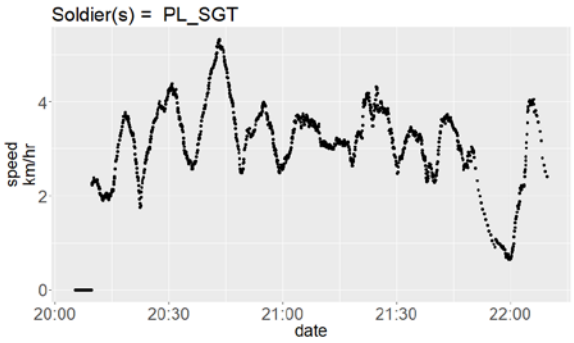

Figure 4. Soldier Movement Over Time

The average speed of the platoon sergeant is about 2.5 km/h. However, the plot shows what times during the mission his speed increased or decreased. Of note, the plot allows the user to infer information such as when the platoon came to a halt, when they stopped at the ORP, or when they were moving most efficiently toward the objective. This type of speed analysis for dismounted soldiers is, again, a capability that the Army has had for a long time, but one that the Army has not explored deeply and has the potential to improve upon using the presented methods.

3.3 Measure Relative Key Leader Position

The third concept analyzes the position of key leaders relative to their subordinate leaders throughout the course of a mission. The goals of this concept are understanding how far apart key leaders generally are from their subordinates throughout missions, and if that distance is important to the success of the unit. Doctrine says each soldier has a standard position in the squad in which everyone can see the next echelon of command (FM 3-21.8, 2007). This information is not very specific and gives no guidance regarding the actual distance commanders should be from their subordinate leaders. Therefore, gaining an understanding of this type of information can lead to a better understanding of what makes a unit successful. In order to collect this information, a script looped through the locations of two soldiers throughout the course of a mission, collected a time stamp and location for each soldier at the beginning of every minute, and measured the distance the soldiers are apart. An example plot is shown below in Figure 5.

3.4 Display and Understand Operational Context

The fourth concept uses position location data and field reports to create a greater understanding of the mission by providing operational context. In turn, this allows the user to gain a deeper understanding of the data and draw more accurate conclusions. Each mission can be divided into smaller periods of time This concept involves limitations in that it is extremely mission specific. Concept four is not a general numeric method like the other concepts. Products such as Figure 6 must be created manually by the user. It requires detailed reports of the mission and the numerical methods outlined in concept 1. The usefulness of this product increases if the user is unfamiliar with the mission being analyzed. For someone who is completely unfamiliar with the specific mission, this concept provides the necessary information to draw accurate conclusions.

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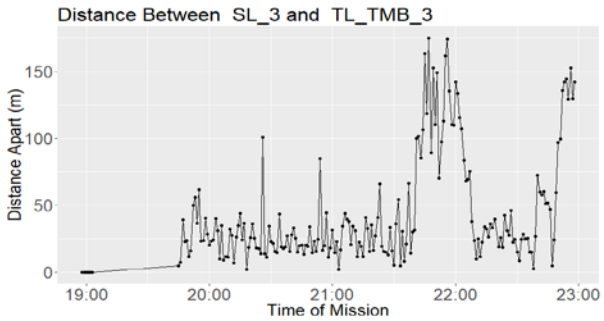

Figure 5. Relative Soldier Distance

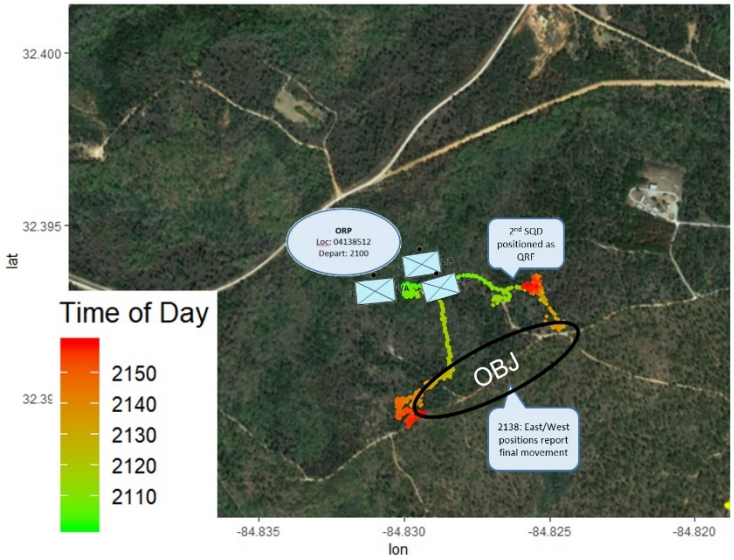

Figure 6. Operational Context

This concept can also be combined with concept 1 and applied to assess the distance of the main element to the objective. Doctrine does not specify this distance, but the user can assess unit effectiveness by asking various tactical questions regarding items such as soldier concealment, minimum safety distances for fire missions, and effective ranges for small arms. Figure 7 provides an example of this assessment. In the mission shown on the left in Figure 7, the main element transitions from setting an ambush to screening for other troops in contact. Their movement goes too close to the road and has the potential to reveal their location to the enemy.

Similarly, many military commanders also assess a unit's performance in a mission by the amount of time spent on the objective. Mission specific information determines the appropriate amount of time a unit should spend on an objective, but concept 1 allows the user to accurately assess the unit's time on objective. The image on the right in Figure 7 provides an example of this assessment, showing that the main element spends approximately 25 minutes on the objective during the mission. This was determined by understanding the location of the objective using the operational reports, then manually finding the timestamp when soldiers first moved onto the objective and when they left the objective, based on the plots of the soldiers' locations.

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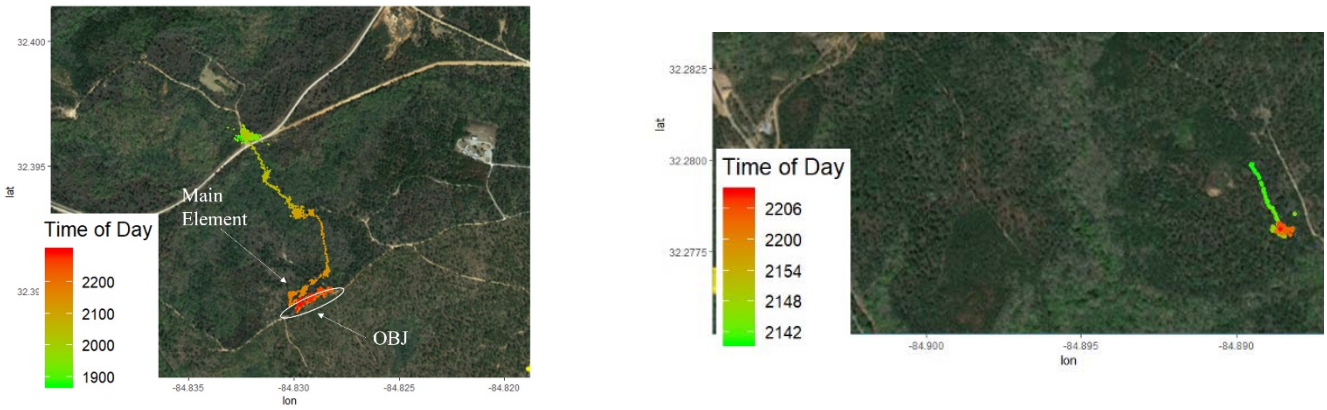

Figure 7. Main Element Analysis & Time Spent on the Objective

4. Conclusion

The presented research provides two primary contributions: (1) a set of basic tools for measuring soldier and small unit behavior using position-location data, and (2) a baseline for future research in the field of quantifying operational behavior and soldier effectiveness. First, the general quantitative method for plotting position-location data can be applied to data sets from soldiers wearing tracking devices. In combination with the other qualitative and quantitative assessment methods presented, commanders can better understand the operational behavior of their soldiers and small units. In turn, this will help them more accurately assess unit overall effectiveness and lethality. Second, the research provides a footing for follow on research in the field. Little quantitative research currently exists to measure small unit behavior, but the subject has the potential to provide important insight into the actions of soldiers and possibly provide knowledge on how to improve small unit effectiveness.

Moving forward, these tools can be improved by standardizing the qualitative assessments. Application of the quantitative methods over many data sets would provide the user a clearer standard to compare against. Additionally, quantifying the data in many data sets would provide a broad assessment to compare against the standards outlined in doctrine. These holistic improvements would further standardize the presented methods across all users in the Army.

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