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# Armor Brigade Combat Team Readiness

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**Author Note:** The purpose of our project is to analyze the readiness of an Armor Brigade Combat Team. Throughout the research and development process of our model, we learned various technical skills related to data analysis and systems dynamics. Additionally, we learned about the various factors that contribute to accurately analyzing Army unit readiness. Finally, it is worth noting that the views expressed herein are those of the authors and do not reflect the position of the United States Military Academy, the Department of the Army, or the Department of Defense.

**Abstract:** The purpose of this report is to explain the principles of readiness in an Army unit and provide a system capable of viewing it holistically to analyze the state of readiness in a unit and to project readiness into the future. Specifically, through our work with clients at the DASD (FR), our analysis is limited to an Armor Brigade Combat Team (ABCT). Our work aims to create a final product that can be implemented to gain a better understanding of force readiness. The bulk of this work was done in Vensim, a systems dynamics modelling software that enables users to create stock and flow diagrams to depict the relationships between the 4 components of readiness outlined in Combined Joint Chiefs of Staff Instruction (CJCSI) 3401, as well as the dynamics that exist within each of these components. Converted to python, the result will be a model verified by the client and validated by subject matter experts and potential end users. Future work in this field would continue to deepen the
precision of systems modelling while also broadening the usability beyond the ABCT.

*Keywords:* Readiness, Armor Brigade Combat Team

## 1. Introduction

No simple, clear-cut solution exists when it comes to unit readiness and the complexity and multitude of variables guarantee the failure of narrow-focused analysis. Embracing the complexity of this issue through systems dynamics modeling will help the army make deliberate decisions on funding, allocation, and deployment that relate directly to unit readiness (Goethals & Scala, 2017). The Army is currently developing and implementing a new system for monitoring unit life cycles called the Regionally Aligned Readiness and Modernization Model (ReARMM), which is designed to facilitate efforts to modernize and sustain 21st-century forces and adapt to multi-domain operations (Suits, 2020). This model represents the framework for modern readiness models and helps address the need for a comprehensive reporting system that works for commanders and is relevant to the current and future mission sets.

### 1.1 Armor Brigade Combat Team (ABCT)

The role of the ABCT is to engage and destroy by means of overwhelming fire power and to perform missions that complement the work of the Infantry and Stryker Brigade combat teams. The arsenal of armored and equipped vehicles operated by the force primarily works to accomplish this mission. The ABCT's ability to apply this speed and combat power is directly related to the readiness of its vehicles, and the training of its personnel to operate and maintain these vehicles to meet the force requirements (U.S. Department of the Army, 2021).

The ABCT consists of 7 total battalions of 3 companies composed of both an armor and infantry variations and 3 combined arms battalions, which consist of two Armor and one Infantry per the recent change to battle order in 2016 (Talaber, 2016).

To limit the scope of the project and reduce some of the complexity, analysis will be limited to modelling the readiness of the combined arms battalions in the ABCT that are primarily responsible for the combat power of the unit and its effectiveness in theater.

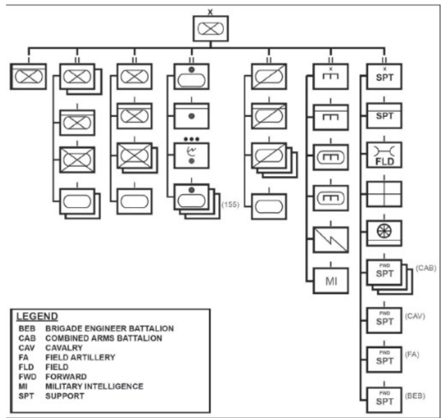


Figure 1. Force Structure of an Armor Brigade Combat Team (U.S. Department of the Army, 2021)

## 2. Readiness

Under the Department of Defense, organizations report their readiness as a C-Level. C-Level is measured on a one-to-five scale where a unit can be reported at a C-1, C-2, etc… (Headquarters Department of the Army, 2022). A unit that is assessed to be a C1 is said to possess, "The required resources and is trained to undertake the full wartime missions for which it is organized or designed." In contrast, a unit categorized as a C-5 is described as, "Not prepared, at this time, to undertake the wartime missions for which it is organized or designed." The C-Level is determined by assessing four components on the same one-to-five scale. The four components are P-Level (Personnel), R-Level (Equipment), S-Level (Supplies), and T-Level (Training). The C-Level is assessed at the lowest level of these four components. For example, if the P, R, and S-Level are all at three, but the T-Level is at a four, the C-Level is supposed to be reported as a four (Joint Staff, 2014). In addition to reporting a C-Level, Commanders also provide comments that are vital to showing their leaders the overall strategic context of their unit's deficiencies or proficiencies in readiness (Flynn, 2020).

| | Resource Area Status Level | | | |
|---|---|---|---|---|
| RULE | P-1 | P-2 | P-3 | P-4 |
| 1. Total Available Strength.<br><br>Total available strength divided by structured strength | >>=90 percent | >>=80 percent | >>=70 percent | < <70 percent |
| 2. Critical Personnel.<br><br>Designated critical MOS/personnel specialty available strength divided by critical MOS/personnel specialty structured strength | >=85 percent | >=75 percent | >=65 percent | <65 percent |
| 3. Critical Grade Fill (Optional) | >=85 percent | >=75 percent | >=65 percent | <65 percent |
| Note: P-5 and P-6 are reported per authoritative organization direction | | | | |

Figure 2. How Readiness is Calculated for Personnel (Chairman of the Joint Chiefs of Staff Instruction, 2014)

Readiness in the Army currently faces various challenges. These challenges include difficulty in expanding the force due to missing recruitment goals, managing and tracking personnel away from their home, evaluating the cost of modernizing technology, and training personnel (United States Government Accountability Office, 2019). Fixing and identifying the roots of these deficiencies requires extensive modelling and a high-level of understanding when it comes to the integrated nature of these issues.

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## 3. Methods

### 3.1 Systems Dynamics

Vensim was the program utilized to analyze System Dynamics for readiness of a given ABCT. Vensim is a modeling tool that allows a user to analyze data through the scope of System Dynamics. When the Vensim model was completed, it was transformed into a Python model to facilitate easy use by Armor Brigade Combat Teams across the Army. Figure 2 (shown below) provides a visualization of the model that calculates the number of Abrams crews that are trained over time.

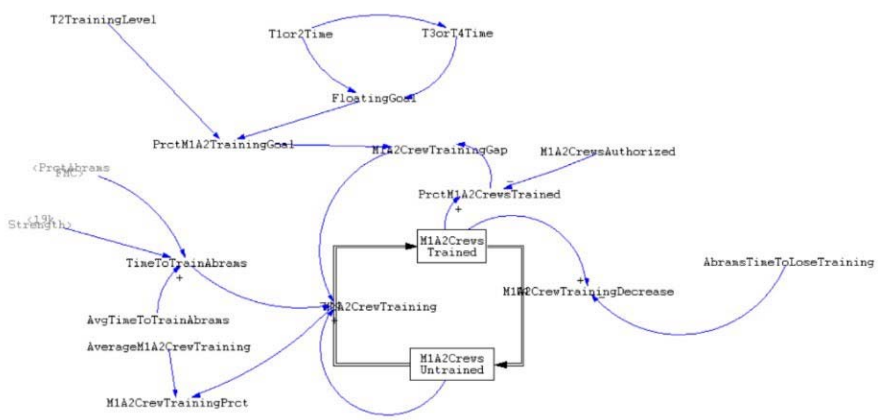


Figure 2. Model of M1A2 Crew Trained

#### 3.1.1 Causal Loop Diagrams

Due to the visual nature of Vensim Modeling, it is vital to understand the basic components that can be seen in our Vensim Model. Figure 3 shows a Causal Loop Diagram that provides an overview of the integrated nature of readiness.

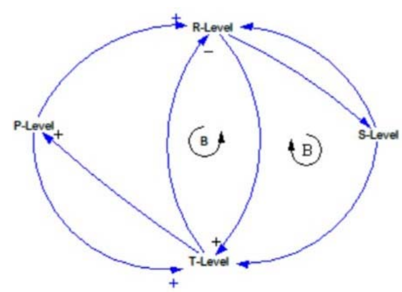


Figure 3. Causal Loop Diagram of Relationship Between Readiness Components

The variables in this high-level model are ‘P-Level’, ‘R-Level’, ‘S-Level’, and ‘T-Level’, which represent the PRST readiness assessment components. The causal links showcase how each variable interacts with the other. For example, as P-Level increases R-Level also increases. In this case it is because, when more personnel enter a Brigade, there will be more maintainers available to fix equipment. Conversely, as T-Level increases, R-Level decreases. This occurs because many vehicles will run into maintenance issues during training events as evidenced by the 3,753 non-combat vehicle accidents between 2010 and 2019 (US Government Accountability Office, 2020). The Vensim model simulates multiple relationships that showcase the requirement to balance a myriad of variables to maintain an appropriate level of readiness.

### 3.1.2 Stock & Flow Diagrams

Figure 4 depicts a Stock and Flow Diagram that analyzes the factors that affect the number of Abrams that an ABCT has on-hand (O/H):

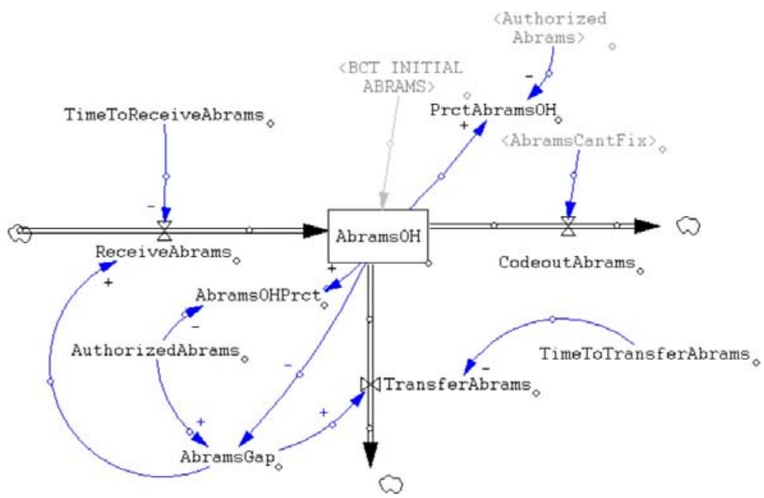


Figure 4. Example Stock and Flow Diagram

The ‘Stock’ in this diagram is the box that represents the Abrams on hand. The flows and variables surrounding it influence the number of Abrams that are present within the system. The ‘Flows’ in this diagram are represented by the text that reads ‘Receive Abrams’, ‘code out Abrams, and ‘Transfer Abrams. These Flows represent the rate at which the ABCT takes in and loses Abrams. Flows that represent the rate at which the ABCT takes in Abrams are called ‘In-Flows’. In this example, the in-flow is the ‘Receive Abrams’ flow. The Flows that represent the rate at which the ABCT loses Abrams are called ‘Out-Flows’. For this Model, the Out-Flows are ‘code out Abrams’ and ‘Transfer Abrams’.

### 3.2 Python

Python, and specifically the use of the PySD library, bridges the gap between the visual systems dynamics modelling done in Vensim and the analytical work needed to aggregate data and provide clear outputs to decision makers. The PySD library has tools to convert Vensim (.mdl) files into Python files that can be ran to create output tables based on the timestep established by the modeler. Using this methodology, it is possible to parse down these output tables to see and graph variables defined in the Vensim model. For the purposes of validating that this process works and is repeatable, we limited analysis to the variables M1A2CrewsTrained, M1A2CrewsUntrained, AbramsOH, AbramsFMC, and Abrams Personnel Strength.

## 4. Data Analysis

While a Vensim model provides the best means of visualizing the system, the quantitative analysis occurred through Python modeling using the tools in the PySD library. The PySD library makes it possible to conduct higher level analysis on Vensim models by translating them into Python modules. These modules can then be read into python script, which creates a table. The rows of which are split by the time step defined in the Vensim model.

Once imported, this table can be parsed and manipulated like a normal data frame. In our case, the essential variables outlined in CJCSI 3401.02B can then be pulled out and used to calculate the final values for P, R, S, and T readiness.

### 4.1 Vensim Results

One of the key features of the Vensim Model is that it can produce outputs over the course of a designated time-period. This is useful when analyzing the readiness of an Armor Brigade Combat Team. Over the course of weeks, months, and years; an ABCT will go through various levels of readiness. The Vensim Model showcases this oscillation effectively.

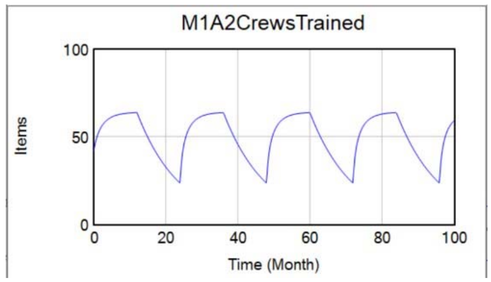


Figure 5. Number of M1A2 Crews Trained Over Time

Cyclical modelling is vital when analyzing the readiness of a Brigade-level asset. This is because it is nearly impossible for such a large conglomerate of personnel and equipment to maintain a high level of combat strength and ability without something breaking down. An ABCT needs time to repair equipment, move around personnel, and replenish supplies during lower-readiness stages of their training cycle. Without these dips in training level, there cannot be high points.

### 4.2 Python Results

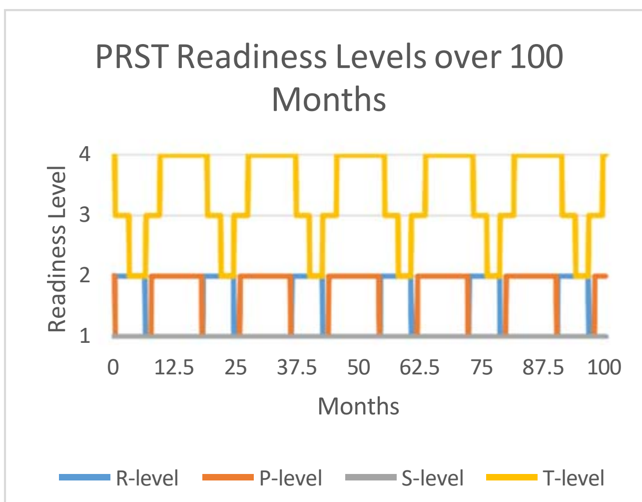


Figure 6: Final Aggregation of Unit Readiness (1 is the highest level of readiness)

## 5. Conclusion

The model that was built throughout the project life cycle represents a potential framework for modern readiness reporting and it helps to address the need for a comprehensive system that works for commanders and is relevant to current and future mission sets. The primary limitations of this model are that it fails to account for various factors that affect an Armor Brigade Combat Team's readiness. These factors include (but are not limited to) the adoption of new equipment, unplanned changes to deployment or readiness cycles, mounting recruitment and retention issues, and routine vehicle maintenance cycles. Despite the shortcomings of the model, it succeeds in showcasing the integrated nature of how the readiness of Personnel, Equipment, Supply, and Training interact with each other. Moving forward, ABCT readiness reporting and modeling can improve significantly by utilizing Vensim to model the complex variables present within Army readiness. When a Vensim model is read into and evaluated using Python, it can be highly effective in giving Army leaders a wide-lens view of their units' status. With this high-level view of current and projected readiness, leaders can implement programs that succeed historically to improve weak points. For example, if there is a projected personnel shortage in a particular MOS, the Army can provide incentives to enlist or continue serving as a given MOS (Inspector General U.S. Department of Defense, 2019). Although no clear-cut solution exists when it comes to analyzing and reporting readiness for an Armor Brigade Combat Team, a deliberate and data-driven approach will be the key to success moving forward.

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