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White Cell Support Application for EXPO OPS Tactical Wargame System

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White Cell Support Application for EXPO OPS Tactical Wargame System

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ABSTRACT

Thesis Title: White Cell Support Application for EXPO OPS Tactical Wargame System
Zackery Milder, Master of Arts/Game Design, 2024
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The purpose of this project was to create a support application for a tabletop wargame currently used for training and scenario simulation by the United States Marine Corps. The EXPO OPS Companion is meant to enhance the capabilities of the White Cell/table director, the unbiased third party responsible for running adjudication for the EXPO OPS Tactical Wargames System. EXPO OPS TWS is "…a table top wargame covering contemporary and future conflict at the platoon, company and battalion level. It is a wargame toolkit that enables wargaming scenarios in the 2020 to 2030 timeframe. The design centers on plans and decisions at the low tactical level with an emphasis on combined arms. A Marine Expeditionary Unit and Brigade is the centerpiece of the design." (EXPO OPS TWS Rules V1, 2022). This project aimed to enhance the White Cell's capabilities through the development of a proof-of-concept application which will:

- Calculate engagement results.
- Track units' resources.
- Provide quick access to EXPO OPS rule set and guidance.
- Be portable and low maintenance.
- Have a user-friendly interface.

The application successfully calculated engagement results based on the ruleset provided in the EXPO OPS Tactical Wargame System rule book and in conjunction with input from the faculty advisors. This enabled the White Cell to focus on other aspects outside of calculating

engagement results. The application also tracked individual units' current force size, ammo, morale and any other attribute deemed important; this allowed for more complex scenarios to unfold while relieving the White Cell or players from having to manually track this information. Additionally, the application has a quick reference guide to the EXPO OPS rule book and the potential for quick access to Marine Corps Publications, especially those on tactics. The application was designed to be self-contained with an easy-to-understand graphical interface, allowing for seamless use for new users.

Wargaming is extremely vital to training the next generation of military officers. One of the main issues of pure virtual wargaming, or computer simulations, is that it is bound by the limits of the program it operates in. One of the limits of pure tabletop wargaming is it can become overly burdensome to track all the individual modifiers that might go into an engagement. This proof-of-concept application is an attempt at creating a hybrid solution to bring the best of both worlds. This application aims to create a limitless wargame, bound only by the imagination and creativity of those executing it and backed with the capability to track and analyze information quickly and reliably.

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To Kara for all the restless nights putting up with me programming. Thank you for bringing me back to earth whenever I spaced out developing things in my head and being my chief editor and reviewer. Additionally, a special thanks is owed to the outstanding team at Marine Corp Universities Expeditionary Warfare School for going above and beyond to provide not only the opportunity to pursue this project but also the mentorship and guidance in developing it for future leaders of the military. Specifically, I'd like to thank Maj Bartos, Maj Meyer, and Dr. Holm. Finally I'd like to thank my outstanding team at Lindenwood University, J Ratican, Ben Fulcher, and Geremy Carnes.

Table of Contents

List of Figures

Introduction / Background Information

The art and science of wargaming can be found as far back as the Roman Empire, with their creation of a simple board game called Latrunculi or "the game of soldiers." (Mason, 2018). It has advanced in many ways throughout the modern era to cover all spectrums and domains of war, including that of cyber space (Long, 2019). Computer simulations and advances in modelling have increased wargaming capability to be used in solving complex problems (Loban, 2021). However, there are limits to the creativity individuals can have when focusing solely on computer-based simulations. Additionally, there are limitations to what tabletop-only wargames are capable of as well, in terms of the amount of adjudication needed and how quickly and effectively it can be accomplished (Hodicky et al. 2020). This project aimed to create a companion app that could be used in facilitating wargames, bringing together the best of virtual simulations while preserving space for the creativity of individuals when conducting tabletop wargames.

Wargaming is vital to training the next generation of military officers, especially in the Marine Corps (Wong, 2019). One of the main challenges of purely virtual wargames, or computer simulations, is that each is bound by the limits of the program it operates in and the effect of participants "gaming the game, " in which players just focus on finding the best way to beat the computer (Frank, 2011). One of the limits of pure tabletop wargaming is it can become overly burdensome to track all the individual modifiers and effects that might go into an engagement (Loban, 2021). This proof-of-concept application is an attempt at creating a hybrid solution to bring the best of both worlds. This application aims to create a limitless wargame, bound only by the imagination and creativity of those executing it and backed with the capability to track and analyze information quickly and reliably.

The idea of using computer-based aids to assist the gameplay and mechanics of tabletop board games is not new. Examples of such hybrid models include a board game version of *XCOM*(Fantasy Flight Games, 2015), where an easily downloadable computer or mobile application provides different missions and timers to facilitate the game. The app isn't necessary to play the game, as players could easily just draw cards and use a timer at home, but the use of the app allows the players to focus less on the mechanics of the game, and more on the strategy of how to win the game. *OathSworn* (Shadowborne Games, 2022), a tabletop tactical RPG, uses a similar method, using a dedicated application downloaded on a computer. As opposed to just missions, this application builds out a fully fleshed story, removing the need entirely for a game master to run and operate the game. However, combat and other mechanics are still dependent on the players. Much akin to *XCOM*, though, *OathSworn* comes with a full campaign booklet and doesn't require the use of the application. *Lord of the Rings: Journey through Middle Earth*(Fantasy Flight Games, 2019) takes the application of hybrid gaming to the next level, requiring players to fully integrate and use the free software on Steam. Not only does the software track the players' missions and standard game information, but it also tracks enemy movements and player resources, such as items. Board games such as these provide an instructional example for what is possible to be done for a wargaming application. This project aimed to explore the use case for a hybrid wargaming model and to show that merging the two formats of conducting wargames was not only a viable option, but a more effective method as well.

The purpose of this project was to create an application that was capable of being used in conjunction with the EXPO OPS Tactical Wargame System, a tabletop wargame used by the United States Marine Corps. EXPO OPS Tactical Wargame System was designed to conduct

modern tactical wargames at the company level. In ideal conditions the wargame is conducted using a double-blind system with a Red Cell and a Blue Cell competing against each other for a given scenario. A White Cell is tasked with adjudicating the movements, plans, and actions of the two opposing sides. The Red and Blue Cells are normally comprised of 16 to 32 Captain planners and the wargame is used as an opportunity for Captains to test their military planning capabilities against each other. The rules for EXPO OPS Tactical Wargame System are the sole property of Marine Corp University and will not be included as part of this research. Additionally, the code used to create the application is also only available for public release from Marine Corp University.

The application's function would be to improve the ability of the White Cell, the unbiased table director responsible for running adjudication for the EXPO OPS system, to facilitate wargames which would enable enhanced wargaming and training, but which would not necessarily be required to run the game. This project was conducted through the Marine Corps University Expeditionary Warfare School's Non-Traditional Fellowship program and to fulfill the requirements for the completion of a Master of Arts in Game Design at Lindenwood University. It is my belief that the completed EXPO OPS Companion tool will be of benefit to both the Marine Corps University and gaming communities at large.

Literature Review

Wargames have a long history of usage for planning and simulating military engagements, with heightened use in the 20th and 21st centuries (Mason, 2018). Multiple sources have covered and discussed the history of wargaming (Curry, 2020; Hanley, 2017; Mason, 2018; Perla, 2011), while others have delved into how to build and employ different types of wargames (Anderson, 2015; Canyon, 2020; Fridheim, 2022; Kania, 2021; Olson, 2021; Terekhova, 2021). Additionally, there are many schools of thought on the implication of using wargames for training and education purposes, whether it be the study of history (Kilgour, 2015; Reynaud, 2014), analog learning (Garcia, 2019), or military planning (Erwin, 2005; Fitzsimmons, 2019; Franken, 2013; Long 2019). Furthermore, many examinations have been made into how wargames should be conducted, whether by computer simulations (Loban, 2021), physical interactions on a tabletop wargame (Perla, 2011), or a hybrid system using computer assisted adjudication (Hodicky, 2020). The variety of topics covered provides an excellent starting point for building a better understanding of wargaming and its complexities.

Mason in "Wargaming: Its History and Future" establishes a background on the history of wargaming. His article starts off by covering the ancient history of wargaming and builds up to the modern era, covering topics of how wargaming was used in Europe in the 16th century, throughout the World Wars, and even in the modern era of combating insurgencies (Mason, 2018). Hanely adds to the history of wargaming by contributing the adaptations of simulations, specifically regarding the Department of Defense acquisition of capabilities processes (Hanley, 2017). Curry also adds to the conversation on the history of wargaming but focuses primarily on the modern uses of wargames in military training and education. He quotes Colonel Matt Caffrey justifying how "Wargames can save lives" and uses several historical examples to show this

(Curry, 2020). Wargaming has a rich history that dates back to ancient times and is in constant flux as systems become more complex.

As human systems and interactions become more complex, multiple researchers have explored different ways to apply wargames to different problem sets. The most common problem sets wargames have been assigned to include those of grand strategy and intergovernmental relationships, as seen in Anderson's "From Cooperation to Competition- The future of U.S.-Russian Relations*"* (Anderson et al. 2015) and Kania's "Learning Warfare From the Laboratory -: China's Progression in Wargaming and Opposing Force Training" (Kania, 2021). Other instances of using wargames outside of the pure war spectrum include Olson's work on exploring emergency response readiness to a bioterrorism event (Olson, 2010). Canyon also explored a combination of the great power struggle as it relates to climate disasters in the twenty-first century (Canyon, 2020). The exploration of different methods of conducting war games is further reinforced in Fridheim's work on developing a baseline for how to conduct a wargame, "Eight Lessons for Planning and Conducting Wargames" (Fridheim, 2022). This work helps establish a baseline for individuals to build and conduct wargames in a more efficient manner. Wargames have found a variety of different use cases in the modern era and are used to explore a vast array of problems; they are also effective training and education tools.

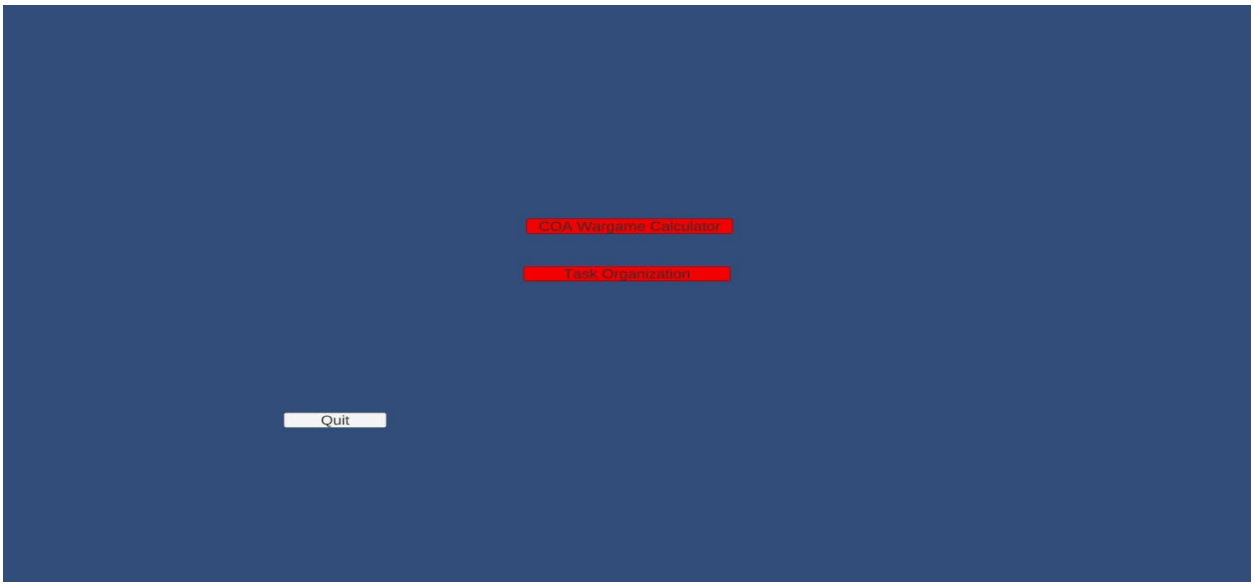
One of the biggest uses for wargaming in education has been the ability to use wargames to teach different time periods of history. Researchers have found that wargames are an effective and engaging tool for teaching students about the World Wars (Kilgour, 2015; Reynaud, 2014). Wargames or tabletop experiments have also been used to research and learn how individuals learn through analog techniques, as explored by Antero Garcia (Garcia, 2019). The biggest use of wargaming for educational purposes has been its use in training and developing military

officers (Erwin, 2005; Fitzsimmons, 2019; Franken, 2013; Long, 2019). Wargaming can come in many shapes and forms as it is used to train and educate different groups of individuals.

The three main categories of wargaming formats are Manual Wargaming, Completely Automated Wargaming, and Computer Assisted Wargaming (Hodicky, 2020). Loban's study on "The Transformation from Physical Wargames to Grand Strategy Games" explored the concepts of utilizing fully simulated war games. The team argued "because of the increasing complexity of historical wargames, there is a need to shift the discipline to the digital space where such complexity can be retained and enable the player to focus on the game's content rather than the technical process of wargaming itself." (Loban, 2020). On the other side of the spectrum, Perla's work argued for maintaining a physical tabletop wargame, stating that the wargame's ability to influence decisions or assist in training grew from the connection between the physical objects and the power of storytelling (Perla, 2011). Hodicky made a solid argument for computer assisted wargaming as a fine balance between a completely virtual game and a cumbersome manual tabletop game. However, the research primarily looked at wargaming as it related to planning and acquisitions. The main goal of Hodicky's computer aided wargame was "reducing his [umpire's] bias and the risk associated with his decisions." (Hodicy, 2020). This project aims to balance the benefits and drawbacks of virtual and tabletop wargaming through a hybrid computer-assisted model, by developing a companion app for the existing EXPO OPS tactical wargame system.

DEVELOPMENT

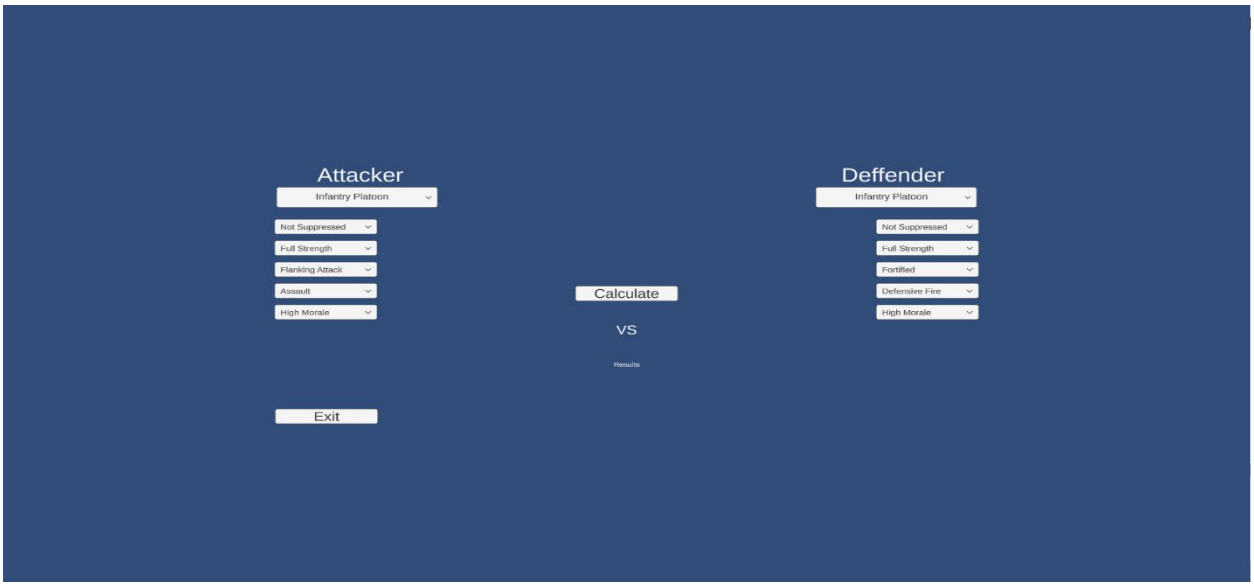
The overall development for the Expo Ops Wargame began in September 2023, starting with initial interviews with Maj Meyer, the wargaming expert and lead at expeditionary warfare school, followed by development of a game framework and an initial scoping document. One of the key aspects of development was usefulness to the end users, namely whoever was serving as the White Cell. On a semi-regular basis, I would meet with Maj Meyer to discuss or highlight current progress on the application, and these discussions would then drive further development or changes in the application. The first few weeks of the project were spent on building out a game design document and finishing initial research. I began coding on the project in late September/early October. By October 12th, I began getting the basic functionality completed for creating a task organization and a combat calculator, shown in Figures 1-4. Note that user interface and graphics were considered much later in the development process.



(Figure 1. Main Menu from Gray Box Test Version 12 OCT 2023)

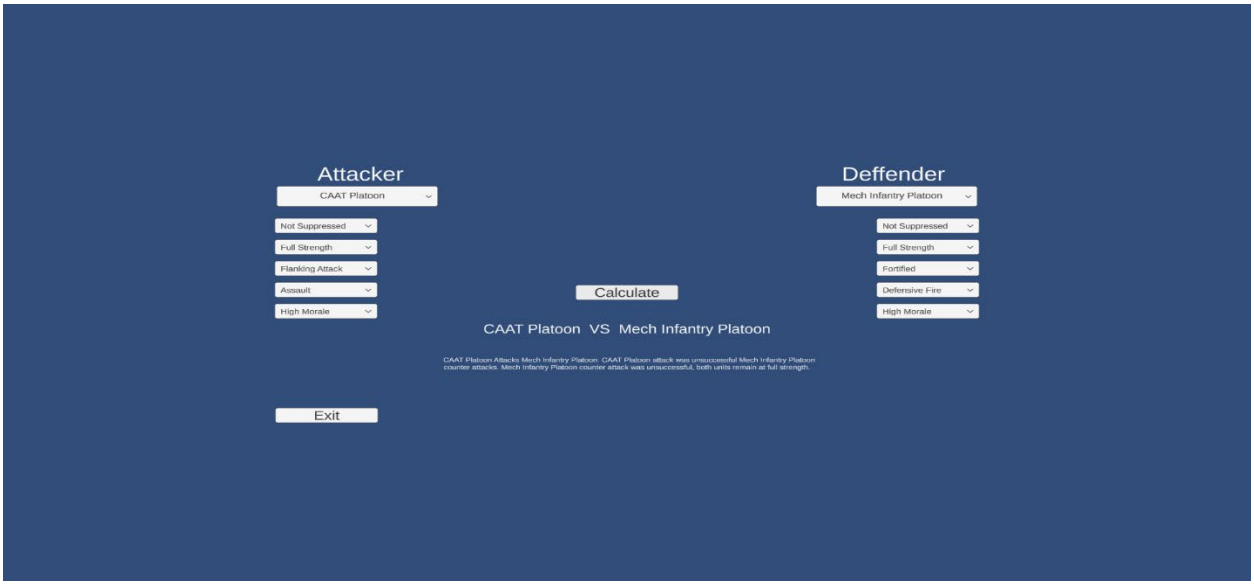
The first iterations of the game were rudimentary. A basic Navigation window (Figure 1) opened with the option to build a Task Organization and go to the COA Wargame Calculator. The intent

at this stage was to get feedback as quickly as possible on overall functionality and use cases for the application by the White Cell. Maj Meyer and Maj Bartos, my faculty advisor, were instrumental in providing feedback for further shaping the application's functionality.

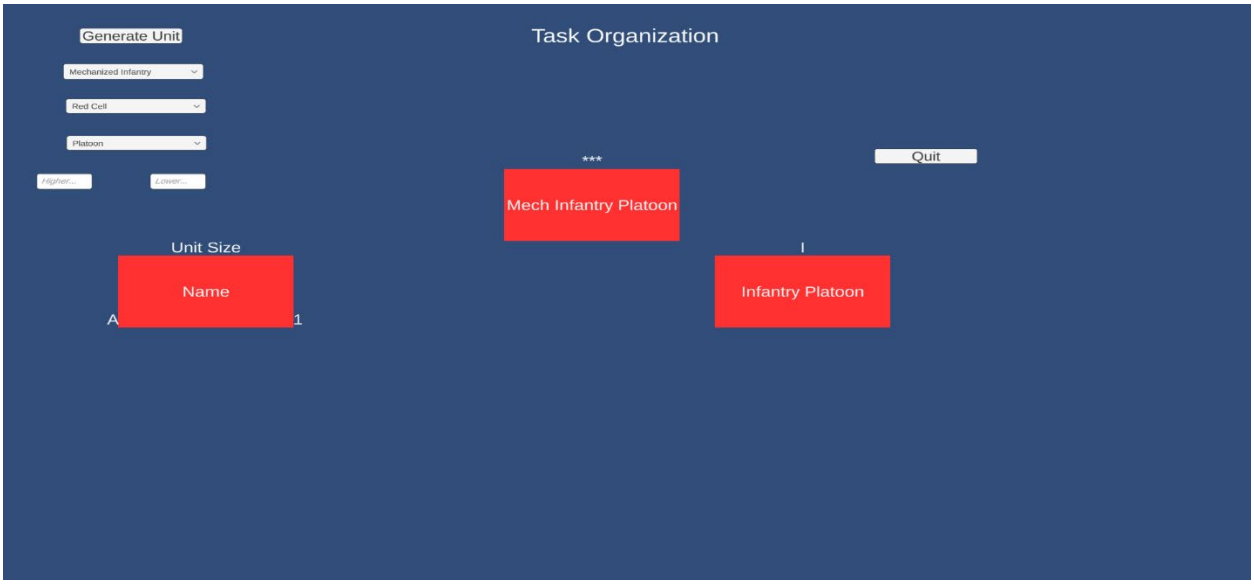


(Figure 2. Combat Calculator Gray Box Test Version 12 OCT 2023)

The combat calculator at this time was a series of drop down menus and was primarily focused allowing one enemy to attack one other enemy (see Figure 2 and Figure 3). The initial feedback gained from this was the need for unit graphical depictions, larger scale combat of more than just one unit vs one unit, and clarified information on what was being presented in the combat log.



(Figure 3. Combat Calculator Gray Box Test Version 12 OCT 2023)

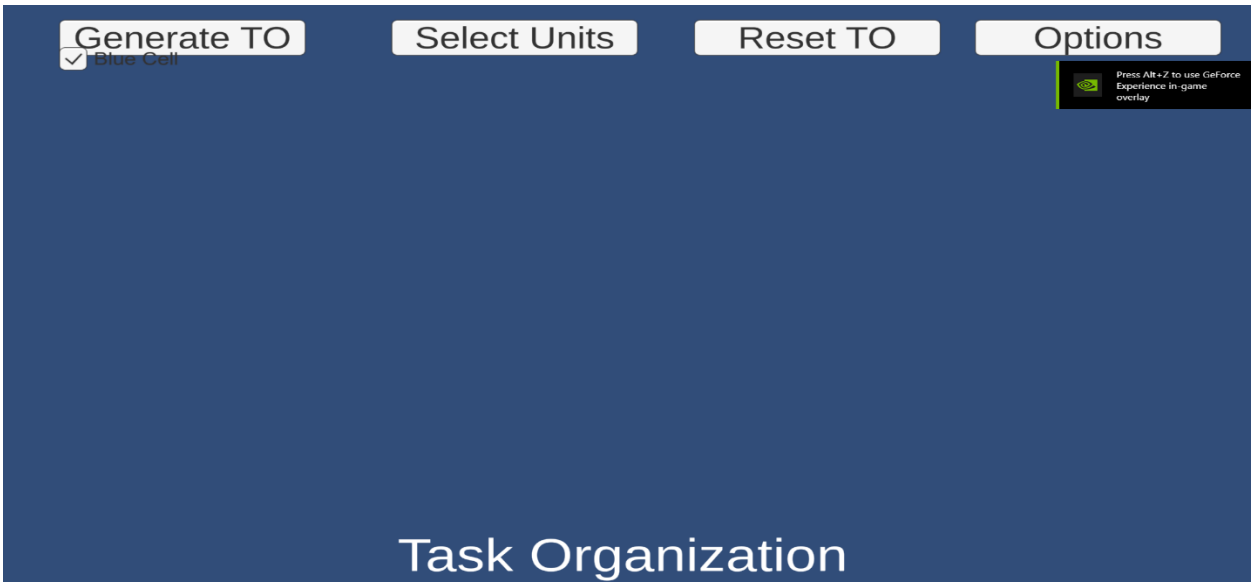


(Figure 4. Task Organization Builder Gray Box Test Version 12 OCT 2023)

The original Gray Box Test Version had a rudimentary Task Organization Builder (Figure 4). This allowed for the user to create a Task Organization and reference the unit's stats as the wargames progressed. This process took a while, though, as it would require the user to build each individual unit. Additionally at this time the unit token didn't have the direct tile matches to

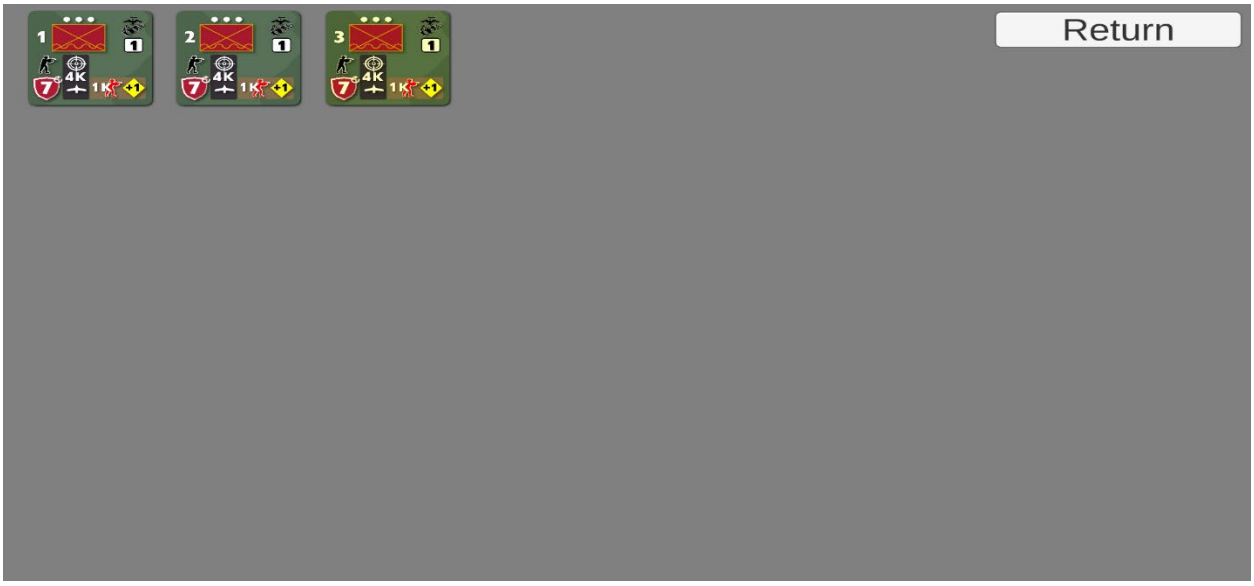
correspond to making it difficult to determine where each unit was being represented. The major points of feedback were to add the ability to integrate the task organization into the combat calculator, and to make the tokens be reflective of the actual game pieces.

Over the course of the next month, I met with Maj Bartos and Maj Meyer to discuss changes and improvements to the overall application. The main focus for the next iteration was to build out the task organization system and work on a direct implementation of units into the task organization selected. The November 13th update, shown in Figures 5-7, includes some of these improvements and updates.



(Figure 5. Task Organization Menu Test Version 2 13 Nov 23)

One of the major changes to the new Task Organization menu (Figure 5) was the removal of the ability to build a unit. Instead, units would be selected based on tiles as depicted in Figure 6. This initial Task Organization served as a test bed implementation for building out how to select different units. Though not depicted in the accompanying images, during this time from October to the end of November the game was also completely rebuilt to a more streamlined architecture, allowing for easier memory management between systems running in the background.



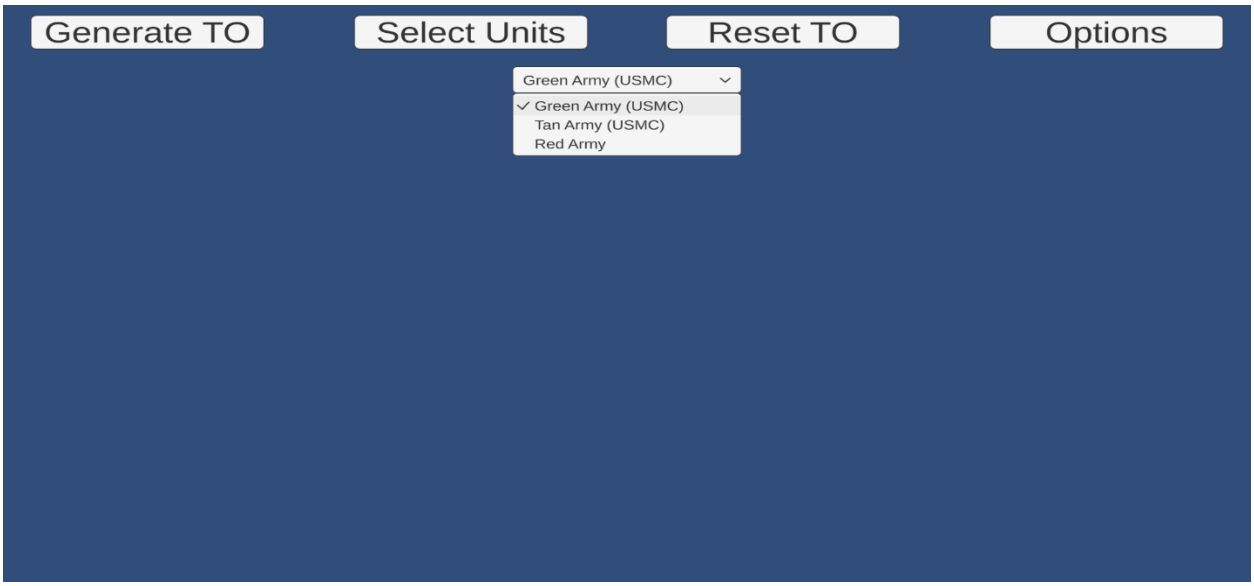
(Figure 6. Task Organization Unit Selector Test Version 2 13 Nov 23)

One of the main requests was for the task organization tiles to be based on the tiles from the physical EXPO OPS wargame. This was the first iteration of implementation and was the baseline for future implementation. This would be the only major graphical user interface change made until January, as all other parts of the project focused largely on functionality.

(Figure 7. Combat Calculator Test Version 2 13 Nov 23)

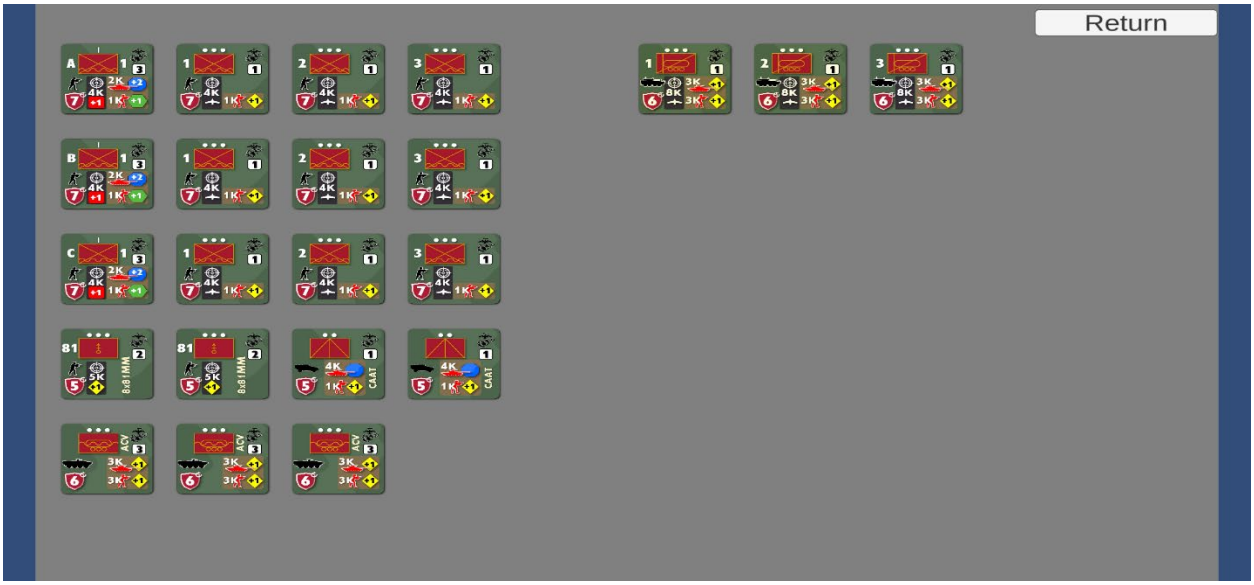
The main addition to the combat calculator in this version was the addition of units from the built-out Task Organization (see Figure 7). This would allow the user to select the units as part of the task organization and then select a unit for combat. However, this iteration still only had the selection of one unit vs one other unit.

With winter break approaching, the application up until this point was still primarily in a functionality testing point. It couldn't be used in conjunction with the Expo Ops Tactical wargame system and did very little to provide tangible benefit to the White Cell other than provide easy depictions of the units. Alpha version .01 released 13 December 23, shown in Figures 8-12, would aim to fix a lot of these issues and provide a system that could be utilized in conjunction with the Expo Ops tactical wargame system.



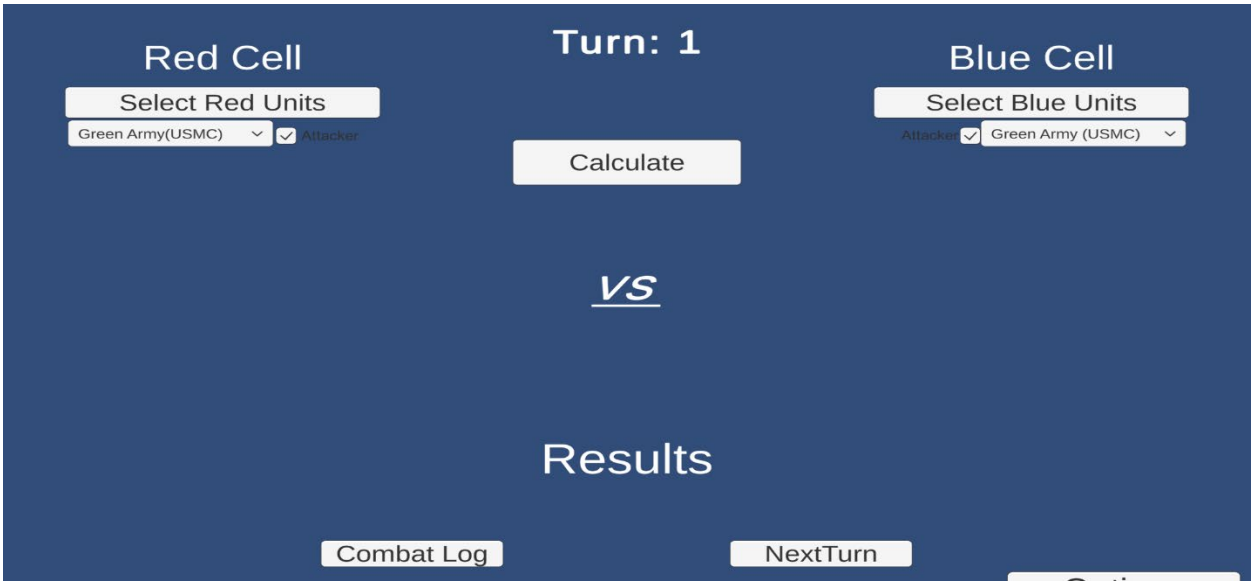
(Figure 8. Task Organization Alpha 1 13 Dec 23)

With the Alpha version in December, a new system was implemented to allow for the selection of different Army Task Organizations (see Figure 8).



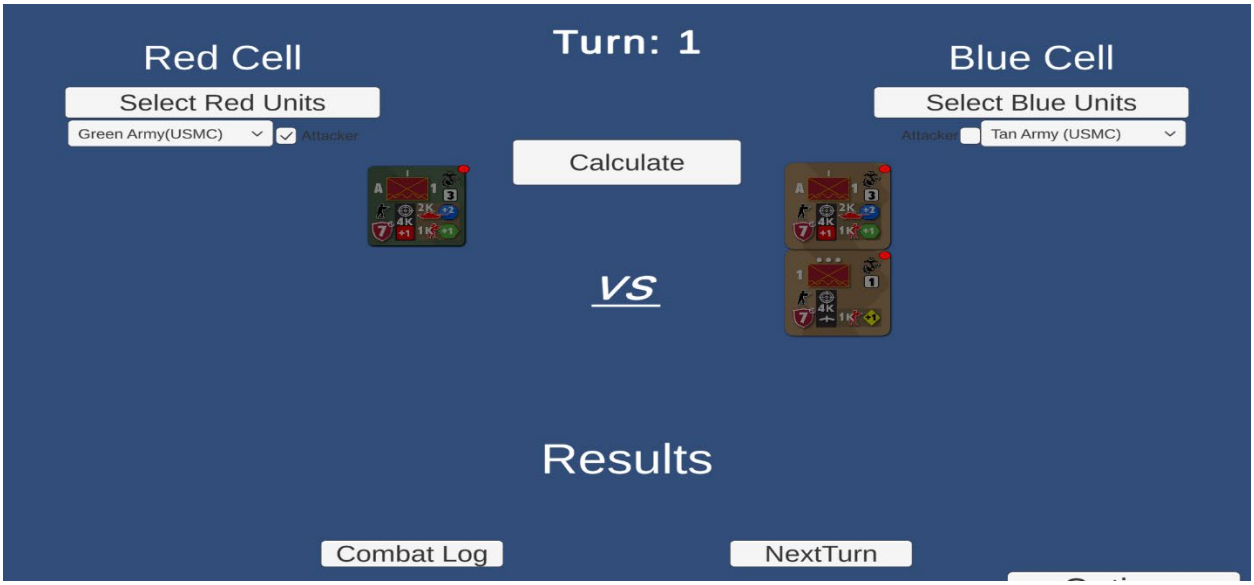
(Figure 9. Task Organization Select Units Alpha 1 13 Dec 23)

Additional Units were built out inside of the select task organization menu to facilitate a small demo wargame (see Figure 9).



(Figure 10. Combat Calculator Alpha 1 13 Dec 23)

The overall combat calculator (Figure 10) was reformed to allow for accounting for turns as well as a combat log.



(Figure 11. Combat Calculator Alpha 1 13 Dec 23)

Multiple units could now be selected for combat and were no longer represented by a name template only, but could be easily referenced on the map based on the tile (see Figure 11).

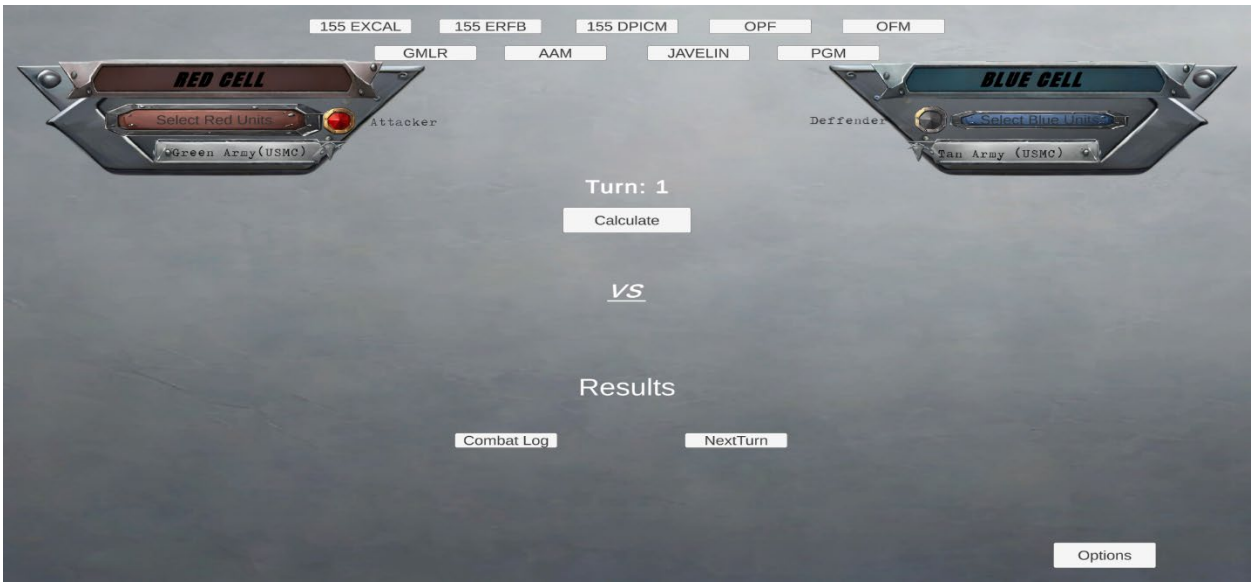
(Figure 12. Combat Results Log Alpha 1 13 Dec 23)

The Alpha version also introduced the combat result log, allowing for the users to see the results of the rolls being made. Not shown is that for each unit, the user could also hover over the unit to display its current force strength, damage dealt, and additional information.

The feedback from the Alpha test version in December was a great success as it showcased the potential capabilities of the application and provided further direction on where to take the application development leading into the new year. Next, I focused on redesigning the tokens to showcase unit damage, suppression, and the need for casualty evacuation. Additionally, the user interface underwent a major overhaul as many of the stand-in buttons and objects were slowly replaced with more complex and aesthetic graphics, as shown in Figures 13 and 14.

(Figure 13. Main Menu Expo Ops Alpha Version 4 23 Jan 23)

The final Alpha version of Expo Ops underwent some major updates and changes. These changes mainly focused on the implementation of the user interface and replacing the placeholder graphics from earlier versions.



(Figure 14. Combat Calculator Alpha Version 4 23 Jan 23)

In addition to updating the UI graphics, the Alpha Version 4 also added the ability to use IDF attacks on units. The final version would continue to build upon the updated graphics.

The process of building the tactical wargaming application heavily relied on timely feedback and focusing on functionality above graphical feel and design. Overall, the development of the application went smoothly. I was able to quickly implement feedback as received, following an agile sprint work pattern. This structure made it so that throughout the process of building the application I could, by request, add and remove features based on feedback. Another important aspect of the development of this game was the use of AI technologies throughout the development process.

UTILIZATION OF AI TECHNOLOGY

Artificial intelligence tools were used throughout the project development process to assist with programming as well as to generate user interface elements. I utilized OpenAI's ChatGPT as a programming assistant. I started with a simple prompt "I'm working on a game for Unity, the script will be written in C#. I'd like you to provide inputs on coding as well as provide coding excerpts for me to build out." Utilizing this script, the AI helped build a number of functionalities throughout the game, and while I wasn't able to directly lift and shift most of the code provided, the code did provide a baseline for me to build off of. My development process for use of AI would typically follow the same pattern: Problem that I don't know how to solve > Google Research > first attempt at solution > Ask AI based on what I've learned > Iterate over AI inputs > Bug fix. A full log of the AI conversation can be found here: https://chat.openai.com/share/5b18d225-a077-4f39-b5a9-63e2e58b3424.

I used Canva's Magic Media tool to create and generate user interface objects. My first iteration started with a prompt: "Video Game User Interface Objects, rusted metal themed." I received the output shown in Figure 15. I continued to iterate through different prompts, adding things such as color and themes to the prompt. Eventually I used the prompt "Military Themed Video Game User Interface, Steel, Red and Silver. Main menu panel."

(Figure 15 Canva UI Elements Generated by Canva AI 12 Dec 2023)

I was able to pull different aspects of the generated user interface objects. I would then have to go through the process of making them ready for use in the game. This included removing and fixing unnecessary parts or expanding different areas of the image. I would then have to isolate the game object I wanted and remove its background. All the user interface elements were built using a variation of this prompt. To get the 20 different objects used as part of the UI, I ended up generating 51 different images with each image containing anywhere from 7 to 30 different user interface elements. This resulted in a total of close to 700 user interface elements generated, of which I found 20 to be suitable for me to clean up and utilize in my game. For the main menu background, I used the prompt “Marines, littoral combat. Marines escorting mechanized vehicles along the beach from a jungle.” It produced the image shown in Figure 16. To get the image ready for use in the game, I had to use Canva tool to expand the picture, making it larger than and convey a larger beach landing area than originally depicted. I also removed the vehicles in the middle of the picture, and added a ship in the distance using Canva’s magic addition tool,

which adds objects to a picture using generative AI. Overall, these AI tools were valuable resources that greatly accelerated the development cycle, especially in the user interface and graphical design of the application.

(Figure 16. Canva Main Menu Background Generated by Canva AI 15 Dec 2023)

Methodology

To test the capabilities of the application, a White Cell observer was embedded with a table director and ran the application simultaneously with the White Cell capturing the results. The White Cell observer observed all the actions conducted by the White Cell for the duration of the wargame and catalogued the results following the turn sequence of events provided. However, after the first turn it was clear that the turn sequence provided was not adequate to run the wargame, so a more fluid action-reaction methodology was taken. As such, the methodology for capturing observations evolved over the course of the two separate wargames conducted. Initially, the actions were captured based on what turn sequence each action was taking place in, with a note delineated for Red Cell actions and Blue Cell actions. Time would be calculated based on the reaction time to respond to events. The raw data represents this with a time in minutes for how long it took a side to respond to the input or action. As the wargame developed, more deliberate tracking began to take place, with an action being recorded as to who was conducting the action, what type of action was being taken, and a simple time stamp. While faster to capture, this did make it more difficult to build connections between events and calculate reaction times.

The primary purpose for capturing time sync data was to build out a sample size of how long it took the White Cell to adjudicate combat actions and then compare those results to how long it took the Expo Ops Companion application to run the same combat actions. Additionally, the observer had no tie to either the Red or Blue Cell partaking in the wargame. However, due to the nature of the littoral defense wargame and a large focus on the naval defense, there were not many opportunities to directly compare the application vs the White Cell table lead; in total seven instances of comparison were captured. The application original intended scenario was focused primarily on company actions during land based tactical movements.

It is recommended that for future wargames, an unbiased third-party observer is utilized to record the results of the wargame. This observer would be able to provide learning points for the Red and Blue Cell planning teams, the White Cell table lead, and the overall game masters who build the wargame. Individuals selected to observe the wargames for this purpose shouldn't be directly tied to the White Cell as a participant, but as a strict observer with the intended purpose of capturing every action that takes place as well as the result of the actions. Information such as time spent on decision making, disagreements in adjudication, and any biases could be captured through this 3rd party observer. A solid formula that should be expanded upon is the methodology developed by the end of the wargame, where the observer records the following information: Time – Red/Blue Cell – Action Taken – Reaction/Adjudication (Response Time). The intended purpose of the observers would be to enhance the overall development of the wargame and to identify any shortcomings of the systems in place. The observers would not be present to validate or invalidate results or argue with implementation.

White Cell Support Application Conclusion

The primary purpose of the White Cell observer was to conduct operational testing of the application developed for use in conjunction with the Expo Ops Tactical Wargame System. The application focuses mainly on land force combat and serves as a calculator for calculating combat results for the White Cell and creating a log of the combat events. The nature of the littoral defense wargame led to limited testing of the application, as the application only had use cases during the 2nd half of each wargame once forces were able to land ashore. There were 7 instances that were reasonable cases to test the application against the White Cell table lead adjudications, 5 instances in the first wargame and 2 in the second wargame. Overall, it would be beneficial to test the application against more land-based scenarios to get a better gauge on the overall benefit of the application.

Testing the application against the White Cell table lead produced the following results: in 3 of the instances the application was faster at calculating combat results, in 2 of the instances the White Cell table director was faster, and in 2 other instances the application and the table director completed adjudication in the same amount of time. Please note that the time for the application is not based on the processing time, as that typically takes less than a second, rather it includes the amount of time taken to select the units taking place in the combat, selecting who they are attacking with what type of attack, and then reviewing the results for adjudication. The only noticeable difference occurred when more units were present; for encounters with 10 or more units the White Cell table director was faster at adjudicating. This was primarily due to a limitation of the application only supporting a maximum of 10 units at a time selected for an encounter.

The application shows promise, but more testing is needed to ascertain the actual value of a computer-aided system for educational wargames. Additionally, there are further improvements

discussed that should be made to the application. The first major improvement is the addition of a robust mechanism for adjusting the dice roll, whether it is adding more dice, upgrading the dice to a higher level die (such as from a D8 to a D10) or adding a scale to change the modifier on an attack. These changes will enable the table director to have more flexibility in how they are adjudicating the wargame. Additionally, the creation of doctrinally equivalent tactical tasks could provide a massive increase to the educational value as students see the result of the tactical tasks they have directed units to take, such as conducting an ambush attack, conducting a withdrawal under fire, or attacking by fire. Another improvement could be the potential to integrate a warfighting multi-player chat functionality to allow players to communicate with the White Cell through the application. This multiplayer functionality could serve other means as well, such as creating a common operating picture of the current Task Organization, which would help eliminate confusion for students regarding which units they have lost contact with, and also notify them of casualties and low ammunition without the White Cell needing to directly create an inject. A final integration is the inclusion of the other steps in the tactical wargame system, creating a single point for table directors to focus their efforts into running the wargame.

Based on the results of the White Cell Support Application testing, there are several additional areas worth further consideration and research at a later stage. The first is discussing the relevance of whether a computer-aided system is worth the time and money to build an educational wargame. The initial stage of this research aimed to determine if it could be done, and if so, what did that look like and would it be useful; the follow-up question to this research is whether developing such an application is worth the additional time and resources. The next area of further investigation is the difference between using computer aided wargames for educational purposes versus using them for wargames used for the development of doctrine and strategy. The

application developed for the EXPO OPS Tactical Wargame System was developed primarily for educational uses. Developing another application for use in building doctrine or actual military strategy might be useful in determining the best overall use case for hybrid wargaming. The final area of further research is an analysis and comparison between a fully computerized wargame, hybrid wargame and full tabletop wargame. This comparison could be used to fully establish and identify the benefits of each type of wargame. The EXPO OPS Companion provided a test case for how a hybrid system might be incorporated into an already created wargame system, and it opens the door for exploration of these and other inquiries.

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