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THESIS

GAMES FOR TRAINING: LEVERAGING COMMERCIAL OFF THE SHELF MULTIPLAYER GAMING SOFTWARE FOR INFANTRY SQUAD COLLECTIVE TRAINING

by

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September 2005

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Combat arms units (both Marine and Army) often do not have enough people, time and resources to properly train collective tasks at the squad level. Resources are often retained by higher headquarters due to tight deployment schedules, land restrictions, logistics constraints and a myriad of other reasons. Due to the current operational demands of combat arms brigades and regiments, the reality of limited resources is often a contributing factor in poor performance at the squad level. Leaders at all levels will need to look for innovative ways to sustain training levels at the small unit level. The scope of this study examined the collective and leader tasks that are required for successful execution of Infantry squad missions (using the Army Training and Evaluation Plan – ARTEP 7-8 Drill), and how those tasks could be trained with the use of commercial off-the-shelf multiplayer gaming software. The end-state of this research study is to provide initial analysis on what collective skills games can be used to train at the Infantry squad level, and develop a training model recommendation for the integration of this tool into existing unit plans.

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ABSTRACT

Combat arms units (both Marine and Army) often do not have enough people, time and resources to properly train collective tasks at the squad level. Resources are often retained by higher headquarters due to tight deployment schedules, land restrictions, logistics constraints and a myriad of other reasons. Due to the current operational demands of combat arms brigades and regiments, the reality of limited resources is often a contributing factor in poor performance at the squad level. Leaders at all levels will need to look for innovative ways to sustain training levels at the small unit level. The scope of this study examined the collective and leader tasks that are required for successful execution of infantry squad missions (using the Army Training and Evaluation Plan – ARTEP 7-8 Drill), and how those tasks could be trained with the use of commercial off-the-shelf multiplayer gaming software. Using a group of Second Lieutenants enrolled at the U.S. Army Infantry Officer Basic Course, we conducted a training event using a commercial game as an additional training event to prepare them for their squad maneuver live-fire event. We found that the squads that conducted the additional training performed better than the squads that did not receive the games-training, and the level of user acceptance by our test squads was high. Overall, we were able to demonstrate that the potential of using commercial games can yield positive results, but the training event needs to be resourced properly (with training officers and NCOs present), structured (to include an AAR process), and the platform needs to be accepted as a training venue by the users in order to gain any value from the event. Future work needs to address games-based training over the length of an entire training cycle, the type of platform best suited for training (PC, console or hand-held devices), and what additional skills that this type of training can be used to train.

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LIST OF ACRONYMS

AAR	After Action Review
AI	Artificial Intelligence
AIT	Advanced Individual Training
ANOVA	Analysis of Variance
ARTEP	Army Training and Evaluation Plan
BBS	Brigade/Battalion Battle Simulation
CALFEX	Combined Arms Live Fire Exercise
CAV	Computer-Aided Vision
CBS	Corps Battle Simulation
CCTT	Close Combat Tactical Trainer
CGSC	Command and General Staff College
CMC	Computer-Mediated Communication
COB	Civilians on the Battlefield
COE	Contemporary Operating Environment
COTS	Commercial Off The Shelf
DARPA	Defense Advanced Research Projects Agency
DLI	Defense Language Institute, Monterey, CA
DoD	Department of Defense
FBCB2	Force XXI Battle Command, Brigade and Below
FM	Field Manual
FPS	First Person Shooter
FTF	Face-To-Face
FTX	Field Training Exercise
GUI	Graphical User Interface
HLA	High Level Architecture
HUD	Head-Up Display
IED	Improvised Explosive Device
IOBC	Infantry Officer Basic Course
ITS	Intelligent Tutoring System
JCATS	Joint Conflict and Tactical Simulation
JRTC	Joint Readiness Training Center, Ft Polk, LA
KSA	Knowledge, Skills, Abilities
LAN	Local Area Network
MED	Mission Editor (for *Delta Force: Black Hawk Down – Team Sabre*)
MILES	Multiple Integrated Laser Engagement System
MOS	Military Occupational Specialty
MOVES	Modeling, Virtual Environments and Simulations, Naval Postgraduate School
NCO	Non-Commissioned Officer
NPS	Naval Postgraduate School, Monterey, CA

NTC	National Training Center, Ft Irwin, CA
OC	Observer/Controller
OPFOR	Opposing Force
OPORD	Operation Order
PC	Personal Computer
PEO-STRI	Program Executive Office – Simulation Training and Instrumentation
PK	Probability of Kill
ROTC	Reserve Officer Training Corps
SASO	Stability and Support Operations
SME	Subject Matter Expert
SOP	Standard Operating Procedures
TAC	Tactical Training Officer
TDG	Tactical Decision Game
UAV	Unmanned Ariel Vehicle
USAF	United States Air Force
USAFA	United States Air Force Academy
USMA	United States Military Academy
VE	Virtual Environment
VoIP	Voice-over-Internet Protocol
WARCEN	Warfighting Simulation Center, United States Military Academy

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Lee Miligan, president of Novalogic® and senior designer Brent Houston provided us material and technical support that allowed us to take full advantage of their software in our study. Their assistance saved us untold hours of trial and error frustration and our discussions provided additional insight into the operations of a commercial game publisher and developer.

We thank all the volunteers from the Naval Postgraduate School who helped us with our initial experiment testing. We also would like to acknowledge the Defense Language Institute for providing Soldier and Sailor support for the conduct of our final pilot studies conducted at the MOVES institute. For our game level editing software usability study, we would like to thank USAFA Cadet Nicolas Skordas for his work and insights.

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I. INTRODUCTION

A. PROBLEM STATEMENT

The infantry community today lacks an accessible simulation tool for collective training events. These events prepare cohesive teams and units to accomplish the mission by integrating individual and crew tasks at the squad level. This tool must be cost effective, robust enough to create virtual environments that replicate the asymmetrical battlefield we face today, and have simple hardware requirements that do not tie units to fixed simulation centers, but can be run at any installation or forward operating base computer laboratory.

B. HYPOTHESIS

Multiplayer commercial "off the shelf" first person shooter games can be effective for use by infantry squads as a low resource, high impact small unit training tool for the conduct of collective training.

C. DEFINITION OF TERMS

- Collective Training – training on collective tasks; collective tasks are those which require the to leader integrate lower-level individual and crew tasks
- First Person Shooter - a computer or video game where the player's on-screen view of the game world simulates that of the character; genre of game with a first-person view, almost always centered around the act of aiming and shooting (Wikipedia, 2005)
- Multiplayer - mode of play for computer and video games in which multiple people can play the same game at the same time (Wikipedia, 2005)

D. MOTIVATION FOR RESEARCH

1. Perspective on Infantry Training

In 480 B.C., a force of some 300 infantrymen from Sparta held off the might of the Persian army, under the rule of King Xerxes, for over seven days at the pass at Thermopylae. The Spartans, known as fierce warriors in their own right, doubled the training of their forces and their Thespian allies to prepare for the closing Persian assault.

The Spartans prepared for the onslaught through the use of serious games (tough, realistic live and simulated collective training events) in order to prepare their warriors. Conducting exhausting picket and shield drills on the training field, practicing swordsmanship against simulated combatants (wooden dummies) and sparring partners, and honing hand to hand combat skills against each other, the Spartan force prepared for a fight to defend the very foundations of liberty and justice. Ultimately, the force of King Xerxes' might proved too much for the Spartans at Thermopylae, and the Spartans fell after a week of bloodied combat. But before the Spartans fell, they killed untold thousands of Persian forces between the rocky mountain passes and sea below. Fighting to the last man, the Spartan Infantrymen, by their example, rallied the people of ancient Greece against the Persian invaders, and ultimately led to the preservation of the seeds of Western democracy and the freedom of man (Pressfield, 1999). Though a doomed mission from the onset, the Spartan's skill and discipline, forged by serious games allowed them to accomplish what no other force in the ancient world had ever done – prove the Persian army was not invulnerable, and crush the momentum of King Xerxes' conquest of the Greece.

Each era of warfare brings unique and demanding challenges for our infantrymen. Although conditions change, tough and realistic training remains as constant a principle for development of the infantryman. As our nation conducts a new asymmetric fight in Southwest Asia, critical infantry collective combat training (once reserved for combat arms alone) is now extending to combat support and service support Soldiers and Marines. Demands on resources, even more limited due to obligations for current combat operations, place trainers in a difficult position balancing people, time, and training requirements. Because training resources are scarce, leaders at all levels are looking for innovative ways to conduct small unit collective training events. Due to Herculean efforts of the Non-Commissioned Officers Corps, individual Soldier and Marine skills continue to be maintained at the highest levels. Additionally, battalions and brigades continue to sustain a strong level of proficiency through use of virtual and constructive simulations such as the Brigade/Battalion Battle Simulation (BBS), Corps Battle Simulation (CBS) and other constructive simulation tools. The training gap that exists

rests between the skilled individual Soldier or Marine and his higher headquarters. Finding a cost effective way to overcome this gap to train small units on combat operations is the challenge of Marine and Army leadership at all levels.

2. Bridging the Gap

This study aims to demonstrate that multiplayer commercial off-the-shelf (COTS) gaming software, in conjunction with existing unit training plans, can bridge the training gap between individual Soldier and Marine and their higher echelon units by providing commanders with a low resource, high impact small unit training tool. The COTS option, versus a slow and ponderous military contract system, allows for increased mobility (as all major DoD installations have at least 1 computer lab with LAN support), reduced cost at the unit and installation level, and the ability to tap into commercial intellectual reservoir.

Although the use of live-five exercises remain the key vehicle for infantry squad training, using computer simulation is increasingly common in order to better prepare Soldiers and Marines for the live-fire events. In a February 2005 interview in Training and Simulation Journal, USMC Major General Jon Gallinetti, the Director for Joint Training, J7, U.S. Joint Forces Command Commander of the Joint Warfighting Center emphasizes how simulations, in conjunction with live training, can expand the live training footprint (TSJ, 2005).

> I don't think anything will replace live training because I believe you need to do the live training to an extent, but I also believe that virtual and constructive training can certainly add to the complexity and to the dimensions of what you can include in an exercise.

By using simulations as a precursor to live training, leaders can commit resources to training more complex events that are often neglected due to resource limitations. A virtual training environment that allows units to exercise and refine Standard Operating Procedures, rehearse reporting procedures and ground tactical movement can save leaders over thousands man-hours, ammunition, rations, and other resources that are typically used during the first 36 hours in the field when squads and platoons are preparing to conduct training.

In the same manner that NASCAR drivers use commercial games on a console platform to "proof the track" prior to a race (Emmons, 2003), virtual training can help get Soldiers and Marines "in the game" by focusing attention to the task at hand prior to going to the field. Squad simulations, if accessible and with a level of mobility, can also be used as a readily available rehearsal platform for deployed units (such as Marines afloat or Soldiers at a forwarded deployed area) to prepare for real missions.

In today's operations in Iraq for example, if an infantry squad receives a mission to conduct a cordon and search mission to seize illegal weapons caches, the unit will create from associated maps and UAV over-flight photos a terrain model in the sand from spent ammunition boxes and other available objects and talk through the mechanics of the unit's movement through the urban area (Figure 1). Given enough time, the squad may conduct a live rehearsal using available buildings in the base camp to prepare for the mission. This train-up window will be condensed due to time available, resources on hand, ability to use blank ammunition in the cantonment area and numerous other restrictions.

Figure 1. Terrain Model Briefing (Horne, 1998)

With an accessible simulation tool that can be easily modified by the users, the squad can conduct a multiplayer mission rehearsal in an immersive virtual environment

that accurately represents the area of operations with a low resource commitment. Within this more robust virtual environment, infantrymen can use weapons without limitation. Squads can exercise fire control and distribution techniques, target effects, and rehearse movements in multiple environmental conditions in a relatively short period of time. Once the training is complete virtually, the leaders can focus on more complex tasks at the live training event thus improving the overall readiness of the unit.

Virtual training can also be used to provide sustainment training, particularly for units with high personnel turn-over rates, in order to capture subject matter expertise and experience. As key leadership positions change within an infantry unit after any deployment, so does the experience base of the unit. Because of the current operational tempo of units today, Standard Operating Procedures, reporting procedures, tactics and techniques of conducting ground operations need to be quickly taught to new personnel and rehearsed collectively in order to be operationally effective. Often, the squad's only chance to execute complex task rehearsals is during a major unit training exercise (NTC, JRTC or CALFEX) conducted prior to deployment to the area of operations. As a result, our infantry units only really conduct an initial "walk-through" of complex tasks (due to resource requirements), and really do not get a chance to refine their rehearsals until they are on foreign soil. With the availability of a small unit simulation platform, a redeploying unit can conduct complex exercises in a virtual environment with new personnel in order to pass on the "library of experiences" from departing subject matter experts with minimal time and resource cost. Conducting this "post-training" virtually will allow redeploying units to maintain a higher level of expertise, and minimize time and resource requirements of the redeployed units as the virtual environment can closely replicate the robust, complex scenarios the unit faced during their time in the area of operations.

E. RESEARCH APPROACH

The challenge that faces researchers in measuring the effectiveness of using simulations for collective training is that at the infantry squad level, much of the evaluation criteria are based on a trainer's subjective evaluation of the unit. The infantry community utilizes the Army Training and Evaluation Plan 7-8 Mission Training Plan

(ARTEP 7-8-MTP) to evaluate performance measures of collective training at the infantry squad level. The ARTEP 7-8-MTP contains a series of performance checklists that the trainer uses to evaluate the readiness level of the training unit. A unit's grade for a given task is solely dependent on the trainer's interpretation of the performance measure from the ARTEP 7-8-MTP and his subjective evaluation of the unit performance. The evaluation scale also leaves little room for specific comparison: task performance is rated as passing ("go") or failing ("no go"). Based on these factors, there is no quantifiable, absolute measure to determine if one unit is some percentage better than another.

For researchers attempting to go further than the Army standard to measure a unit's performance, the evaluation criteria become difficult to articulate or justify. For example, do we measure how quickly a unit shoots targets at the live fire range once the targets are presented or do we measure how many shots per target? This type of arbitrary evaluation lends itself towards far too many confounding variables. In our previous example, if we measured reaction time (first shot down range) – is this based on our unit's training level or the marksmanship skills of one or two Soldiers? Could the better trained unit react slightly slower because of their more deliberate tactical movement based on a higher level of enemy threat analysis than the untrained unit that has 2 or 3 great marksmen? Because of the current subjective methodology of measuring infantry squad performance, attempting to measure a simulation's impact on collective training becomes even more clouded.

Due to the difficulty in obtaining quantifiable performance data (and inevitable debate that would ensue based on any "quantifiable" performance measures that we could select), we took a different approach for our thesis research. Instead of trying to "reinvent the wheel" and create a new collective training measure for our thesis research, we set out to determine if commercial gaming software can be used by trainers based on the ability of the platform to replicate the audio/visual cues required to conduct collective training and the degree of user acceptance of the gaming platform as a training venue. At the core of games-based training, both of these questions are the key and essential measures of a system's effectiveness. If a system cannot provide the cues necessary to

elicit the required response, then the system is not effective. Additionally, the users of the simulation must be able to look beyond the fact that they are at a computer workstation in order to accept the virtual environment as a legitimate training venue. Given these tenets of computer based training, we designed our research groundwork.

The scope of this study examined the collective and leader tasks that are required for successful execution of the squad "React to Contact" battle drill in accordance with the ARTEP 7-8-MTP, and how those tasks could be trained with the use of a COTS gaming software while members of the unit are executing missions in a multiplayer virtual environment from individual desktop computer workstations. We kept the focus of the research to the "React to Contact" battle drill, because this task is the fundamental building block for the squad attack mission. Although we kept the scope of the experiment to the squad level, the findings from our research experiment could be may be applicable to the rifle platoon as well.

We will discuss methods for properly integrating gaming technology into an existing training plan and game selection criteria in order to select the proper platform to meet the training unit's needs and provide sufficient audio/visual cues to support user "buy-in" of the virtual training venue. We also explored ease of modification of a commercial product given nothing more than the commercially available mission editor in order tailor the virtual environments to meet specific unit requirements. The end state of this research study is to provide initial analysis on what collective skills COTS gaming software can be used to train at the infantry squad level, develop a training model recommendation for the integration of this tool into existing unit plans, and provide recommendations for product selection criteria. Given our end state, we framed our research questions as follows:

- How should the infantry company and battalion integrate the use of COTS game exercises into their existing live, virtual and constructive training plans?
- What are the qualities for COTS game selection to use as training tools for the infantry squad?
- Will subjects accept the virtual environment as a legitimate training venue?

- Do users feel that a COTS game can provide the audio and visual cues required to conduct the “React to Contact” battle drill at squad level?
- How quickly and accurately can a novice computer user create a virtual training environment given a COTS gaming mission editor?

F. METHODOLOGY

In order to properly address our research questions, we outlined a methodology roadmap to focus our efforts. Our roadmap included the following steps:

- Clearly define the critical collective tasks required for execution of infantry squad “React to Contact” battle drills in accordance with ARTEP 7-8 Drill.
- Select a game platform that can:
  - Provide sufficient audio/visual cues that can drive a collective infantry training event.
  - Allow for easy modification of the virtual environment to tailor towards meeting specific unit training needs.
  - Can run on hardware specifications that are not commonly found on computers at installation laboratories.
- Can be easily learned by the test subject and can support up to 50 trainees in a multiplayer session over a local area network.
- Map the tasks, audio/visual cues, and environment of the “React to Contact” battle drill to a COTS game platform.
- Create a survey that will capture user’s level of platform acceptance, experience and any other relevant data required to determine if the COTS game is a suitable training venue.
- Conduct pilot and field experiments to answer the research questions using a variety of different users, and capture all relevant qualitative data that results from the use of the COTS gaming software.

Our research was conducted over four phases at two locations: The Naval Postgraduate School, Monterey, California and the United States Infantry Center at Fort Benning, Georgia. The four phases were broken down into the following:

- Phase I: Analysis of key collective tasks required for execution of infantry squad battle drills
- Phase II: Mapping the key collective tasks to the COTS game platform and execution of the pilot study
- Phase III: Execution of the test experiment
- Phase IV: Analysis of the findings and recommendations

During Phase I, we conducted a task analysis of the "React to Contact" battle drill utilizing the ARTEP 7-8 Drill as a guide to determine the critical collective tasks that are required for successful battle drill execution. We also selected the COTS game platform, *Delta Force: Black Hawk Down – Team Sabre*™ by Novalogic™, Inc., as it provides a common game interface for our test subjects that was not complex to operate, accurately modeled current infantry weapons, provided a multiplayer environment and did not require a high-end graphics card or processor . Using the mission editor, two preliminary virtual environments were created for the conduct of the pilot and field tests. To support the training scenarios, we created eight mission orders with operational graphics for our subjects in order to drive the planning and squad operation orders process. We completed this phase by identifying the key collective/leader tasks required for infantry battle drill execution, selecting the game platform, and completing our virtual training venues for the execution of the "React to Contact" battle drill.

Phase II was the conduct of our local pilot experiments using test subjects from the Naval Postgraduate School and Defense Language Institute to measure the effectiveness of the game platform to model (or replicate) the cues required for leaders and unit members to execute missions during a battle drill. The results of our pilot experiments were used to determine the "alpha" tasks (those to be measured with during the unit level experiment) from the total task list. The "beta" tasks, those in which the game did not accurately provide cues for subject execution, were used as our preliminary

starting point for analysis on what tasks or skills the game cannot be used to train. Additionally, we used the pilot studies to refine our subject surveys, rehearse timings of key events for the conduct of the field test, and ensure the virtual environment that we created with the *Delta Force: Black Hawk Down – Team Sabre*™ game mission editor provided enough of challenge to exercise the trainee's teamwork without being so difficult that we would alienate our subjects. To prepare for the field test, we traveled to Fort Benning, Georgia in order to determine the hardware and software capabilities of the test site, coordinated for the scheduling of test subject support (Second Lieutenants attending the Infantry Officer Basic Course - IOBC), and brief the Fort Benning Command Group on the task, purpose and end state of our thesis research. We concluded Phase II by creating an initial list of "alpha" and "beta" tasks, completing the coordination with IOBC and finalizing our resource requirements for the field test.

Phase III was the conduct of the unit experiment. Through coordination with the command group of IOBC, we randomly selected two 10-11 man rifle squads as our test subjects (those who would receive the games treatment) and two rifle squads as our control group (those who would not receive the games training). Based on the IOBC training plan, we elected to use the games as an additional training event versus an in lieu of training event. The subjects had completed initial individual skills training which included weapons marksmanship, land navigation, and drills for crew served weapons. The subjects had received their classroom block of instruction on the "React to Contact" battle drill, but had not yet conducted any formal field training to apply what they had learned in class.

In discussions with IOBC, we decided to conduct our games-based training experiment after the completion of the classroom block of instruction and prior to the IOBC field deployment for the conduct of their first live fire squad "React to Contact" exercise. The control groups received no additional training other than the classroom block of instruction prior to the live fire exercise. Each test group underwent an eight hour training event with the COTS game that included an individual familiarization exercise, a unit familiarization exercise and six or seven mission exercises (the difference was due to time constraints) with operational graphics, maps and overlays (from the

game) provided to the unit. The leaders and key members of the squad were selected at random. We used the ARTEP 7-8 Drill for the conduct of an after action review (AAR) after completion of each exercise, and subjects completed a comprehensive survey prior to, during and after the conduct of the exercise to capture all relevant data on prior experience in conducting infantry ground operations, computer game use, individual training assessment, and assessment of the game platform as a viable training venue. Following the conduct of the experiment, we deployed to the live fire field site with both the test and control squads to observe qualitative data on the unit's performance and complete our test and control group survey and after action review as well as complete personal interviews with the IOBC leadership for assessment and recommendations for COTS games integration into unit training plans.

Phase IV began with the analysis of the data and thesis document production. In addition, we had the opportunity to conduct a very limited test on the game platform's mission editor to determine ease of use and time required to create a robust visualization given an overhead UAV photo. The intent was to determine if the game can be modified quickly enough, by a trained user, to be effective for forward deployed units as a mission rehearsal platform. For this task, we utilized a U.S. Air Force Academy Cadet on an internship at the MOVES Institute, who had very limited computer experience (games or otherwise), to create three virtual environments based given only a cursory introduction to the mission editor, three current UAV overhead photos of towns in Iraq and Afghanistan, and a computer workstation. We concluded this final phase by completing our findings and providing recommendations for future thesis research work.

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II. BACKGROUND

A. FRAMING THE PROBLEM

The core of our research is the examination of whether COTS games can be used by trainers to make our infantry squads better prepared for diverse and complex situations, more effective in communicating tactically and overall a more lethal combat force. To this end, we broke down our hypothesis into three key areas for our literature review:

- What defines an effective team?
- What impact do simulations have on improving team performance?
- What skills can a COTS game train?

With a goal of improving overall team performance, we needed to examine what makes an effective team work, and design our experiment with an environment that supports, in part, tenants of a successful team. Next, we had to explore whether simulations, of any type, can be used successfully to train teams. Finally, we had to look to previous work on the leveraging of COTS software by the Department of Defense in order to identify advantages and disadvantages as well as techniques for using commercial games. Exploring these three areas in the existing literature provided some direction for our research, and ideas for implementation of our experiment.

B. DEFINING THE EFFECTIVE TEAM

1. Factors of Effective Teams

Infantry squads, much like any small unit that conducts high risk tasks (paramedics, SWAT teams, etc.), need to perform at peak efficiency in order to conduct operations while reducing casualties and damage to critical infrastructure such as churches and schools. Understanding the factors that define an effective team and developing tools that can help teams achieve goals are keys to ensuring success.

During the formation of any team, there are four distinct phases that a group of individuals goes through to create an effective force: forming, storming, norming and performing. Forming consists of the group of individuals coming together to solve a problem or work on a given task. The formation of the team can be either self-directed or

dictated by a higher headquarters. This phase usually ends with the group identifying goals and initially selecting group members to execute each task. Next, the team goes through the storming phase. This phase is characterized by disruption as the group debates techniques for goal accomplishment, selection of leadership and distribution of workload. As the team finds solutions for these areas, they enter the norming phase. In the norming phase, the group has settled on leadership roles, accepted the methodology of task accomplishment and workload distribution. Finally, the team enters the performing phase where the unit works together towards the common goal through effective communication, mutual support and accomplishment of subordinate tasks that contribute to the overall mission (Sheard and Kakabadse, 2002).

Sheard and Kakabadse (2002) explored the contributing factors of effective teams and identified which factors were crucial at each stage of team development. Observing teams from a multinational engineering company through the forming, storming, norming and performing stages, the authors defined the following nine factors of effective teams:

- Clear goals that are understood by all.
- Priorities aligned with subordinate team's duties and responsibilities.
- Roles and responsibilities that are agreed to and clearly understood.
- Self-awareness that in turn drives team behavior.
- Leadership that serves as a catalyst for dynamic changes.
- Group dynamics defined by a social system (or chain of command).
- Communications defined by open dialogue.
- Context of orders influenced, but not directed by organization.
- Infrastructure supported by the organization.

The author's "team landscape" (mapping the nine factors of team effectiveness over the four team forming stages) provided us with ideas for groundwork for creating an experimental environment that would support our test subjects. Our goal was to minimize disruptions to the team by providing a test environment that would support the subjects, thereby focusing the effort on evaluation of the COTS software.

Page and Donelan (2003) focused more on the individual roles team members for their factors of effective teamwork. Creating elements of a psychological contract (a contract based on common goals and values), the authors identified the need to assign responsibilities and accountability to individuals, foster accurate and timely communication, and have leaders check subordinates for clear understanding of orders. We ensured that the elements that the authors identified were present by directing (in the operations order) our subjects to conduct back-briefs and inspections of individual team members to make sure the mission and intent were clearly understood. We also questioned key leaders to ensure that mission essential tasks were delegated. With this delegation of the tasks, we also monitored the leaders to ensure an inspection mechanism was present in order to ensure delegated tasks were tracked. These control measures were not unique to our experiment, and are common in any ground force chain of command. Our challenge was to replicate a "higher headquarters" for our experimental group in order to create a sense of the unit belonging to a greater force, and keep the fact that our subjects were, in fact, operating independently in a virtual environment transparent.

2. Challenges of Measuring Team Performance

As previously discussed, neither the Army nor Marine Corps has true quantifiable performance assessments for infantry squads. The evaluation criteria utilized in both organizations consist of performance measures and task checklists for mission accomplishment, but the degree to which the unit successfully performs the action rests on the evaluating training officer or NCO. As a result, attempting to produce a quantifiable team performance measure for our experiment presented a challenge. Jack Zigon (1998), President of the Zigon Performance Group which specializes in customer-performance management and team performance measurement systems, describes difficulties of team performance measurement and provides some techniques for overcoming this challenge. Some of the challenges that he addressed are:

- It is not always obvious what results should be measured
- Even if you know what to measure, it is often not clear how the measurement should be done

- Teams are made up of individuals, thus the measurement must be done at both team and individual levels

Zigon (1998) goes on to present different techniques for measuring team performance with groups who have quantifiable goals (such as retail sales departments), and describes a technique for extracting qualitative data from groups without concrete measures. Because of the difficulty in designing a reliable measurement system for infantry squad performance, the latter technique presented us with some ideas to capture meaningful qualitative data from our test subjects. He notes:

> Not everything can be measured with numbers. Trying to quantify everything sometimes results in meaningless measures. Good measures are those that can be verified by someone else and are observable…Descriptive measures use words to evaluate the accomplishment and identify who will judge the performance and what factors they will be evaluating.

Given this recommendation, we elected to include the training officers and NCOs from IOBC for the conduct of the experiment. Since we ultimately wanted to determine if COTS games can be used by training units, we felt that the performance evaluation of the team should remain with the test subjects' current instructors. This method allowed for consistency of evaluation, and provided us with an accurate current training assessment (versus our limited assessment for the 6-7 hours we worked with the test groups). Finally, Zigon (1998) recommends the use of feedback system to capture the data of the team's performance. He describes the steps for data collection that include determining what data to collect, feedback sources, data collectors and the appropriate use of aggregation of data. The author's description of this feedback system helped us begin to frame our subject survey methodology to capture data from our experiment.

3. Using Self-Assessment as a Measure of Team Performance

We realized that we needed to gather self-assessment data from our subjects in order to measure how our subjects feel that using the COTS game would affect their unit performance. Bateman and Wilson (2002) describe an experiment where they used individual self-assessment as an audit tool to determine team effectiveness. Using a

Likert scale self-assessment questionnaire, the authors examined 400 subjects from 37 healthcare professional teams in order to measure team effectiveness. They limited the areas for assessment to measurements to:

- Team synergy: A sense of purpose which is shared among the team members
- Performance objectives: There are clear performance objectives which have been established by the team which are monitored on an ongoing basis
- Skills: Team members are adequately trained and competent to do their work
- Use of resources: All resources are used effectively
- Innovation: The degree to which the team looks for ways to improve products and systems
- Quality: Degree of customer awareness and standards are identified and monitored

By using this individual self-assessment tool, the authors ran correlations against quantifiable team measures to determine effectiveness of the technique. They found a high correlation between the self-assessment and the actual team performance (based on organizational measures such as customer satisfaction). Additionally, the subjects used the results of the anonymous self-assessment to identify areas for improvement in order to make the overall organization better. We adopted this methodology of self-assessment as a measure of team performance and user acceptance for our experiment. We felt that the degree to which our subjects responded to acceptance of the platform, effects of the training event on individual and team performance, and ability of the COTS game to provide audio/visual cues to drive human interaction would provide us with the insight to begin answering our research questions.

C. LEARNING, TEAM PERFORMANCE AND SIMULATIONS

1. Effecting Team Learning and Training Techniques

Although the literature identifies training as a key and essential component of team effectiveness, exploring how teams and individuals learn is fundamental to

understanding training techniques. "There are many training methods available; some are more effective than others. To understand why one method may be more effective than another, it is important to have a basic understanding of how people learn." (Read, 1996). Effective learning, as defined by the authors, includes active participation by the trainee, positive reinforcement of actions correctly performed and clearly understandable benefits of the experience by the participants (Read, 1996).

Feinstein, Mann and Corsun (2002) continue the examination of learning by noting that learning "exists when the learner processes information in an active and immersive learning environment." (Feinstein, 2002). With this in mind, we strove to ensure that our virtual environment provided an immersive scenario populated with adequate events to illicit active participation by all participants to support individual and team learning.

Although initial training of the officers attending IOBC includes lectures, the bulk of the infantry training events includes active participation by all team members in as robust an environment as resources permit. Select trainers are designated as observer/controllers (OC) and serve as the subject matter experts (SME) to provide the feedback for members of the training team. Through the use of the after action review (AAR), OCs make recommendations for individual and team improvement, and provide the direct link from training to the real world. The shortcoming for infantry training occurs when resources are not allocated in order to meet the requirements. The question is whether computer simulations can bridge the gap when people, time and resource deficiencies prevent the conduct of robust, immersive training exercises.

2. Using Simulations for Training Teams

For infantry training, nothing will replace going to the field and conducting live, realistic, collective training on terrain similar to where infantrymen can expect to fight. Major Wilfred Rodriguez, branch chief for the Dismounted Battlespace Battle Lab at Fort Benning, Georgia, discusses these challenges in *Infantry Magazine*, Fall 2003 (Rodriguez, 2003).

> Training areas are busier, and are not as plentiful as in the past. Ball and tracer ammunition and grenades are scarce. Missiles are expensive, and small arms rounds' usual priority of issue is to support marksmanship.

Given today's reality of resource constraints and limited time, alternative training techniques must be pursued. Additionally, better use of live resources could be achieved by conducting preliminary virtual training prior to a live event. To this end, the author outlines what he identifies as requirements for an infantry-centric simulation tool to bridge the gap when resources are unavailable, and to make the most of live fire exercises. Major Rodriguez states that a "simulation is needed that gives the infantryman training value in offensive and defensive scenarios in the types of terrain that we (infantrymen) will fight". He describes the need to get "whole unit interacting together in a virtual battlefield" that replicates the venue and threat of today's enemy force (Rodriguez, 2003).

> Virtual simulations are a potential solution to training resource scarcity, integrating highly lethal and costly combat multipliers and developing the skills to use them. These virtual simulations could serve as an excellent training gate to gain a certain level of proficiency before units execute costly, rare and dangerous live training. These same virtual simulations make mission rehearsal for far flung or quickly developing contingency operations possible.

As Major Rodriguez correctly notes, the human cost – the cost associated with high risk training – also contributes to the need for simulation use. In a November 2001 interview with National Defense, Brigadier General Stephen M. Seay, former Commanding General of the Army's Simulation, Training and Instrumentation Command, expands on the risk cost savings (Kennedy, 2001):

> Soldiers still have to learn to deal with the extreme risks of real-life combat, and live fire is needed for that, but simulations let them experience something that's very close to the real thing, without any danger.

General Seay notes that cost savings can have a significant impact, beyond risk, to include resources required for live events and training readiness. He notes that "in simulation, when you're finished with a drill, you can go back and do it again in a matter of seconds" and not incur the costs of field-feeding troops, rest plans, transportation and

equipment maintenance (Kennedy, 2001). By having the opportunity to repeat complex scenarios relatively quickly in a virtual environment, units can refine SOPs and techniques that allow them to focus on more challenging conditions when deployed to a live training scenario. Repeatability of scenarios allows units to build a "library of experiences" that increases proficiency and expands footprint of expertise throughout the entire unit.

In commercial business, companies are using computer simulations tools to build their subject matter expert (SME) base with preliminary success. Much like the military model, businesses are dealing with high personnel turnover, and as a result, their management teams struggle with maintaining a high level of expertise with limited resources. One tool that is being used is computer-aided vision (CAV). CAV is a low cost computer simulation that can allow business leaders to conduct operations in a virtual venue and provides "a realistic and engaging vehicle to stimulate managers to reconsider their ways of doing things, and perhaps adjust their mental models" (Winch & McDonald, 1999). With the ability to repeat scenarios under different conditions, managers can build upon their experience base. Although CAV cannot be used to predict real-world outcomes, it can provide a venue to allow managers to exercise critical thinking techniques that "could, at least partially, overcome the disadvantages" of a smaller SME base (Winch & McDonald, 1999). Much like the CAV model, simulations can provide infantrymen with the same non-attribution type venue to build an experience base prior to conducting live exercise which will reduce cost, and increase efficient use of real resources.

3. Methods for Using Simulations in Team Training

Although computer-based simulations can help units build virtual experiences, they must be used as a collective training tool (with the entire team participating) to truly improve team effectiveness. Feinstein (2002) correctly notes that a shortfall to single participant computer-based training is the absence of interpersonal learning that is associated with role-play training common in live exercises. In addition, simulations, by themselves, must not be viewed as a panacea. Simulations are not in itself the trainer, but the tool used by leaders to enhance performance of the team (Bell, 1999).

To be effective, trainers considering use of computer simulations must clearly define the task, purpose, intent and expected goals of training prior to conducting any exercise. Subsequent to defining the tasks, a task analysis must be conducted to determine the individual and crew tasks that are required to conduct the collective event. With these two requirements met, trainers can determine how best to maximize this training tool. Schlager (1994) described a technique for setting the groundwork for virtual environment use. In his article, he recommends that trainers determine the task selection criteria by outlining the training constraints (tasks that can and cannot be done in VEs), the impact of the event, and expected learning outcomes. Tasks must consider participants, environments and the knowledge, skills, and abilities (KSAs) required, while clearly outlining the tasks, steps for conducting the task, causal links, ordering and roles of the team members (Rickels, 1999). It is equally important for the conduct of the event that the instructional requirements (lesson plans and feedback mechanisms) and outcome requirements (partial task performance) are clearly defined.

Ultimately, the cost effectiveness of the use of these types of tools must be conducted to determine if investment is worth the outcome (Schlager, 1994). For example, if the use of a fixed computer simulation facility requires more man-hours to train Soldiers on its use than it can be used for training or costs hundreds of thousands of dollars for trainers to operate and maintain, is the cost worth the benefit? Alternative solutions must be considered in order to leverage the benefits of simulations without expending the types of resources these products were designed to conserve.

For the conduct of a simulation exercise, the issue of distributed applications versus centralized training location needed to be addressed. Specifically, do teams perform better centrally located or can teams gain the same benefits from remote sites? Potter and Balthazar (2002) examined the structure and performance of face-to-face (FTF) and virtual or computer-mediated communication (CMC) teams to determine performance measures and differences between the two media. The authors noted that findings from previous experiments included increased performance of CMC teams with regards to candor of personnel when discussing difficult issues while FTF teams demonstrated increased acceptance (or team loyalty). The authors decided to conduct an

examination of CMC and FTF team structures and include the individual personalities to measure performance. Ultimately, the authors concluded that predicting team performance, whether a CMC or FTF team, relies more on the team interactive style than their media. Bell (1999) examined the use of Distributed Mission Training (networked simulations for team training). In his research, he found that participants participating in full spectrum networked simulations (F-15 fighter simulators) exercises as part of Road Runner'98, in which flight simulators at several distant locations, demonstrated "considerable improvement on both the process (communication quality and frequency) and product (numerical flight data) measures." (Bell, 1999). Potter, Balthazar and Bell's work is important as it leaves running a distributed application open as a possible technique when leveraging commercial gaming technology for training. Distributed application could reduce cost for units conducting this training by limiting the up-front cost of a fixed venue; however, interpersonal learning that Feinstein (2002) noted previously could be impacted without effective communication tools available to all players.

D. USING COTS GAMING SOFTWARE FOR TEAM TRAINING

1. Emergence of PC Based Simulations

As computing power has increased, simulations once reserved for mainframe computers are now available for the personal computer. Additionally, network architectures, local area networks and unit level intranets allow for the use of multiplayer simulation exercises to be conducted at a unit level without the scheduling of a fixed facility (Rodriguez, 2003). This flexibility of training, only recently enabled by technology advances, opens the door for the leveraging of low level simulations by unit leaders to conduct task specific training events. The commercial gaming industry, in an ever increasing race to remain competitive, has created very robust military multiplayer games that have potential for training collective tasks at the infantry squad level. Warren Katz, CEO of MaK Technologies (a commercial game developer) notes in a November, 2000 interview in Training and Simulation Journal that "improvements in 3-D image generation on the PC and the speed of the internet" have increased the military's interest in the use of video games as training tools (Erwin, 2000). He goes on to say that "PC-based video games have come so far in the quality of imagery, that they rival multi-

million dollar Defense Department simulators" (Erwin, 2000). Although Mr. Katz does not address ability of video games to match the complex algorithms that make up the underlying architecture of DoD level simulations, he is correct in his observation that use of COTS gaming software remains a key area of interest for DoD.

General Kevin P. Byrnes, former Commander of the U.S. Army Training and Doctrine Command at Fort Monroe, Virginia addressed the need for wider use of computer games-based simulations in training in the August/September 2005 issue of Training and Simulation Journal (Anonymous, 2005).

> The best use of simulations lies now with leader-type training exercises using small laptop driven vignettes where small unit leaders anywhere are immersed in a combat situation in the contemporary operating environment. After a few minutes, they start feeling as if they are really in it.

In General Byrnes' comments about general simulation use, he addresses three key areas in which COTS games may be utilized: keeping cost low by making the simulation able to run on a laptop, maintaining an engaging learning environment for users, and vignette driven design. When determining selection criteria for the COTS platform used in our experiment, we modeled our top three screening factors in a similar manner: computer system requirements, immersion and user ability to easily modify the "vignette." In particular, the ability of the trainer to easily modify the scenario could allow a COTS game platform to be used as not only a tool for home station training, but as a mission rehearsal platform for forward deployed Soldiers or Marines aboard ship.

The Marine Corps, due to the training resource limitations while afloat, has embraced COTS gaming technologies, and is aggressively looking at ways to exploit games as a virtual training asset for all military occupational specialties (MOS). The 32nd Commandant of the U.S. Marine Corps, General James L. Jones, in an interview in National Defense stated that commercial computer games have "great training value" for the force (Erwin, 2000).

> There is a Squad Leader's course where a Squad Leader can stand up in front of a giant screen and actually run through a particular scenario (from urban to desert terrain). The computer picks up (the Squad Leader's)

> command, as if he were talking to a real squad…When he is engaged by an enemy force, he can maneuver his squad, and they react on the screen.

General Jones identified the importance of integrating live, virtual and constructive simulations to achieve a balanced training approach, but felt that "simulation can do an awful lot for learning the basics" and thus make live training more productive (Erwin, 2000). By providing an environment to learn cognitive skills, leaders can use PC games to help train critical thinking and problem analysis skills prior to one live round being fired. General Byrnes goes further to address the potential of PC games to provide a venue where cognitive skills are exercised (Anonymous, 2005).

> It (a PC simulation scenario) poses questions that (leaders) really have to think through. The more we get combat veterans to help us redesign the vignettes with the realism they experienced in Afghanistan or Iraq, the better quality the training is.

Although there are DoD simulations where modifications can be made based on end user requirements, they typically require from weeks to years to develop, and necessitate the use of a contractor to adapt. In contrast, the commercial game industry, in an attempt to extend the life of their product, has begun to embed level (or mission) editing software to allow consumers to create unique environments. By placing the tool directly in the hands of the end user, COTS gaming software can be used to develop specifically tailored training venues to meet specific unit requirements. Additionally, as General Byrnes points out, units could use Soldiers or Marines with recent combat experience to develop scenarios for training using COTS software.

2. Tactical COTS Game Use within DoD

The Defense Advanced Research Projects Agency (DARPA) has funded a project, DARWARS, which utilized the COTS game market for the development of training systems based on the contemporary operating environments of Afghanistan and Iraq. The first of these efforts, *Ambush!*, is a PC-based multiplayer simulation tool designed to provide a venue where squads can learn the challenges and dangers of wheeled convoy operations (Walker, 2005). The game provides scenarios where users learn how to identify an IED (Improvised Explosive Device), and "it trains convoy Soldiers to think and act like a team" (Walker, 2005). Based on the COTS game

Operation Flashpoint by Bohemia Interactive, *Ambush!* is currently used by Army units at Fort Lewis, Washington and Fort Hood, Texas as well as Marine Corps units stationed at Twentynine Palms, California. "'DARWARS' goal was to create a scaleable architecture…that could be used to train small groups of people in team thinking" (Walker, 2005). Ralph Chatham, DARPA program manager for DARWARS, explains that the game is "not teaching how to shoot or to drive; it's teaching the cognitive" (Walker, 2005). By providing contemporary scenarios, DARPA believes that small teams can learn the critical thinking skills that combat operations in Iraq or Afghanistan demand, but results on the effectiveness of *Ambush!* have not been presented.

MAJ Carl Jaquet, Director of the United States Military Academy Warfighting Simulation Center (WARCEN), noted that the Department of Military Instruction (the tactical training arm of the academy's education program) has been using PC-based games for cadet training for quite some time. WARCEN has expanded the breadth and scope of team training by using a distributed multiplayer approach and leveraging commercial off the shelf (COTS) products as alternatives to high end DoD simulation tools. WARCEN developed training scenarios in which infantry squads conduct combat operations using level editing software from the COTS game *Operation Flashpoint*™, created by Bohemia Interactive Studio™, and *America's Army*™, developed at the MOVES Institute at the U.S. Naval Postgraduate School. Because of time and laboratory resource constraints, MAJ Jaquet set up the multiplayer exercises for cadets to either run from their dorm room or meeting collectively at a fixed location. He noted that the academy was expanding its WARCEN operation to support up to 130 cadets in an online, multiplayer scenario in order to support team training from the infantry fire team to a rifle company sized element (2004). During the initial experiments conducted by WARCEN, MAJ Jaquet observed anecdotal improvement to the cadets' team performance on cognitive tasks such as command, communication and control of key weapon systems during the academy's annual summer field tactical exercise (Jaquet, 2004).

In addition to the work conducted at USMA, the Army has looked at several other COTS games for conducting small unit "cognitive" training. At Fort Benning, Georgia, captains attending the Infantry Captain's Career Course (ICCC) have used *Full Spectrum*

Command, a PC game where the players command a light infantry company in a combat scenario. William Fisher, president of Quicksilver Software which developed the game, stated that "This (*Full Spectrum Command*) is not a skills trainer. We are training your mind. You're not holding a gun" (Pappalardo, 2004). Although the game was well received by the staff at ICCC, the debate over the effectiveness of the tool remains to be resolved. In another example, the Army has used *Spearhead*™ (a COTS M1 tank simulation game) as a virtual venue to train armor crews on armor maneuvers as well as artillery fire control. With *Spearhead*™, under a $750K contract awarded from PEO-STRI, the Army worked with the game developers Zombie Virtual Reality Studios™ and MaK Technologies™ to modify the COTS game platform for HLA (High Level Architecture) compliance in order to allow scenarios driven from the game to be sent digitally to the Army's Force XXI Battle Command, Brigade and Below and Control (FBCB2) platform (Erwin, 2000). By requiring HLA compliance, the Army was able to absorb the robust virtual environments from the PC-based game for crew training, and allow their actions to be sent to the FBCB2 system in order to extend the training footprint to the maneuver commanders and their staffs. *Spearhead* has been well received by users at the Army's Fourth Infantry Division, but measures of effectiveness for the tool are unclear (Erwin, 2000). In both examples, user acceptance of the platform by users, ability of the game to replicate audio/visual cues required by a human operator to conduct complex operations and a task analysis of skills that can and cannot be trained with a COTS game are not discussed.

As with the Army, the Marine Corps has explored the use of COTS software to train Marines. The first of these efforts was the training individual team members with first-person-shooter games such as Doom™ and Tactical Decision Games (TDG) simulations used for developing platoon commanders such as *Close Combat Marine*™. In an effort to train platoon commanders to combat terrorism, the Marine Corps helped in developing the PC-based COTS game *Red Phoenix*™. Created by Atomic™, Inc., *Red Phoenix*™ is loosely based on Larry Bond's novel about a North Korean invasion of South Korea (Peck, 2004). In *Red Phoenix*™, up to eight players can command a platoon of Marines and use most combined arms assets available to a rifle platoon including

indirect fire and close air support. What makes *Red Phoenix*™ unique is the psychological computer modeling of civilians on the battlefield (COB). The leader's actions, either positive or negative, in the game scenario can either cause the civilians to support the U.S. actions or create an environment where COBs become disenfranchised with the Marines and support terrorist cells. Michael Woodman, program manager for Marine Corps Systems Command whose office co-developed *Red Phoenix*™ with Atomic™, described the positive impact of games-based training as providing a venue where Marines can learn the six C's: command, control, communications, cooperation, coordination and cognition instead of teaching a specific task such as marksmanship (Peck, 2004). As with the Army's *Full Spectrum Command*™, the military use of *Red Phoenix*™ is not as an individual skills trainer, but as an environment where players can develop cognitive skills.

3. Innovative COTS Game use Beyond Maneuver Training

In addition to *Red Phoenix*™, the Marine Corps developed the next generation of *Close Combat Marine*™ entitled *First to Fight*™. Unlike more robust multi-million dollar DoD level simulations, *First to Fight*™ was developed by extending an available COTS product at a cost of $800K. The Marine Corps took an innovative approach to the basic tactical simulation training with this new PC-based game. Identifying the growing concern of illicit drug use within their ranks, the Marine Corps developed a module within *First to Fight* ™ that allowed a player to conduct the mission while under the influence of illegal narcotics (Peck, 2004). By severely limiting the player's ability to control his squad, presenting computer-operated squad members who disregard orders and act dangerously while in a combat scenario, the Marine Corps' intent of the game module was to reinforce the dangerous consequences that drug abuse can have on an infantry squad deployed to a combat zone. Although the drug abuse awareness module can be turned off and players can use *First to Fight* ™ as a virtual venue for maneuver training, the fact that the Marine Corps Systems Command thought outside the box for different uses of COTS technology sets a precedent.

In another example of innovative leveraging of the PC-game genre, the Army Research, Development and Engineering Command, along with business partners Warner

Brothers On-line™ and the Institute for Creative Technologies™, for $450K developed a training platform to improve Soldier-level situational awareness while deployed to Iraq or Afghanistan. *Every Soldier a Sensor* was designed to teach Soldiers how to use their observations and judgments of the environment and turn the findings into actionable intelligence. Presented as a first-person-shooter game, the players gain points by collecting information and spotting hazards, such as Improvised Explosive Devices (IED), instead of eliminating terrorists (Peck, 2005). U.S. Army Lieutenant Colonel Yvette Hopkins, Division Chief for the U.S. Army's Actionable Intelligence Task Force, said of *Every Soldier a Sensor* (Peck, 2005).

> If I'd had this tool when I was doing the train-up for all the guys we headed out to Mosul, it would have been great. It's getting people into the mindset. I can get that from this game, and trust me, I'm not a game person.

In both the examples, innovative use of PC-based or COTS software for other than tactical exercise allowed leaders to reach a broader to training audience by providing an engaging learning environment that was accessible and cost effective.

4. Mitigating Financial and Time Costs with COTS Games

Understandably, certain military simulations such as JANUS, OneSAF, and BBS, an Army Brigade/Battalion Battle Simulation, are expensive to develop, operate and maintain. The required level of detail for algorithms, scale of the exercises and entities involved, and interoperability issues drive not only financial costs, but also costs associated with product development time and user learning time. Due to these costs, availability of simulation products becomes resource intensive requiring management at the battalion or brigade levels. While it must be made clear that COTS gaming software is not meant to replace, but to complement high-end simulations. Potentially they can provide any unit access to a simulation where Soldiers and Marines can train complex tasks in an environment with unlimited resources.

Furthermore, leveraging COTS software can provide military simulation developers with access to a wide range of tools to recommend to the field with a lower overhead cost than developing a system from scratch. Colonel Matt Caffery, Professor of War Gaming at the Air Command and Staff College and senior reservist in the Air Force

Research Lab's Information Directorate described this trend in an interview in a November 2003 National Defense (Peck, 2003).

> People in the Department of Defense will go to commercial designers and say 'your game is almost what we want.' Instead of paying millions to design it ourselves, maybe you can customize it for much less.

Leaders in the Department of Defense are not the only ones who are observing this trend. The commercial gaming market has become more aware of the uses of their products beyond the entertainment industry. Mark Herman, president of Booz Allen Hamilton and Breakaway Games, notes that senior leaders are just as concerned with development time of a "good enough" simulation as they are with financial cost (Peck, 2000).

> There is interest in commercial games, because the senior military guys are saying 'I can't wait two years (for in-house simulations). If I can go to CompUSA™ and get a game that I can get some insights and answers out of, why can't we do that?'

Both COL Caffery's and Mark Herman's observation reflect a risk management approach to software development where the initial start-up and development costs are absorbed by the commercial market. By avoiding this huge initial investment (in the case of *Spearhead*™, development costs exceeded two million dollars), DoD can make a much smaller investment by extending the COTS product for its use (in our *Spearhead*™ example, the Army invested $750K for the modified game platform) (Erwin, 2000).

At Fort Knox, home of the U.S. Army's Armor School, COTS gaming solutions have been used to train future tank leaders in order to save money, and most importantly, time. Major Michael Muller, USMC, an instructor at the Army's Armor school and Cavalry officer, used the COTS PC-based game *TacOpsCav* ™ to train everything from standard operating procedures to maneuver battle drills (Peck, 2003). Although the Armor School (a subordinate of the Army's Training and Doctrine Command) endorses the use of the DoD level simulation JANUS, Major Muller prefers the COTS game *TacOpsCav*™ because it is easier to resource and the train-up time for the interface is much less than with JANUS. "I can teach someone to be user-capable with TacOps in a half hour. It takes them a day to become a talented user, and they like the game so much

that they take it home." (Peck, 2003). Major Muller contrasts this training time with JANUS which requires a three-day block of instruction. *TacOpsCav*™ saves resource planning time in addition to student training time, according to Major Muller. Scenario creation for JANUS takes the contractors at the Simulation Center weeks to develop and schedule for training officers like Major Muller. Additionally, according to the National Simulation Center at Fort Leavenworth, Kansas, JANUS' installation operational costs are two million dollars. With *TacOpsCav*™, Muller contends that trainers can create scenarios within hours and run exercises on any available computers. Although Major Muller concedes that JANUS is more realistic that *TacOpsCav*™, the time that he saves using a COTS game is worth more than the increased level of detail JANUS provides. "It's ultimately not as realistic as JANUS, but what does it cost to run TacOps? Nothing" (Peck, 2003).

The U.S. Army Command and General Staff College (CGSC), at Fort Leavenworth, Kansas, has also used *TacOpsCav*™ as a simulation to save time and increase training for majors taking brigade staff training courses (Peck, 2004). Comparing the use of DoD level simulations CBS (Corps Battle Simulation) and JCATS (Joint Conflict and Tactical Simulation) with *TacOpsCav*™, the cost savings of supporting an exercise using the COTS alternative was significant. In the CBS exercise, 400-500 personnel are required to run a division staff training exercise. The problem, notes Jeff Laser, head of the CGSC Digital Leader Development Center, is that only a few participants actually train using CBS, and the remaining personnel are required to play the opposing force, among other roles, because the artificial intelligence (AI) of the CBS is minimal. For the JCATS exercise, 40 students performed duties as a brigade staff while an additional 40 support personnel (including retired military officers contracted to support the training event) were required to control both friendly subordinate and enemy units. In contrast, the trainers using *TacOpsCav*™ were able to train 600 students with a requirement of only 100 support personnel. With *TacOpsCav*™, the AI allows users to simply issue orders and allow the game to do the rest (Peck, 2004). In addition to the support cost savings demonstrated by using *TacOpsCav*™ for the brigade staff training event, the COTS game platform has the advantage of brevity according to Lieutenant

Colonel Blaise Cornell-d'Echert, tactics instructor and exercise coordinator for CGSC's Advanced Operations Warfighting Course (2004).

> (With JCATS, students) would be able to spend one day executing a plan and maybe there would be enough time to run a second time. Because (*TacOpsCav*™) scenarios are shorter, you can do one, have an after-action report and do it again with a modified version of the scenario.

While COTS gaming software has great potential as a military training simulation to reduce training costs by saving money, reducing investment risk, limiting resource requirements and increasing training through-put, COTS games used as simulation tools must be utilized correctly, as these products are first and foremost designed as an entertainment product for the commercial marketplace.

5. Concerns for COTS Use

Opponents of large scale simulations correctly point out that looking at price tags alone can be misleading (Peck, 2003). One of the advantages of developing COTS gaming software is that there are no requirements for accurate, real world modeling. DoD simulations, alternatively, require very detailed algorithms that are validated using real weapons and operational data. For example, high-end simulations may determine that a probability of kill (PK) is 90% based on all available real-world data. A commercial game company, who is not restricted to real world data, may use a simpler algorithm which places a PK at 60% (Peck, 2003). If a simulation is being used to make billion dollar force assessment decisions, opponents to using COTS software contend, "there is a big difference between a 60% (solution) and a 90% probability of something happening" (Peck, 2003).

"Video games are video games" concludes John Lenyo, vice president for business development at BAE Systems Flight Simulation. In an interview in National Defense magazine, Mr. Lenyo outlines the differences between a PC game and full simulations (Erwin, 2000).

> The reason you can do a game on a PC but you need a full fledged simulator to do a simulation is the computing power isn't there, and there are shortcuts everywhere to make it fit on a PC. Huge shortcuts (a $29 game) will never be like a $29M simulator. The reason it costs $29M is because it is much more sophisticated.

Mr. Lenyo's concern is a significant one, and the degree of realism required by the simulation must be determined by the trainer before selection of any platform. Mark Herman, president of Booz Allen Hamilton and Breakaway Games, concedes this argument, but points out that if total realism is not a requirement, COTS games may provide a cost effective alternative (Peck. 2003).

> If you want operational code for a weapons system, you wouldn't use commercial game designers. They have a very rapid build process, and it's often a little shoddier. But if it's for things that don't get anyone killed, you can get a product that is much cheaper and frequently better.

Ultimately, the level of detail and required use of the simulation must be determined by the trainer. Trade-offs must be made in determining if the training value of the event is to draw conclusions from the simulation or have the simulation provide an environment where teams are learning cognitive tasks not based on conclusion from the simulation.

Adapting COTS gaming software for military training also requires users to place control measures in place in order to reduce horseplay, and increase user acceptance of the game as a legitimate training venue. Major Chris Sharp, assigned to the College of Continuing Education at the Marine Corps University, notes that elements such as establishing a chain of command are some of the unique requirements of COTS games used by military trainees (Baker, 2001).

Although the literature identifies areas for concern when using COTS software, by defining the intended use of the platform, understanding what conclusions can and cannot be provided by a commercial game, and placing control measures for COTS application users can leverage this accessible product to meet specific training needs.

E. CONCLUSIONS FROM LITERATURE REVIEW

Overall, the literature hints at the possibility of increasing team performance through the use of simulations, but does indicate that additional work is needed to capture the impact and measurable differences that simulations can provide. Based on what we found during the review of the existing literature, we were able to refine our research

approach, determine expected findings, and begin to determine what training events would be suitable to train using a COTS game.

Additionally, the debate over the effectiveness of games versus simulators demonstrates that additional studies to measure the differences in the training value provided by each are required. These studies must determine exactly what tasks a game or simulator can and can not be used to train. The literature clearly shows that when a high degree of detailed accuracy is required, a true simulator is likely the right tool for the job. But when the degree of accuracy is less important than a system's use to facilitate training, a COTS solution may suffice.

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III. SELECTION OF PARTICIPANTS, SOFTWARE, AND METRICS

A. INTRODUCTION

The key considerations in conducting our work were the selection of our participants, the tasks and/or battle drills we would attempt to train, and the software we would use to conduct that training. Upon selecting our participants, we reviewed manuals and training references (FM 7-8, *Infantry Rifle Platoon and Squad* and ARTEP 7-8-MTP, *Mission Training Plan for the Infantry Rifle Platoon and Squad*) relevant to squad-level tasks. At this time we also played-tested several commercially available, multiplayer computer games to evaluate their strengths and weaknesses.

B. PARTICIPANT SELECTION

From the beginning, we knew wanted our experiment participants to match our target audience: US Army Soldiers training on dismounted squad tactics. Possibilities included: junior enlisted infantry Soldiers during their Infantry Advanced Individual Training (AIT), junior officers in the Infantry Officer Basic Course (IOBC), or Reserve Officer Training Corps (ROTC) cadets. We ultimately selected the junior officers (newly commissioned second lieutenants) attending IOBC for several reasons: they were scheduled to conduct squad-level training on the tasks we planned to research, our familiarity with their training syllabus and the leadership at IOBC, and we wanted an audience that we theorized would be familiar with using a computer, as IOBC students are required to have some number of college credits if not a completed degree, and we assumed these second lieutenants would have some basic knowledge on operating a personal computer from their college experience.

C TASK SELECTION

To focus to our research, it was necessary to identify a task or drill to train and observe in the virtual environment and in the field. Our critical resource for task selection was FM 7-8, *Infantry Rifle Platoon and Squad*, March 2001, which provides "doctrine, tactics, techniques and procedures on how infantry rifle platoons and squads fight" (FM 7-8, 2001). This reference serves as the basis for training infantry Soldiers to conduct collective (squad and higher level) tasks. Fundamental to the execution of

collective tasks is the battle drill, which is "a collective action rapidly executed without applying a deliberate decision-making process" (FM 7-8, 2001). Battle drills are also described as "how platoons and squads apply fire and maneuver to commonly encountered situations. They require leaders to make decisions rapidly and to issue brief oral orders quickly" (FM 7-8, 2001). ARTEP 7-8 Drill, June 2002, identifies the following battle drills:

- Break Contact (Dismounted)
- React to Ambush
- Knock Out Bunkers (Platoon & Squad)
- Enter and Clear a Building (Platoon)
- Enter and Clear a Trench (Platoon & Squad)
- Conduct Initial Breach of a Mined Wire Obstacle (Platoon)
- Enter Building/Clear Room (Squad)
- React to Contact (Platoon & Squad)
- React to a Chemical Attack (Platoon & Squad)
- React to Nuclear Attack (Platoon & Squad)
- React to Indirect Fire (Squad)

With these drills as reference, we began the process of identifying the drill we wanted to incorporate into our training transfer research. As a training device, a standard computer monitor with typical stereo speakers or headphones severely limits the natural cues and inputs a Soldier receives in order to conduct the actions required to support the aforementioned battle drills. Considering this inaccurate representation of field of view and audio cues, we identified criteria we felt were critical in selecting a battle drill:

- Reproducible in the virtual environment. This was a screening criterion; if it wasn't possible then the task was not considered.
- Capable of supporting multiplayer missions with up to thirty players on a local area network (LAN).
- Accurately modeled scenarios and equipment. The software does not require an accurate ballistics model.

- Peripheral (visual and aural) cues are important, but not critical to performance. While peripheral cues are critically important in both the real and virtual world, the reduction in cues inherent in using a computer monitor and speaker system severely limits the amount of information available.
- Minimal requirement for precise body awareness. Playing from a first-person perspective typically shows only the hands and weapon of the in-game avatar, leaving the remainder of the body un-drawn except in a third-person perspective.

While all of the tasks met the first criterion, reproducibility in the virtual environment, all but "React to Contact" battle drill are heavily reliant on peripheral cues and precise awareness of the avatar's position in the environment. While peripheral cueing and body awareness are necessary in the "React to Contact" battle drill, the fact that the attacker has the initiative to decide where and when to attack mitigates these factors. Additionally, this battle drill is the fundamental building block of infantry maneuvers, and the other drills are extensions of the tasks defined by "React to Contact". In selecting this battle drill, we theorized that if we could determine if the COTS software could support the basic building block of infantry maneuvers, then subsequent research using COTS software for other battle drills was viable.

D. SOFTWARE SELECTION

1. Introduction

"It's not teaching how to shoot or to drive; it's teaching the cognitive" is how Ralph Chatham, the DARWARS Program manager, describes what leaders can learn from multiplayer PC-based training systems (Walker, 2005). While an entertaining process, the task of selecting the right commercial gaming software was challenging. Foremost, in keeping with our goal of a less-expensive training device, we wanted a game that could be used on systems readily available to Soldiers and units. For this reason, we eliminated console systems like the Microsoft Xbox® and Sony Playstation® from consideration and focused us on Personal Computer (PC) based software due to accessibility of PCs from unit level to computer labs common at most major military installations. There was no shortage of titles available that met our screening criteria of a

PC-based first-person perspective shooting game that was multiplayer-capable. The following paragraphs discuss the criteria we established for selecting software and a comparison of the other titles considered but not selected.

2. Selection Criteria

Fundamental to our research was finding software that could provide appropriate cues that would lead the squad to make tactical decisions without a prohibitive set of system requirements. Essentially we wanted to use software that would work on computers that our experience has shown to be available to most Army units: a computer that is two to three years old equipped with integrated graphics and sound. To meet this need, we looked at software that was one to two years old. We acknowledge that the newest software titles would likely have the best graphics and sound, but a game that was even two years old would likely have graphics and sound that were passable and not so bad that they would be distracting from the trainee's experience.

We wanted a game that could do the job but not require a cutting edge equipment to use. Our criteria were as follows:

- a game platform that did not require high overall system requirements
- easy multiplayer set-up and play on a local area network
- weapons, equipment and missions consistent with current US armaments
- the ability to easily modify the game space to a viable training venue.

We needed the flexibility to take existing games and create new mission areas that include appropriate landscaping, structures, equipment, and characters managed by the game's artificial intelligence to support the training requirements set forth by the unit commander. Because of this, the ease of the tool to modify the game environment was a key factor in the game selection. The level editing tool must be intuitive, quickly mastered and robust enough to create a believable virtual training venue.

The following tables show our screening criteria for game selection and system requirement evaluation. Table 1 details the commercial software titles we considered and their relative strengths and weaknesses according to our criteria. Table 2 describes the method we chose for determining computer system requirements. The degree of

difficulty in creating a level with the game's level (or mission) editing software is based on our assessment of the Graphical User Interface (GUI), numbers of models supported and required understanding of computer code in order to script events.

Table 1. Commercial Game Software Comparison

	PC-Based	Multiplayer (>30 goal)	System Requirements	Modern Scenarios / Weapons	Modifiable & Degree of Difficulty
America's Army™	Yes	Yes (32 Players)	High	Yes	No
Delta Force 2™	Yes	Yes (50 Players)	Low	Yes	Yes (Easy)
Delta Force: Black Hawk Down – Team Sabre™	Yes	Yes (50 Players)	Medium	Yes	Yes (Easy)
Unreal Tournament 2004™	Yes	Yes (32 Players)	High	No	Yes (Difficult)
Joint Operations: Typhoon Rising™	Yes	Yes (150 Players)	High	Yes	Yes (Moderate)
Rainbow Six™	Yes	Yes (16 Players)	Low	Yes	Yes (Moderate)
Operation Flashpoint™	Yes	Yes	Medium	Yes	Yes (Moderate)
Soldier of Fortune™	Yes	Yes (32 Players)	Low	No	No

Table 2. System Requirement Evaluation for Game Selection

	Operating System	Processor Speed	RAM	Video Card	HD space
Low	Windows 98	Less than 733MHz	Less than 128MB	Less than 32MB	Less than 750MB
Medium	Windows NT, Me or 2000	733MHz - 1.0GHz	128MB to 256MB	32MB to 128MB	750MB to 1.4GB
High	Windows XP	Greater than 1.0 GHz	Greater than 256MB	Greater than 128MB	Greater than 1.4GB

E. SELECTION OF SOFTWARE TRAINING METHOLOGY

1. Introduction

Our early pilot studies were instrumental in fine-tuning our approach to training. The challenge of taking traditionally entertainment-focused software and converting it to a training tool was brought to the fore during our early pilot studies. How they were trained to use the software, what scenarios were best suited to the task, the composition of the opposing forces and the equipment available in the environment were areas we had to address to support the transfer of classroom computer executed training to a field environment.

2. Participant Training

Our experiment was scheduled to take place while our participants were in their 7th and 8th week of Infantry Officer training. Prior to our experiment, the lieutenants had received training on a numerous individual infantry skills including: prepare and issue an operations order, engage a target with individual weapon, and provide a situation report to a higher element. Without this base of knowledge on individual tasks, our participants may have gained some familiarity with tactical operations from their training in the virtual environment, but their ability to transfer those skills to the field environment would likely have been reduced by their need to later learn their individual skills.

To make the training transition from classroom to the field environment, the participants in our study needed to learn how to use the keyboard and mouse control scheme. In early pilot studies, we provided a classroom presentation on how to control their avatar and how to interpret information the software provides them. After this briefing, the participants played one or more of the game's single player missions for 20 minutes while the researchers provided assistance and game-play tips. To further aid the participants, each workstation had a keyboard and mouse reference card available throughout the training. We initially felt the training we provided and their exposure to the game environment would be sufficient. Survey results from these early pilot studies indicated that the participants felt that there was too much lecture and not enough hands-on training. Additionally they felt that the single-player gaming session did little to prepare them to work together as a squad.

Based on this feedback, we altered our training for the remaining two pilot studies. Our familiarization and training program evolved to a much shorter classroom presentation followed by a group, hands-on training session in the virtual environment. To better prepare them to work as a team; we executed game familiarization and training using their doctrinal elements: the buddy team, the fire team and the squad. In these elements, they were trained and helped each other learn to control their avatar; operate weapons and equipment; and execute team operations. The positive results from the training in these pilot studies led us to use this as our training and familiarization technique during the experiment conducted at Ft Benning, GA.

3. Training Scenarios

Our goal in creating a training scenario was to create a tool that would advance the training of our participants. Given our participants, we designed scenarios consistent with training they would receive at the Infantry Officer's Basic Course. Based on this, we prepared two game 'maps' with four missions on each map. The intent of these missions was to gradually increase the level of difficulty by adding additional enemy forces and varying the terrain in the objective area. To support the preparation of the IOBC students to conduct the squad live fire event, we contacted the unit commander, and developed the scenarios for game play that would compliment the classroom instruction the second lieutenants received on the conduct of the live fire event. Specific descriptions of the virtual maneuver training lanes are detailed in Chapter IV, Appendices A and E. contains the operations orders and maneuver graphics that drove the training scenarios.

4. Opposing Force

This section will deal with our dilemma of using human-controlled or Artificial Intelligence (AI) OPFOR. Initially, we planned to use soldiers not affiliated with our participant group to act as OPFOR. The advantage of live OPFOR came in its flexibility to react to any given situation. Three to four soldiers would provide us a cadre of OPFOR and provide the participants with a realistic enemy. After one play-test and a pilot study though, we realized that using human OPFOR would provide several challenges: logistically it would require more computers and a separate room to work from; their ability to control their avatar would be greater than the participant opponents in the second squad's treatment; people want to win, and if they're not allowed to win (or attempt to win), their skill with the game can make them harder to kill.

While a cadre of human-controlled OPFOR was undesirable, an all AI OPFOR was equally unpalatable: their reactions and responses to events in the game environment were based on predetermined trigger points that do not take into account the potential actions of the training force. The AI OPFOR were very effective at standing on an objective

Ultimately, we decided a mix of these worked best. We placed an AI-managed threat force in and around the objective areas and used one or two human-controlled agents to draw attention to tactical areas that were being poorly executed. Flank security is an example where a human agent was most useful. As they neared the objective, squad members ceased to provide security to the left and right, focusing their attention completely in the direction of the objective. We would use a human OPFOR agent on their flanks to stress the importance of flank security.

5. Equipment Options

While basic tactics could be taught with the right collection of weapons from any era, we elected to use weapons and equipment currently in use by the U.S. Army. *Delta Force: Black Hawk Down – Team Sabre*™ allowed us to remove equipment from the game that was inconsistent with the basic infantry rifle squad. Basic squad equipment types that the COTS game supported included: M4 carbine with Close Combat Optic (CCO), M249 Squad Automatic Weapon (M249 SAW), M16A2 rifle with M203 40mm grenade launcher (M203), M61 fragmentary grenades, AN-M8 HC White Smoke grenades, and binoculars.

F. TASK SELECTION AND ANALYSIS

1. Overview

In order to maximize the training effect of simulations, leaders must first conduct a task analysis of the collective event in order to determine those skills which can be trained through simulation, and those that cannot. Due to the limitations of simulation, it is important to set realistic training expectations for both trainers and trainees. Additionally, trainers and leaders must determine the potential for negative training transfer from the use of simulations and implement control measures to prevent adverse team learning. With these thoughts in mind, we believe that given a detailed task analysis and proper training expectations, a COTS game could be used as an effective training tool.

2. Task Analysis for Squad "React to Contact"

For our experiment, we conducted a thorough task analysis of the Squad "React to Contact" battle drill using the Occupational Information Network's O*NET Descriptors (2005). We first examined the individual and crew supporting tasks of "React to

Contact", and then reviewed each performance measure of the battle drill in order to determine an initial list of tasks that could potentially be replicated by the COTS game.

For the individual and crew skills, we determined that the COTS game could not replicate all the sensory inputs required to properly train and execute the steps involved in most tasks. It did however, provide a "good enough" replication of completed individual tasks to support the higher collective performance measures without forcing the Soldier to manually execute each step in the task. For example, the individual task "Load, Unload and Reduce Stoppage of an M16A2 Rifle" requires a M16A2 and a great degree of haptic feedback in order for a Soldier to execute this task. Haptic feedback such as pulling the charging handle, loading a new magazine and tapping the forward assist are critical in order to train this task to standard. We found that the game does provide reasonable visual cues for users to recognize the completion of the task.

Since we never intended to use the COTS game to train "Load, Unload and Reduce Stoppage of an M16A2 Rifle" or other individual Soldier skills, but as a venue to train collective performance measures, the visual cues provide an adequate replication to support such collective tasks such as "squad/team leaders locate and engage known or suspected enemy positions with well-aimed fire, and pass information to the platoon/squad leader." (ARTEP 7-8 Drill, 2-38). For our experiment with the IOBC students at Fort Benning, all the individual and crew collective tasks that supported the squad "React to Contact" battle drill were trained prior to our use of the COTS game.

For the collective tasks we used the O*NET Descriptors to examine all the human abilities required for selected leader performance measures. In our previous example, "squad/team leaders locate and engage known or suspected enemy positions with well-aimed fire, and pass information to the platoon/squad leader" (ARTEP 7-8 Drill, 2-38), we identified human abilities such as Spatial Orientation, Near and Far Vision, Hearing Sensitivity, Sound Localization and others that were required for the human operator to properly perform the task (Fleishman, 1995). We then examined our COTS game platform to determine the degree of replication that the simulation could render. By mapping the human abilities to the COTS game, we created a roadmap for our survey

questions and developed an understanding of what COTS games can offer. Appendix F contains our Task Analysis results for "React to Contact."

3. Findings from the Task Analysis

We found that the COTS game could not adequately provide sufficient sensory cues to train individual or crew tasks to standard. However, the visual and audio cues from the game were good enough for human operators to accomplish a replication of most individual supporting tasks required to conduct the battle drill "React to Contact." In areas where the COTS game could not directly provide required sensory cues, we flagged the human ability requirement of the task for future observation to determine if the shortfall had an adverse effect. Using our example, "squad/team leaders locate and engage known or suspected enemy positions with well-aimed fire, and pass information to the platoon/squad leader" (ARTEP 7-8 Drill, 2-38), the COTS game did not replicate the human ability requirement for Far Vision. The subjects were viewing a computer monitor approximately 20 inches from their eyes, not trying to discern enemy locations at an actual distance. To capture the impact of this type of shortfall, we designed our participant surveys to address any sensory cue problems in the game and interviewed the IOBC training officer. We felt these two control measures allowed us to fairly examine the COTS game as a potential training tool and identifying areas where additional training may be required due to the inability of the game to support required sensory cues.

IV. CONDUCT OF THE EXPERIMENT

A. OVERVIEW

For this research experiment, we wanted the COTS game use to be as transparent a training venue as possible for the second lieutenants at IOBC. Using this tenet as a cornerstone of our experiment, we modeled the event as close as possible to the field training exercises (FTX) the IOBC students conduct in preparation for live fire events. During the FTX, the trainers establish an initial chain of command, administer a five paragraph operations order (OPORD) with maps and graphics, and brief the OPORD on a sand table that represents the objective terrain. Following the OPORD brief, the second lieutenants conduct rehearsals, back briefs, and begin movement towards the field objective that is populated with a live OPFOR element (which is controlled by the trainer, and consists of students and cadre in enemy threat uniforms). Once contact is made with this OPFOR element, the students, using Multiple Integrated Laser Engagement System (MILES) on their weapons, conduct actions on contact. Following the event, the trainers conduct an after action review in which students can identify strengths and weaknesses of their unit and use those lessons to improve performance during the next event. In general terms, for our experiment we simply replaced the field with a virtual environment created using the COTS game *Delta Force: Black Hawk Down – Team Sabre*™. For the subjects and trainers to accept this methodology (of using COTS software), we felt that we needed to maintain as many traditional training elements as possible. Additionally, we felt that maintaining the structure of a traditional training exercise would focus the attention of the subjects to the tactical and not the technical.

B. PILOT TESTING AND PRELIMINARY FINDINGS

In order to prepare for our experiment at Fort Benning, we conducted extensive local pilot studies using Army and Navy students attending the Defense Language Institute at the U.S. Army Presidio of Monterey and both military and civilian students at NPS. Our preliminary pilot studies provided very worthwhile detailed feedback on the experiment set up, conduct of software training and refinement of our data collection method. The final two pilot experiments provided us with an opportunity to conduct a

full dress rehearsal for our actual experiment with IOBC. For future studies in this research area, it is highly recommended that multiple pilot experiments be conducted (with participants from different backgrounds) in order to allow researchers to be fully prepared for the conduct of the test.

As previously discussed, we selected the infantry squad "React to Contact" battle drill, from the ARTEP 7-8 Drill as the task to be trained in the simulation exercise. Utilizing the level (or mission editing) software that came with the *Delta Force: Black Hawk Down – Team Sabre*™, we created a virtual environment equipped with a fixed, AI driven opposing force (OPFOR) which would provide the majority of resistance to the squad. As discussed previously, we planned to bring a live OPFOR avatar into the virtual environment to either reinforce a teaching point or to maintain control of the event. During the first pilot studies (I-III), we kept the conduct of the event as previously described, but changed the conditions of the workstations. For these pilots, we utilized students and faculty (as a 7-9 man squad) in a local, LAN supported, computer lab.

During the first and second pilots, we wanted to determine how to set up the audio and communication methods for the participants to interact. We utilized headphones with microphone (similar to those which support the Marine Corps DVTE system) to provide audio cues and a method for subjects to communicate. We used an open source software tool called TeamSpeak™ that provided voice over IP (VoIP) capability to allow for group communication within the game environment. We also reduced the lighting in the lab and added background noise (Nature Sounds™ Rainforest Soundtrack CD) played on a small radio in the back of the room to increase immersive qualities of the virtual venue. We found that the VoIP performed poorly due to the proximity of subject's workstations and an approximate one second delay in audio transmission. The subjects overheard commands from their leaders and then heard the VoIP transmission. As a result, subjects either removed the headphones all together to talk or ignored verbal commands. We also found out that lower lighting made finding game control keys difficult, and the background sounds did not contribute to an immersive quality. During the third pilot, we used the computer speakers vice headphones, and allowed the subjects to talk above the audio cues from individual workstation speakers for communication.

We found that the ability of the subjects to overhear other workstations speakers led to missed or inaccurate audio cues from the game environment. Additionally, we rehearsed timing of administering surveys, key events and game interface training during the first three pilots. Key findings from the first three pilots included:

- Using headphones without microphones allowed users to receive the accurate audio cues from their position within the game environment. By adjusting individual sound levels, users could hear game audio cues and spoken commands from other squad members
- Using a partition to separate the two squad fire teams reduced audio cue mismatch from the two fire team leaders
- Reducing lighting impaired subject's (particularly novice computer users) ability to find game controls
- The best technique for training users on the game interface
- Timings of after action reviews, issuing of OPORDs and administration of the subject surveys

Using the findings from these three preliminary pilot tests, we refined our test conditions, and finalized our written products (surveys and OPORDs) in order to prepare for our remaining two local experiments. Our goal was to use these remaining studies as our full dress rehearsal for the Fort Benning experiment. We framed our expected learning outcome for the final two pilot studies to focus on usability of the interface, ability of the leaders to control unit small arms fires, squad communication, and command and control. For our pilot IV and V participants, we selected two groups of nine Soldiers and Sailors attending the Defense Language Institute (DLI) to serve as our rifle squad. The following will address the formal method and findings from these two studies.

1. Method

a. Lab Setup

We utilized a local computer lab for the testing, and reconfigured the workstations to allow the fire team members to be grouped together with the squad leader in a central position located to the rear and center of the two teams. To accomplish this,

we set up two rows of local area networked connected workstations oriented towards a sterilized wall (Figure 2). Each workstation in the first row facing the wall had desktop computers with 17" to 21" color monitors, three-button (wheel) mouse and keyboard. The second row of workstations (located behind the first and oriented towards the same wall) contained power and LAN plugs for participants using laptop computers. Both of the laptops had a three-button (wheel) mouse in order to maintain consistency between the desktop and laptop workstations. Although the additional two laptop computers were available, only one was used.

Although we were unable to provide desktop workstations for all test subjects due to resource limitations, we did not observe notable performance differences between the laptop and desktop computer users. Each workstation's minimum system requirements included a Pentium III 733 MHz processor (or higher), a 32 MB video card, and a 4X speed CD-ROM. Most of the workstations exceeded these benchmarks. The final modification to the test site was a partition wall placed between the Alpha and Bravo teams in order to limit the viewing areas of the participants to only their immediate team members. The squad leader workstation was located behind the partition to allow for viewing of both teams to replicate the command and control position of the leader in a tactical field formation.

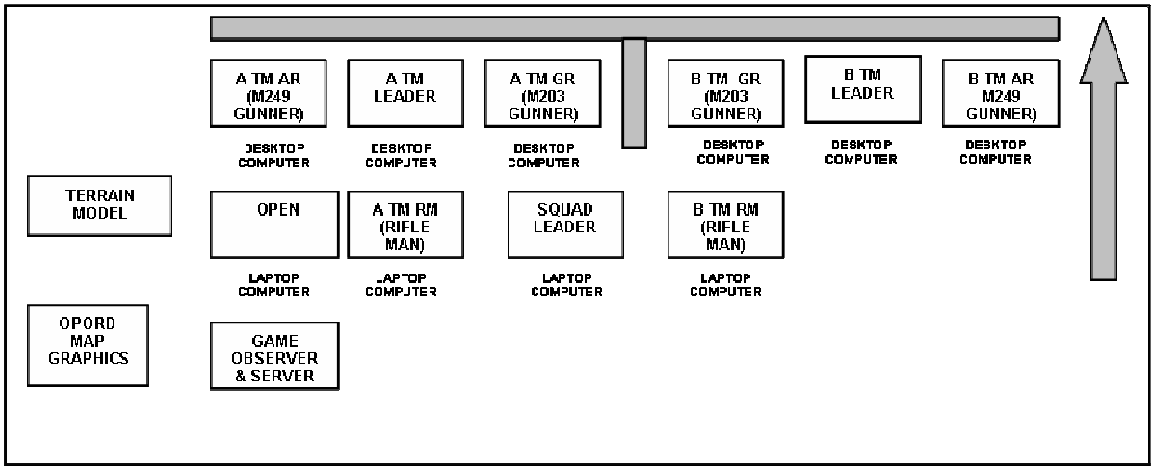


Figure 2. Pilot Test Site Layout

With the site established, we then loaded the software on all the desktop workstations, one dedicated server station, and two of our personal laptop computers for use by test subjects without a desktop workstation. With the software loaded, we assigned each workstation a duty position within the game in accordance with the task organization of a rifle infantry squad. Each workstation was then assigned the equipment authorized by each infantryman's duty position. For example, the squad's automatic rifleman workstation character within the game was assigned the M249 Squad Automatic Weapon, ammunition basic load and grenades authorized by the U.S. Army Table of Equipment and Allowances (TOE) for an automatic rifleman.

Within the game's player options, we also assigned each member a duty position label for the other team members to view once in the multiplayer session. Continuing with our automatic rifleman example, we assigned the workstation "A AR" for Alpha Team automatic rifleman. Once the entire team entered the multiplayer session, the workstation label would appear as a green text box above the participant's avatar for identification by other team members. We considered, but rejected, leaving the identification labels off, as they are not present in the real world. After some discussion with subject matter experts (SMEs) with at least ten years experience in dismounted operations, we determined that squad (or team) members that have been formed for some time would be able to recognize the gait and posture of its team members. Because the game's avatars are essentially the same, we concluded that allowing labels would allow leaders to command and control more efficiently, and not create negative training transfer situation.

For the tactical orders portion of the experiment, we created a terrain model (sand table) that replicated the immediate terrain around the first mission objective site. A topographical (1:50,000 scale) map with tactical graphics was posted adjoining the terrain model to allow the experimenter to brief the squad OPORD from the map and then discuss actions on the objective using the sand table. For squad and team leader use, we created and handed out sector sketches on 8.5 x 11" paper that included graphic control measures placed over a picture of the target objective map obtained from the game. Using the three products, we overcame the game platform's lack of ability to

generate a Military Grid Reference System topographical map and operational graphics which are used by infantrymen when conducting tactical real world operations.

b. Virtual Environment Design

For the multiplayer missions, we used the *Delta Force: Black Hawk Down – Team Sabre*™ Mission Editor (MED) to create a virtual environment (VE) for our participants to tactical operations. For the VE, we chose to loosely base the terrain, structures, enemy and environmental conditions on a Southwest Asia terrorist insurgency scenario. The VE was five square miles in size and contained terrain features similar to those of the topographic map used to brief the squad operations order. The participants began at a friendly firebase which contained a helicopter hangar, a tactical movement training lane, and a UH-60 Blackhawk helicopter for insertion of the squad into the mission zone once team training was complete on the tactical movement lane. The mission zone contained a moderately wooded area with rolling hills and a river on which the four mission objectives were located.

The tactical movement training lane was placed at the firebase to allow the team members to practice tactical movement techniques once in the VE. The 500 x 200 meter site contained two lanes, each consisting of two bunkers at a start point, two obstacles to be used as cover and concealment when negotiating the lane (a broken wall section and a pile of three destroyed cars), and an enemy bunker at the end of the lane for the teams to focus direct fires and movement direction. A wooden watchtower was paced beside the lane to allow the squad leader to observe the fire teams' training on the lane, and make spot corrections. Two enemy insurgents (AI) were placed in the end bunkers with a programmed instruction set to engage the participants negotiating the lane in order to provide a look and feel of moving under direct fire to the teams. The AI weapon accuracy instruction set was set to zero to ensure that no participant avatar was killed during the lane training.

The next feature of the VE was the use of helicopter insertion. During a previous pilot study, we observed that test subject's attention level increased dramatically once they boarded a helicopter for an insertion into the tactical mission. With this in mind, we maintained the helicopter insertion portion of the VE for the pilot testing. Once

training was complete at the tactical movement training lane, the participants boarded the UH-60 Blackhawk and conducted a 2000 meter air movement into the mission zone.

For the mission objectives, we selected targets and sites that would normally be assigned a 9 to 11 man infantry squad. In keeping with the scripted scenario, we used infrastructure nodes that insurgents may seize in order to disrupt or terrorize local civilian populations (radio towers, oil and water pumping sites, etc). We placed 6 to 9 enemy insurgents (AI) armed with crew served machine guns, rocket propelled grenades and AK-47 assault rifles. We set these models to fight from fixed positions and engage once the insurgents established visual contact with the test squad. We set the weapon accuracy of the AI agents initially at 60%, and then increased it on subsequent lanes as the squad became more proficient in the VE.

At the end of each objective, we placed health and ammunition game icons that permitted each team member to refresh their ammunition basic load and avatar's health prior to continuing to the next mission site. A game spawn point (which allows players to return to a specific location in the game if killed) was placed after each objective in order to get subjects back into the VE and not have to move 2000m to link back up with their unit (in the OPORD, we referred to these as checkpoints, and required our subject squad to secure them in the coordinating instructions of paragraph III). These features allowed us to use one VE saving game loading time thus increasing our number of mission iterations we could execute with the participants.

Finally, the server workstation was loaded with an open source video capture program (Fraps) that allowed us to capture video of the squad within the VE at critical points during the mission. We entered the VE from this workstation as an enemy player, so as to not appear on the test participant's Head-Up Display (HUD), move to a position that afforded a key vantage point of each objective, and use the Fraps program to capture video of the squad's actions on contact, movement techniques, and fire control and distribution. The intent of the captured video was for use during an after action review with participants following completion of a mission. Although not used in this manner during the pilot studies, we did validate the method of capturing game play for AAR purposes.

The test participants started the experiment in a classroom where they completed the demographics portion of the survey, received an overview of the experiment, a block of instruction on the fundamentals of infantry squad movement techniques, the squad attack, and game console controls. Once complete, the participants moved to the test lab where they were assigned a workstation by rank for leaders, then random assignment for the remaining positions, and completed the second portion of the interface training. Once complete, we briefed the tactical operations order to all participants, handed out the appropriate maps and graphics, and directed the participants enter the VE in a multiplayer session. The operations order directed the squad to conduct rehearsals on the tactical movement training lane (Figure 3), and once complete, the squad would board the UH-60 Blackhawk for air insertion to the first mission location (Figure 4).

Figure 3. In-Game Live Fire Range

Figure 4. Helicopter insertion

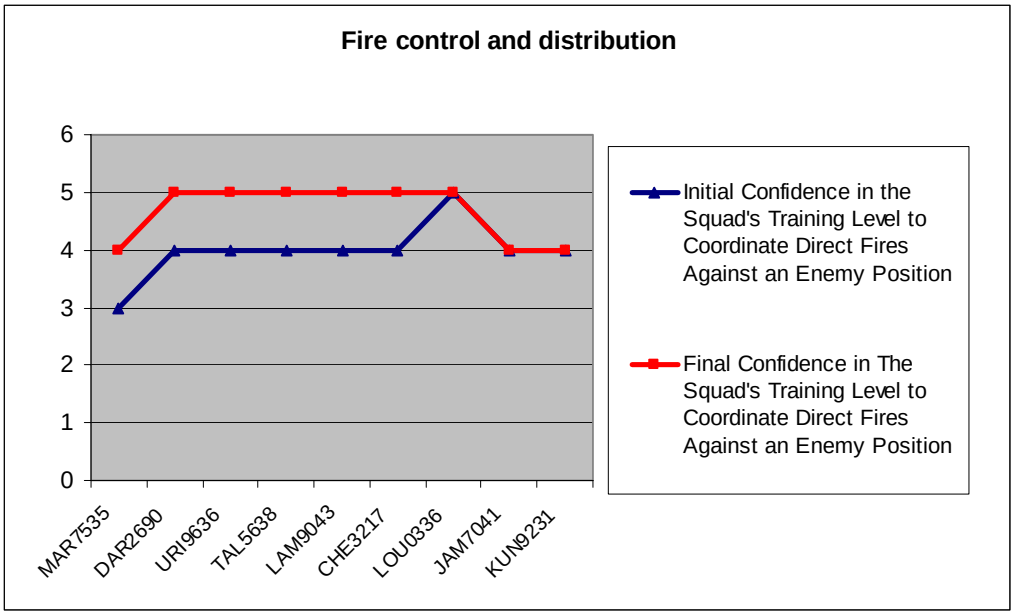
Time was afforded the leaders to review the order with the members of the squad on the terrain model or maps, and to develop initial standard operating procedures (SOP) for movement, communication, and actions on enemy contact. Following each of the missions, the test group completed a post game survey to capture learning and skill acquisition progression. At the completion of the last mission, the participants completed an end-game survey and received a debriefing.

2. Results from Pilot Studies IV and V

The participants of pilot IV were U.S. Army Soldiers from the Defense Language Institute (DLI) located at the Presidio of Monterey, California. The Soldiers were completing foreign language training at DLI in order to serve as ground interpreters for deployed maneuver units. The nine member group had conducted some training in infantry squad tactics during periodic field exercises, but not as a fixed group. The experience base of the grouped ranged from Staff Sergeant (E6) to Private First Class (E3). Three of the nine participants were female, two participants were National Guardsman, and the ages ranged from 20 to 34. We also gathered general information on video game playing experience and rifle hunting background in order to provide a broader assessment of the participant's level of expertise.

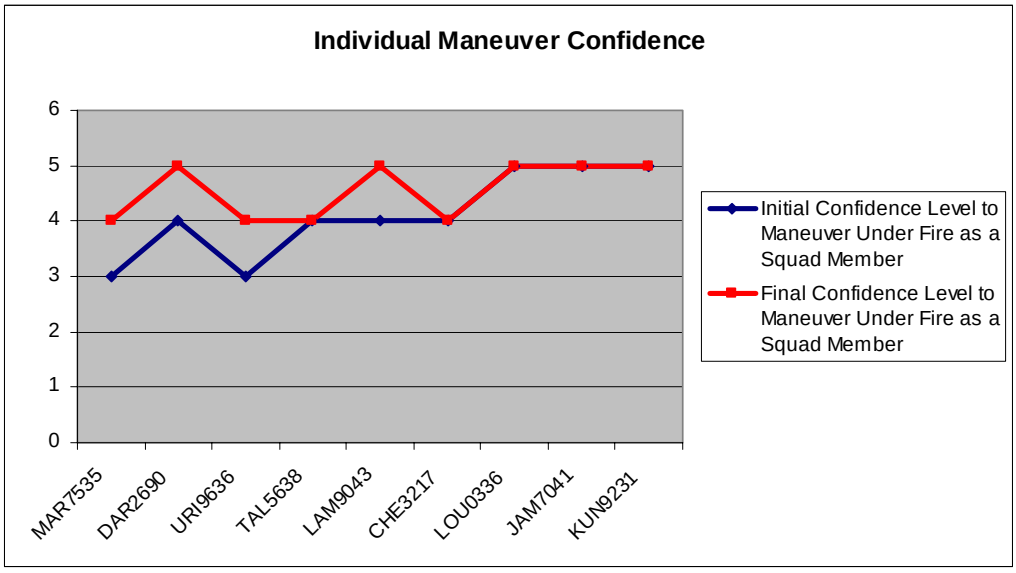
We had two interesting findings from our pilot IV experiment. The first involved an improved participant assessment of the squad's ability to conduct small arms "Fire Control and Distribution". We used a five point Likert scale for training confidence assessment (1 = Very Unsure, 2 = Unsure, 3 = Neutral, 4 = Confident, 5 = Very Confident). Six of six participants with less than two years military experience indicated that their confidence of their squad's ability to conduct "Fire Control and Distribution" improved after conducting the games-based training. Of the remaining three participants with more than two years military experience, none reported a change to their initial assessment. This sustained assessment could indicate that the participants with more than two years military experience did not feel the training had a negative impact (Table 3).

Table 3. Pilot Study Fire Control and Distribution (Squad Assessment)



Our second finding was a reported improvement for confidence level of conducting individual movement as a member of a squad. Four of six participants with less than two years military experience assessed an increased confidence level to maneuver under fire as a member of a squad. Of the five remaining participants, all indicated that the games-based training event either sustained or improved their assessment of their individual ability to conduct maneuver under fire as a squad member (Table 4).

Table 4. Pilot Study Participant Individual Maneuver Confidence



The participants from pilot V were 10 U.S. Navy Sailors attending the DLI. The results of their pilot mirror much of those found during pilot IV, but in the area of initial self-assessed confidence level to conduct tactical maneuvers as a member of a rifle infantry squad, the Sailors, who never conducted any formal training other than the block of instruction we provided, rated themselves as very high. This result gave us cause for concern that our Fort Benning subjects would overrate themselves based on either their lack of experience or demand characteristics. Because of this finding, we exercised increased caution when we analyzed both our pilot and Fort Benning experiments.

3. Discussion from the Pilot Studies

One of the senior participants in our pilot studies indicated that at first, his frustration was with the interface, but towards the end of the exercise, his frustration was with his ability to maneuver his squad. Based on his comments and participant comments from previous sessions, we felt that the training event portion of our experiment was having an effect on the target audience. Frustration concerning command and control is a common experience during field exercises, so hearing his comments meant that he accepted the interface, and was focused on the collective task.

Possible confounds in our pilot data include the lack of experience base of the individual squad members and the fact that our participant squads do not normally train together makes team assessment difficult to measure or validate. Additionally, the participants from DLI are language speakers just completing their initial Army or Navy training, so any experience and recommendations whether to use this type of training remained unresolved at the conclusion of the pilot study.

C. FORT BENNING EXPERIMENT

Based on the results of the pilot studies, we refined our experiment for the students at IOBC. We made adjustments to the survey, and refined the game environment to fix game play errors discovered during the pilot testing. The conduct of the Fort Benning experiment mirrored that of our previous pilot tests with the subjects completing demographic surveys, receiving a blocks of instruction and practical exercise on the game controls, and conducting tactical missions in the VE. The Fort Benning computer lab we used for our experiment contained an overhead projector and screens that we used for the game training and Fraps video playback for the AAR (Figure 5).

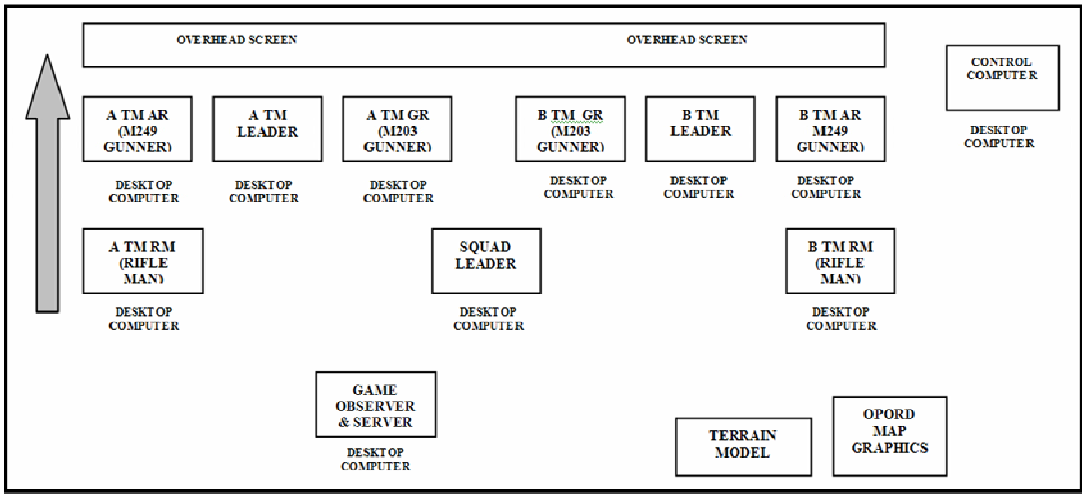


Figure 5. Fort Benning Test Site Layout

Upon arrival at Fort Benning, we linked up with the IOBC chain of command to provide them an overview of the experiment and secure the test location. After the commander assigned a platoon to support our experiment, we met with the platoon training leadership and administered the Demographics portion of the survey to all four squads. The IOBC company commander assigned the trainer from the platoon who provided the four squads (two test and two control squads) to be present for our

experiment in the computer lab. The platoon trainer, an infantry Captain who served as the TAC officer for 4th Platoon, helped us immeasurably in control of the overall test from ensuring squads reported in a timely manner to providing insight to training updates from the Infantry Center.

Originally scheduled as four four-hour sessions, we conducted the experiment with the two IOBC test squads in the computer lab over two-eight hour training sessions due to IOBC schedule conflicts. During the lab portion of the experiment, we allowed the 4th Platoon TAC to enter the VE (as an OPFOR player) in order to observe his squad's performance. Under our direction, he actively engaged the test squad in order to reinforce learning points the IOBC students received during previous classroom instruction, such as failure to provide 360 degree security or not massing small arms fires on the objective. At the completion of the lab portion of the experiment, the test subjects were instructed not to discuss the experiment with their peers in the control squad until after the FTX conducted at the Ware live fire range complex the following week.

We deployed to Ware range, after IOBC arrived at the live fire range, and with the 4th Platoon trainers, observed the test and control squads conduct a blank fire exercise on a squad "React to Contact" lane in preparation for the live fire exercise later in the week. We observed the performance of all four squads from receipt of mission, through execution, and to the AAR. After the AAR, we administered the final portion of the survey and conducted our debriefing. As the individual test and control group completed their survey, we conducted an open forum interview in order to capture anecdotal data from their experience. Finally, we conducted an interview with the 4th Platoon TAC officer to capture his thoughts and observations from the experiment.

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V. ANALYSIS OF EXPERIMENT

A. INTRODUCTION

The results presented in this chapter are based on survey results, researcher observations and interviews with subjects. Throughout our surveys, we found very few statistically significant results. We feel that this is largely based on two factors: the small number of participants in the research (41) and our participants' overestimation of their abilities. The small number of participants was largely a result of the time available to conduct our research – it was the inflation of self-reported data that made our data harder to demonstrate change.

As stated, our survey results were primarily self-reported opinions of the participants' skill and training confidence in various tactical areas. Our final pilot study was the first time we recognized that for some survey questions, our scales were not well anchored, which led to some participants reporting an ability level that was clearly inflated. In the final pilot study, our participants were a group of U.S. Navy Sailors from the Defense Language Institute. During the introductory training we provided, they advised us that they had no training in field tasks. After our 20 minute class on tactics and individual movement techniques, they reported a level of confidence in tactics and maneuver that was not consistent with the amount of experience and training they had received. While we know the training we provided was doctrinally correct, the participants uniformly assessed their skill in tactics as a four or five on a one to five scale where higher is better.

B. EXPERIMENTAL RESULTS

1. Demographic Survey Results

Our demographic survey was aimed at determining the baseline of our participants and finding any confounding factors within their past experiences. The survey covers personal information, military experiences, and commercial game and military simulation experience. We did not find any significant differences between the participant groups or other confounding factors as a result of our demographic data collection.

As stated in Chapter IV, we randomly selected two squads to receive the treatment with the other two squads acting as the control group for the experiment. Table 5 shows the age and number of years of military experience broken down by control group and treatment group. The soldiers in the platoon are assigned to squads in alphabetical order, so we were surprised to see the age difference between the two groups (control 28.1 and treatment 25.8). 61% of the participants have prior military experience with the rates being similar between the groups (62% with experience in the control group and 60% in the treatment group). While over 60% have prior military experience, of those, less than 5% have served in a combat zone with a ground unit.

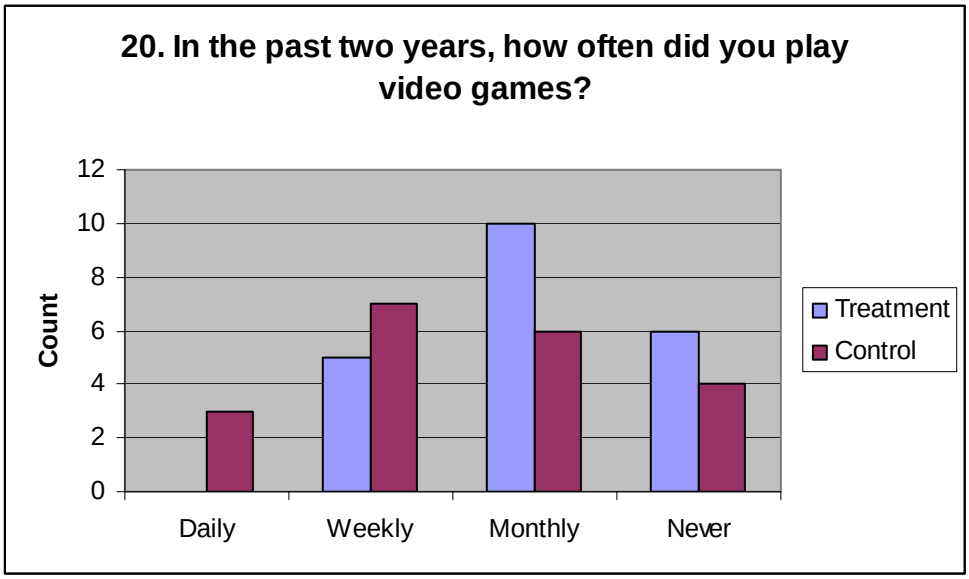
Table 5. Participant Age and Military Experience Prior to IOBC

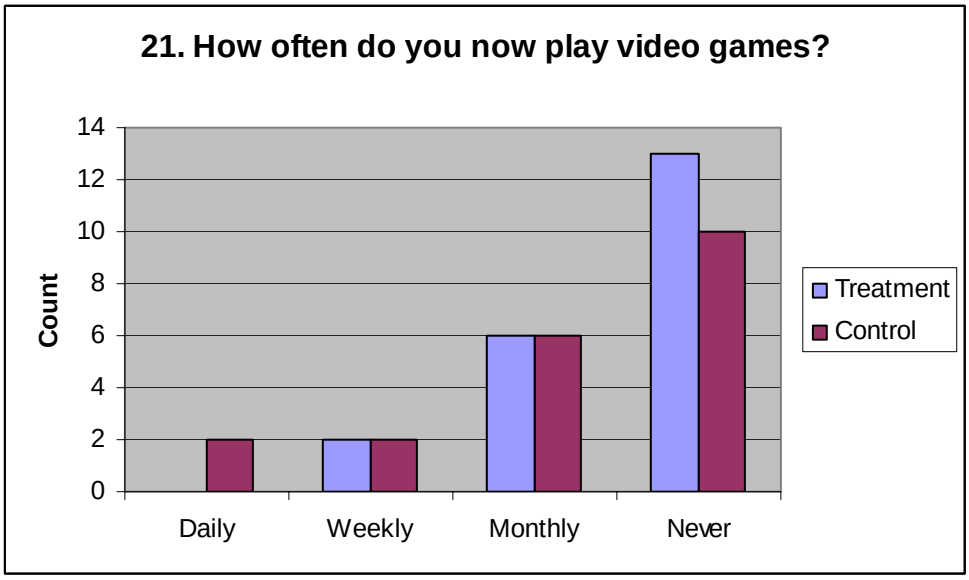
	Group	N	Mean	Std. Deviation	Std. Error Mean
4. Age:	Control	21	28.10	4.867	1.062
	Treatment	20	25.80	3.778	.845
12. Do you have any prior military experience?:	Control	21	.62	.498	.109
	Treatment	20	.60	.503	.112
16. Have you served in a combat zone with a ground unit?:	Control	12	.17	.389	.112
	Treatment	13	.15	.376	.104

Given our research area, we also looked at what percentage of our participants had experience playing commercial computer or other types of video games. We looked at both the frequency that they currently play commercial games as well as the frequency with which they played games in the past two years. We were particularly interested in the gaming experience in the treatment group; knowing that their familiarity with the game control scheme would affect their ability to perform in the virtual environment. That comfort in the virtual environment may indicate a reduction in the amount of attention they would require to control their avatar, which would potentially affect their ability to execute the required “React to Contact” tasks.

The results showed that while 75% (31 of 41) of the participants reported playing games at least monthly in the past two years, only 44% (18 of 41) report playing games monthly or more often. Table 6 shows the results for the control and treatment groups.

Table 6. Commercial game play experience for the participants by group.





Given our use of a multiplayer, first person shooter for our study, we surveyed the participants for their experience with first person shooter games and multiplayer games. Within the treatment group, 60% (12 of 20) had played first-person shooters and 80% (16 of 20) had played multiplayer games. The results were similar with the control group,

with 62% (13 of 21) having some experience with a first-person shooter and 72% (15 of 21) having experienced a multiplayer game.

In an effort to identify other potentially confounding factors between the groups, we surveyed participants on areas related individual skill in the field environment and squad socialization. We found no significant differences between the two groups in these areas. In our survey we asked for experience rifle-hunting, with more frequency being better, as a basis for individual skill in moving through the field and identifying a target in a cluttered, woodland environment. The results were not significantly different between the groups (control: 38% yes, treatment: 35% yes). From our experience with small unit dynamics, we felt that the amount of time a squad spends together may indicate a level of synergy within the unit. Numbers skewed in either the low or high end of the scale shown in Table 7 could indicate an additional factor present in the squad's performance. The results found the squad socialization data to be similar between the two groups.

Table 7. Squad socializing results by participant groups.

		Never	Rarely	Seldom	Often	Daily	Mean (sd)
30. Do you socialize with your squad after duty hours?:	Control	0%	4%	38%	38%	9%	3.33 (.232)
		0 / 21	1 / 21	8 / 21	8 / 21	2 / 21	
	Treatment	0%	15%	25%	40%	20%	3.65 (.221)
		0 / 20	3 / 20	5 / 20	8 / 20	4 / 20	

2. Post-Mission Survey Results

Upon the completion of each mission in the virtual training environment, participants filled out a post-mission survey covering: their performance in the game environment, their duties in the squad, their actions during the mission, and any comments or recommendations they had for the training. This survey section was completed only by the treatment squads. The squad that underwent the treatment first executed seven missions in the virtual environment. Due to time constraints, the second squad to undergo the treatment was only able to execute six missions. At the completion of the treatment stage of the experiment, we received 132 Post-Simulation Mission surveys. The comments section of this survey will be covered in section 3, Simulation results. The results in this section will focus first on the participants' reported

performance in the environment and then look at what they perceived to be the training value of executing these tasks using a commercial PC game.

First and foremost, we wanted to determine how the participants felt about their performance in the environment. Table 8 shows how the participants reported their competence with the game controls and environment on a scale from one to ten. The first table shows the mean score by mission number. Table 9 shows the complete information in a box plot format. With the exception of mission four, the treatment subjects reported improved performance in the environment on a relatively consistent basis. After reviewing our notes, we found that mission four occurred immediately after our evening break for dinner, which may have been a factor in their scoring and game-play competence.

Table 8. Self-reported competence mean score by mission.

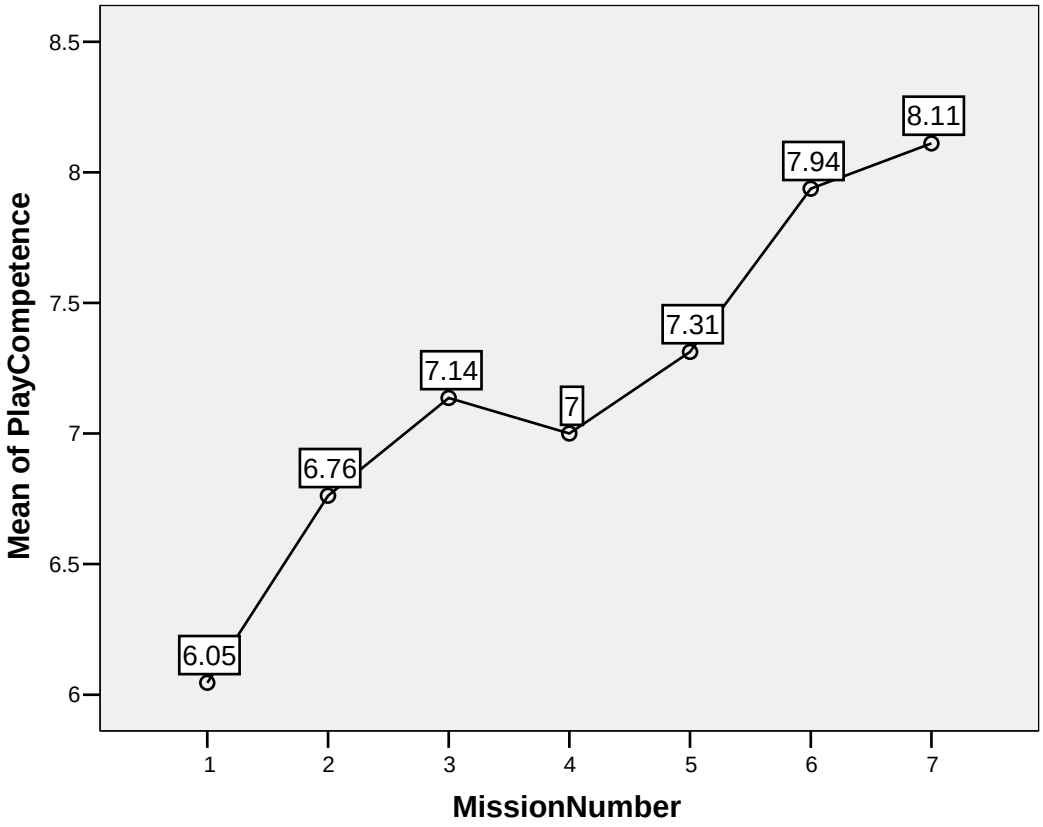
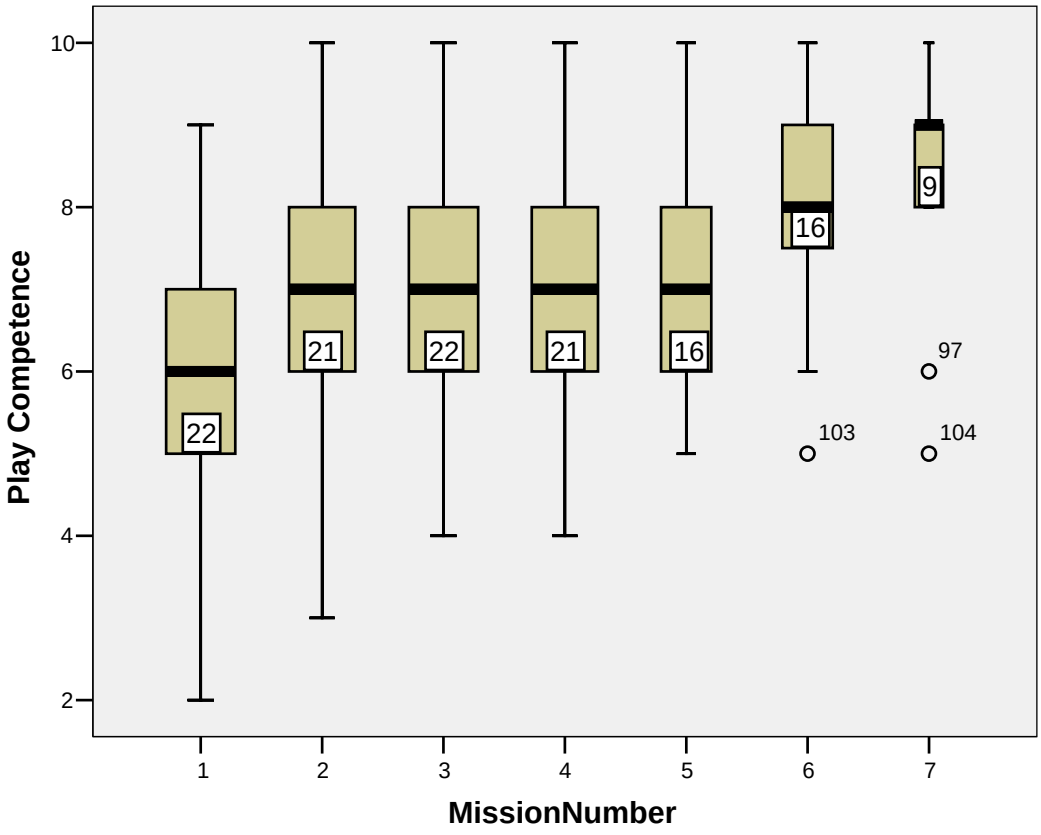


Table 9. Self-reported competence box plot.



One concern we had with using a computer as a training tool for squad maneuvers was the ability of the participants to actually maneuver as a squad. The restricted view frustum provided by a traditional computer monitor limits peripheral vision, which is used to maintain position in a formation. To assist the player with finding objectives and squad members in relation to the player's position, *Delta Force: Black Hawk Down – Team Sabre*™ provides the player with a circular, overhead moving map in the lower right corner of the display.

This moving map displays an icon for friendly forces and squad objectives and can be zoomed closer and further from a position above the player. Figure 6 shows a typical display from the player's perspective. The moving map with a blue diamond icon representing the player is the circular area in the lower right-hand corner of the display. The moving map technique proved to be suitable to the treatment group over the course

of the experiment, with over 88% of the post-mission reports rating their ability to maintain position in the formation as “Good” or better.

Figure 6. Screen shot from *Delta Force: Black Hawk Down – Team Sabre*™

Over the period of time required to conduct the treatment, the performance of the older graphics from the game engine and the integrated graphics chip did not negatively affect their ability to observe and engage the enemy. 74.2% (98/132) of the post-mission surveys indicated that the participants observed the enemy during the mission, while 72% (95/132) indicated they engaged the enemy. Of those participants who engaged enemy forces, 78% (103/132) reported they were able to observe the affect of their actions.

In addition to visual factors affecting their performance, we surveyed the treatment group on their ability to communicate with members of their squad during each mission. Given that the squad used headphones to provide audio cues but had to use voice commands in the room to direct and report, our participants were initially concerned about their ability to communicate with other squad members. Results from the survey and observation of their actions in the training environment showed that

ultimately the squad had little trouble communicating (Table 10). In fact, participants stated that this exercise "improved our squad's communication" and "forced the user to communicate and organize (information) to standard."

Table 10. Squad Communication assessment after each game mission

	Poor	Fair	Good	Very Good	Excellent
9. Rate your ability to communicate with your superior:	-	2.30%	55.70%	29.80%	12.20%
	0/132	3/132	73/132	39/132	16/132
10. Rate your ability to communicate with your Teammates	-	3.10%	57.30%	29.80%	9.90%
	0/132	4/132	75/132	39/132	13/132
11. Rate your ability to communicate with your Subordinates	-	5.30%	55.30%	29.80%	9.60%
	0/132	6/132	63/132	34/132	11/132

3. Post-Simulation Exercise Results

Once the complete series of missions in the virtual training environment was executed, the treatment group completed a survey assessing thoughts on the experiment as a training event, their confidence in executing tasks as an individual and as a squad, the effectiveness of training using COTS software, and any additional comments they had on the event. This survey after training in the virtual environment was the final step in our treatment prior to the platoon deploying to the field for their squad-level training exercises.

One of the key questions we wanted to answer in this section of the experiment was whether Soldiers would accept an entertainment-focused COTS product as a training device. Although we made no effort to disguise the training tool – it was clearly marked as a commercial computer game product – only 19% (4/21) stated they felt like they were playing a game during the study. The results listed in Table 11 demonstrated that the overwhelming majority of participants felt that they were conducting training (81% selecting this statement as "True" or "Very True"). It was also found that participants did not believe their actions in the game environment were without consequence (66.7% believed a statement "that their actions had no consequences" was "Not True" or

"Somewhat True," with none of the group identifying that statement as "True" or "Very True"). On the overall experience of using a COTS game as a training tool, one participant stated:

> I was skeptical (about the game) at first, but (I was) converted by the end. Without a facilitator leading AARs and pushing the squad to improve upon weaknesses, this would not have been worthwhile.

Table 11. The COTS Virtual Training Environment as a training tool

	Not True	Somewhat True	Neutral	True	Very True
26. Rate this statement's description of your experience: *"During this exercise, I felt like my actions in the virtual environment had no consequences."*	42.90%	23.80%	33.30%	-	-
	9 / 21	5 / 21	7 / 21	0 / 21	0 / 21
27. Rate this statement's description of your experience: *"During this exercise, I felt like I was playing a game."*	19%	57.10%	4.80%	19.00%	-
	4 / 21	12 / 21	1 / 21	4 / 21	0 / 21
28. Rate this statement's description of your experience: *"During this exercise, I felt like I was conducting training."*	-	14.30%	4.80%	42.90%	38.10%
	0/21	3 / 21	1 / 21	9 / 21	8 / 21

While the participants clearly indicated they believed that COTS games could be used to conduct training, it was important that they were aware of the skills that the event was intended to train. Our focus was on training the squad "Attack" and "React to Contact" battle drills, and from the participant's feedback, the training provided left the students feeling that the experience was good training for themselves as individuals and the squad as a whole. Table 12 contains the detail on participant responses with all 21 respondents rating the training as "Good" or better in both individual and squad categories.

Table 12. Training effectiveness on the Squad "Attack"/ "React to Contact" battle drills

	Poor	Fair	Good	Well	Very Well
23. Rate the simulation exercise's effectiveness to train ***you*** to conduct a squad "Attack"?	-	-	38.10%	42.90%	19.00%
	0/21	0/21	8 / 21	9 / 21	4 / 21
24. Rate the simulation exercise's effectiveness to train ***your squad*** to conduct a squad "Attack"?	-	-	33.30%	52.40%	14.30%
	0/21	0/21	7 / 21	11 / 21	3 / 21

When we identified the platform and software for our study, a key concern that arose from using older software was "would the audio and visual cues allow the participants recognize the threat force when it arose?" Older graphics and the reduced capabilities of an integrated graphics and audio on our experiment computers would produce less robust cues than software and hardware built to support computer gaming, and significantly less cues than the real field environment. And while the treatment group felt that their training with the virtual environment was effective, they did have less favorable opinions about the audio and visual cues presented by our training tool (see Table 13).

Table 13. Audio and Visual Cues from the virtual training environment.

	Poor	Fair	Good	Well	Very Well
19. Rate the simulation's ability to provide ***audio*** cues that allowed you to identify the location of enemy fires?:	9.50%	28.60%	23.60%	28.60%	9.50%
	2 / 21	6 / 21	5 / 21	6 / 21	2 / 21
21. Rate the simulation's ability to provide ***audio*** cues that allowed you to determine the location of your squad members?:	19%	42.90%	14.30%	14.30%	9.50%
	4 / 21	9 / 21	3 / 21	3 / 21	2 / 21
20. Rate the simulation's ability to provide ***visual*** cues that allowed you to identify the location of enemy fires?:	-	4.80%	33.30%	33.30%	28.60%
	0 / 21	1 / 21	7 / 21	6 / 21	6 / 21
22. Rate the simulation's ability to provide ***visual*** cues that allowed you to determine the location of your squad members?:	-	9.50%	28.60%	38.10%	23.80%
	0 / 21	2 / 21	6 / 21	8 / 21	5 / 21

The most frequent issue related to audio and visual cues was the limitations on peripheral vision. Comment sections on the survey include requests for "better peripheral vision" and "more peripheral feedback." In addition to comments on peripheral vision, participants requested the ability to "see where the squad leader and team leader were pointing" in the environment. In a tactical situation, it is common for leaders to use hand and arm signals to direct their Soldiers and identify targets or fields of fire by pointing. Some leaders solved this by getting up from their computer, walking to a squad

member's station and pointing out an object on the computer display. While this is an effective technique for providing guidance, it leaves that leader's avatar defenseless in the virtual environment.

One theme that showed up typically in early Post-Mission surveys was that the participant "didn't know what to look for" in the environment. This comment or a similar comment on being challenged to identify the enemy was made by four members of the treatment group within their first three missions. The comment was likely a factor of their unfamiliarity with the game environment as it was not repeated in their later Post-Mission surveys.

Closely tied in with audio and visual cues was the player's ability to make sense of the data presented and gain situational awareness. The majority of participants, 85% (18/21) reported that the software provided them "Good" or better feel for the situation during the virtual training exercise. Of the remainder, only one participant reported the situational awareness from the exercise to be "Poor," the worst rating available. Table 14 details the results from this question.

Table 14. Participant's measure of the situational awareness.

	Poor	Fair	Good	Well	Very Well
25. Rate the simulation exercise's effectiveness to provide ***you*** with situational awareness? (How I see myself & the enemy)	4.80%	9.50%	23.80%	42.90%	19.00%
	1 / 21	2 / 21	5 / 21	9 / 21	4 / 21

Given the above factors, what is the impact on the confidence of our participants? Did this event bolster their confidence in the abilities they have learned in IOBC or did it open their eyes to the many elements of the task that a classroom session does not prepare them for? One participant stated "…I could tell that during the course of the training my squad was becoming more proficient." The survey results supported that view, showing a slight improvement in the treatment squads' confidence on maneuvering under enemy fire as a member of a squad, from a mean of 4.07 to a mean of 4.19. A similar result was obtained when comparing the treatment group's initial responses on the Demographic survey and the Post-Simulation Survey. Confidence in the squad's training level to

coordinate direct fires against an enemy position rose from mean 3.76 to 3.95 while confidence to maneuver under enemy fire rose from 3.63 to 3.95. While we were encouraged by the increased confidence our participants reported, only the results from the field would demonstrate that the skills learned in the VE could be transferred to real world actions.

4. Field Training Results

As previously discussed in chapter IV, the post-FTX survey was conducted on the test and control squads as they completed the blank fire exercise on the Ware range complex. We used two separate post-FTX surveys (one for the test and one for the control squads), and conducted an open forum interview with each squad after completion of the survey and a one-on-one interview with the 4th Platoon TAC officer. Findings from the survey data overall showed no significant difference between the test and control groups on the self-assessed questions concerning training confidence on individual movements, fire control and communications within the squad. However, on the question of how well the squad conducted actions on contact (using the blank fire exercise as the benchmark), the platoon TAC assessed the test group's performance higher than the control group.

Of the question "how well did your squad conduct actions on contact?" with a Likert 5 point scale (1 = Poor, 2 = Fair, 3 = Good, 4 = Well, 5 = Very Well), the test groups assessed themselves a mean of 4 (Well), and the control groups rated themselves slightly higher than good (3.57) (Table 15). Using a one-way ANOVA, we were able to determine a 0.12 level of significance on the question of how well the subjects assessed their squad's ability to conduct actions on contact (Table 16).

Table 15. Assessment on conduct of actions on contact (Live)

	N	Mean	Std. Deviation	95% Confidence Interval for Mean	
				Lower Bound	Upper Bound
Control	21	3.57	.811	3.20	3.94
Test	20	4.00	.918	3.57	4.43

Table 16. Significance of assessment of conduct of actions on contact (Live)

		Sum of Squares	df	Mean Square	F	Sig.
31. How well did your squad conduct actions on contact?	Between Groups	1.882	1	1.882	2.518	.121
	Within Groups	29.143	39	.747		

Despite the fact that the number of subjects is low and the data comes from a self-reported assessment of a group of relatively inexperienced subjects (initial entry training IOBC second lieutenants), the fact that they felt their squad did well indicates a degree of confidence in the group's ability to conduct this complex task – whether based on the additional training they received or not. When conducting ground operations at the small unit level, where each doorway and alley pose a lethal threat, confidence in your unit (and fellow infantryman) is essential for effective operations. Whether real or perceived, infantry leaders at the squad level need for their Soldiers and Marines to trust in their training, because hesitation by any man can have catastrophic results. This data point, regardless of the confounding variables, is important because it demonstrates this confidence.

The treatment group's post-FTX survey also included eleven questions that elicited an assessment of the simulation (or game) exercises on their squad training level. The data points to areas in which games utilized in a manner similar to the experiment may be a viable training alternative and other areas where they may not. First, we asked the subjects to assess what impact the simulation exercise had on their individual performance, then their squad performance. We found that none of the 22 respondents reported any negative impact on their training, with the specific assessment rating varying based on the task at hand.

Of the overall assessment of the simulation exercise on their individual performance, all respondents stated that it had a positive effect on their performance, with 81.8% reporting it as "Very Positive" and 18.2% reporting it as having a "Positive" effect (Table 17).

Table 17. Participant assessment of the simulation on performance

	Very Positive	Positive	No Effect	Negative	Very Negative
38. What impact did the simulation exercise have on your performance?	81.80%	18.20%	-	-	-

When it came to cognitive tasks such as assessing the situation or understanding of squad maneuvers, we found that the experience in the virtual environment rated high, but for tasks that require a type of tactile response, the results were mixed. For example, when asked about the impact of the simulation exercise on understanding squad maneuvers, responses were 68.2% positive and 31.8% very positive, but when addressing ability to use available cover or concealment for maneuvering against an enemy, 40.9% of respondents indicated the exercise had no effect in their ability to use cover and 36.4% responded no effect for concealment (Tables 18 - 19). This may be due in part to the limited field of view that the COTS game can provide versus the full view in the real world and the tactile feedback required by the tasks of finding cover and concealment.

Table 18. Simulation impact on individual understanding of squad maneuvers

	Very Positive	Positive	No Effect	Negative	Very Negative
47. What impact did the simulation exercise have on your understanding of squad maneuver?	31.80%	68.20%	-	-	-

Table 19. Simulation impact on individual training of cover and concealment use

	Very Positive	Positive	No Effect	Negative	Very Negative
44. What impact did the simulation exercise have on your ability use available cover to maneuver against the enemy?	18.20%	40.90%	40.90%	-	-
45. What impact did the simulation exercise have on your ability use available concealment to maneuver against the enemy?	18.20%	45.50%	36.40%	-	-

Additional results from the survey indicate that the exercise was either positive of had no effect on the subject's ability to assess the situation when in contact and maneuver as a squad member (Table 20). For individual ability to scan, detect and identify the enemy, 22.7% of respondents indicated no effect on this task from the exercise (Table 21). This may be due in part to the limitation of the COTS game platform to render distant objects well or the lack of "visual noise" within the game environment. We use the term "visual noise" to refer to additional objects such as birds, dust, blowing grass, etc. Visual static is an element of the real world that is important in training the task of scanning and detection of enemy forces. The ability to filter this static requires training in the presence of this clutter, something that none of the COTS games we considered could provide. However, many of the current state of the art games are beginning to provide this visual noise.

Table 20. Simulation impact on training assessing situation and maneuvering under fire

	Very Positive	Positive	No Effect	Negative	Very Negative
39. What impact did the simulation exercise have on your ability to assess the situation when in contact?	18.20%	72.70%	9.10%	-	-
40. What impact did the simulation exercise have on your ability maneuver under enemy fire as a member of a squad?	36.40%	54.50%	9.10%	-	-

Table 21. Simulation impact on individual ability to detect enemy

	Very Positive	Positive	No Effect	Negative	Very Negative
46. What impact did the simulation exercise have on your ability scan, detect and identify the enemy?	27.30%	50.00%	22.70%	-	-

The subjects' assessment of the impact of the simulation on their squad's abilities was mixed. In the assessment of the impact on the squad's overall performance, communication and ability to maneuver under fire, over 80% of the subjects reported a "Positive" or "Very Positive" impact from the exercise with the remainder reporting it had no effect (Table 22).

Table 22. Simulation impact on squad performance, communication and maneuver

	Very Positive	Positive	No Effect	Negative	Very Negative
48. What impact did the simulation exercise have on your squad's performance?	27.30%	54.50%	18.20%	-	-
49. What impact did the simulation exercise have on your squad's ability to communicate information?	36.40%	50.00%	13.60%	-	-
51. What impact did the simulation exercise have on your squad's maneuver under enemy fire?	27.30%	54.50%	18.20%	-	-

In the area of the squad's ability to control direct fires, while over 70% reported a "Positive" or "Very Positive" effect, 27.3% of the subjects indicated that the simulation had no effect (Table 23). This response was higher than anticipated, as earlier pilot study results rated the impact of the game on the control of direct fires higher than that reported by the IOBC students. This may be due to the direct fire control methods taught by IOBC which include leaders physically touching operators of key weapon systems to indicate direction of fire, and the use of the AN/PEQ-2 infrared illuminator aiming designator for directing fires during night operations. Both of these methods could not be accurately represented by the COTS game exercise.

Table 23. Simulation impact on squad's ability to control direct fires

	Very Positive	Positive	No Effect	Negative	Very Negative
50. What impact did the simulation exercise have on your squad's control direct fires?	27.30%	45.50%	27.30%	-	-

Our most interesting data came from the interviews conducted with the 4th Platoon TAC officer and test subjects in the open forum discussion following the post-FTX survey. The TAC officer indicated that he observed a moderate difference between the test and control squads in overall performance. These differences included the ease at which the test squads were able to get into movement tactical formations (traveling, traveling overwatch and bounding overwatch) and generally being more aware of their

surroundings (in the field site). Additionally, the test groups communicated spacing and distance better at the assault position than the control groups.

The TAC noted that the test squad's planning for the live event was better than the control squad's. Specifically, he observed that the test squads used binoculars more often at security halts during the FTX and some of the test squad members actually purchased civilian binoculars in preparation FTX. He observed, as did we, that the test groups utilized the binoculars often during the game play to increase their ability to detect enemy forces in the virtual environment, and that the use of binoculars transferred directly from the game experience to the FTX for the test squads. In addition to binocular use, he observed a direct fire planning difference between groups. He stated that the test squads discussed the use of visual signals more for fire control, and assigning specific tasks for key weapon systems on the objective such as using the M203's 40mm grenade for clearing defilades. We asked the TAC if he received any feedback from the test groups with regards to the COTS game use as a legitimate training venue, and he responded that overall the IOBC students accepted the game as a legitimate training tool with some test group subjects going as far as to purchase the *Delta Force: Black Hawk Down – Team Sabre*™ after the experiment in order to replicate the training event at their home. During the interview, the TAC said that he observed no negative effects training transfer from the game experiment squads.

The TAC officer felt that the 8-hour exercise time was worth the training benefits, but would have preferred it be conducted over a few days rather than all at once. Conducting this over several days was our original plan, but due to scheduling we were only allowed one day per squad. The TAC indicated that the exercise was conducted at the correct time in the students' training sequence, between classroom instruction and the FTX, and said that given a training plan he would use this type of product for future squad training with IOBC students. As a recent veteran of Operation Iraqi Freedom, he felt this could further benefit his students if this or other training system integrated vehicles and Close Air Support in order to expose IOBC students to the challenges of controlling vehicles and aircraft that could be attached to their unit.

When asked what capabilities and equipment he felt could be used to provide better training to Soldiers, he indicated the ability to call for indirect fires (mortars and artillery), the PEQ-2 weapon-mounted target pointer/illuminator/aiming laser, flares, and vehicles. For basic missions such as raids, reconnaissance and conducting ambushes, he noted the game could be a good training tool, but cautioned against its use for such missions as Stability And Support Operations (SASO) because human interaction is essential to training tasks such as these effectively. The TAC liked the ability to easily modify the virtual environment using the mission editor. Finally, he said that he would like the simulation to support different types of environments to include desert, jungle and urban terrain.

The interviews we held with the participants echoed many of the observations made by the TAC. From our test group, these included a feeling of increased awareness of their surroundings in the field and comfort level in conducting tactical movement through the woods as a member of a squad. One subject noted that "we were forced to learn (to maintain 360 degree security while conducting ground tactical movement) during the game play, and now it is natural."

The test subjects also indicated that they felt more comfortable conducting tactical movement through the woods (and maintaining proper spacing and distances) because they experienced similar challenges within the game environment. The participants also noted the effective employment of binoculars as a positive learning event during the conduct of simulated missions. Most of the test group indicated that they would use this type of training tool at their unit given the equipment and a training plan, but cautioned against its use without unit leadership controlling the exercise. The test group indicated that without leadership supervision, this type of training could easily turn into a "playground" environment and not a training one. All the test subjects concurred that using COTS games for training has potential, but without clear guidance and supervision, its use may not be effective.

Finally, we asked the test and control groups to discuss effectiveness of simulations in general, to train infantry squad collective tasks. Comments were varied, and provided insight to the different learning styles of the subjects from both groups. Of

the subjects who found utility in using simulations to train infantrymen, comments included: training with simulations "(you) get to see actual movement and contact, and get immediate feedback on (your) actions", and "simulation (use) allowed us to practice in more than one scenario, and it saved time. We got done more in less time".

Other subjects, from both test and control groups, acknowledged the potential benefit of simulation use, but preferred other training methods entirely. One subject stated that briefing an operation on a sand table, and then discussing the lesson in a classroom was his preferred learning style. He notes that using sand tables "help lowest level operators get (a) big picture view", and that complimenting its use with classroom instruction "provides calm, slow-moving environment to properly receive details and retain them for live exercise later". Another subject said that conducting rehearsals in a garrison environment (held in an available open field, and conducted without ammunition) was better that using simulations. "(Garrison level) physical rehearsals give everyone an idea of the actions" and that simulations "will only familiarize the actions". These comments reinforce the importance of trainers at all levels to be aware of the individual learning styles of students and plan training events accordingly.

C. RESULTS OF COTS GAME MISSION EDITOR USABILITY TEST

To determine the usability of the mission editor tool we used for the experiment, we conducted a limited scale usability study upon returning from Fort Benning. The scope of the study was to determine how long it would take an inexperienced user to use the *Delta Force: Black Hawk Down – Team Sabre™ Mission Editor (*MED) to recreate an environment given only an aerial photograph. The intent was to determine if a novice user could be trained in the MED's use and recreate operationally relevant terrain based on current intelligence assets. Due to time constraints, we were not able to set this test up in such a way that we could validate the accuracy of the simulated environment.

The subject for our study was an U.S. Air Force Academy cadet on assignment as a research intern at the Naval Postgraduate School. The cadet was a pre-Med student and had limited computer science skills. Additionally, the cadet indicated that he rarely played PC-based video games, and used his issued academy computer for mostly web access and word processing.

We assigned the cadet a computer workstation loaded with the *Delta Force: Black Hawk Down – Team Sabre*™ software and MED and over the course of the next two weeks instructed him to become familiar with the game, complete the MED tutorial that came with *Delta Force: Black Hawk Down – Team Sabre*™, and create two game levels of the contemporary operating environment (COE) from web aerial photos of Iraq and Afghanistan. We instructed him to record the time it took to become familiar with the MED, create the environments, and any lessons learned from the experience. Although we acknowledge this study was very limited, it did provide us with insight for our recommendations for COTS use.

We conducted this study in five phases:

- Phase I: Introduction to software platform
- Phase: II Initial familiarization with level editor (Mission Editor Manual)
- Phase III: Selection of aerial photo (Tikrit, Iraq) and Detailed VE design using aerial photo
- Phase IV: VE design of Al-Udeid Airbase
- Phase V: Finalize and present results

At the completion of each phase, the cadet briefed us on his findings and we provided guidance for the subsequent phase of the study. For Phase I, we allowed the cadet to play *Delta Force: Black Hawk Down – Team Sabre*™ on solo missions in order to become familiar with the look and feel of the game platform. We felt that this game orientation would help him better understand object placement in the 3D game environment. Phase II, which took the cadet three hours to complete, involved completing the MED tutorial that came with the *Delta Force: Black Hawk Down – Team Sabre*™ game. This tutorial involves creating a simple game level that includes several buildings, AI driven OPFOR and vehicular movement orders. Phase III and IV took the cadet 27 hours to complete. He created a virtual portion of Tikrit, Iraq, (Figures 7 and 8), and a USAF airfield in Afghanistan. The cadet indicated that actual creation time for both levels was about 10 hours, and the remainder was used becoming familiar with the MED advanced features.

Figure 7. Aerial Photo of Tikrit, Iraq, June 2005

Figure 8. Virtual Tikrit using the MED

At the completion of Phase IV of the usability study, our study participant identified the following lessons learned and recommendations:

- Game orientation useful for introducing users to interface requirements
- Mission Editor manual that came with the game provided adequate interface orientation
- Fan web sites provided a good resource for VE layouts and examples
- Once trained on the GUI, the interface was easy to navigate and control
- For end users learning to use level editing software, a 3-day training course should be developed to achieve a useful proficiency
- For trained users, creation time for robust VEs should range from 2 to 10 hours depending on the complexity of the environment

- Usability, applicability, and simplicity should be considered when choosing between different level editing software platforms

The findings from this small study confirmed many of our impressions of this particular level editing software, but we realize more work should be conducted in this area. Overall, the findings here provided insight for our recommendations for COTS use and selection criteria.

VI. RECOMMENDATIONS AND CONCLUSIONS

A. OVERVIEW

During our research we found that by properly framing an event infantry leaders can use COTS gaming software for specific squad collective training. Due to our limited sample size, we were only able to observe subjects conducting a squad attack mission, but the elements of what a COTS game can provide to trainers could potentially be transferred to additional squad tasks such as conducting reconnaissance, ambushes and other combat missions. The key to leveraging COTS software lies with managing the expectations of leaders and conducting a thorough task analysis to ensure the trainer knows what tasks can and cannot be trained using COTS. These games will not train individual tasks such as firing a rifle, but will provide an environment where leaders can train cognitive skills such as maintaining security or refining standard operating procedures. Training units on these skills is the leader's responsibility, and it typically requires resource intensive live training events. The COTS game alone will not train units, but can support unit leaders who leverage the game's ability to provide robust and complex scenarios with minimal resource requirements.

B. RECOMMENDATIONS FOR TRAINING WITH COTS SOFTWARE

For leaders planning small unit training events that call for COTS game use, a thorough analysis of the task, conditions of the event and standards for evaluation must be determined. In the following sections, we make recommendations based on the findings from our experiment and our combined 25 years of military experience. These recommendations are not meant to be all inclusive, but to provide trainers with a basic roadmap for using COTS game software to support infantry training.

1. Task Analysis

Once leaders select a unit collective task to be trained, either driven from their Mission Essential Task List or war-time mission, a thorough analysis of the task must be conducted. In the case of the Army, leaders should use the appropriate ARTEP or field manuals to determine performance measures, and associated individual and crew tasks that support the collective task. As with live training, supporting subtasks should be

trained prior to conducting the collective event. As an example, Soldiers should be trained on how to engage a target with their primary weapon. Because COTS games do not always model individual skills with precise accuracy, trainers who complete this pre-training prior to using a COTS game can reduce potential negative skills transfer, because the Soldiers will already know the proper way to perform the specific task in the real world.

Tasks that require a very high level of sensory input or fine details that are not replicated by the game should be trained in either a specialized training device or during a live collective training event. During our task analysis, we separated tasks into two groups – alpha and bravo tasks. Our alpha tasks are those which can be replicated in the COTS game platform and bravo tasks are those which cannot. For example, an alpha task may be engage an enemy with an M16A2 rifle which can be represented well enough in the game to support a higher collective task of "React to Contact." A sample bravo task could be search and process an enemy prisoner of war (EPOW). This task requires a very high level of tactile feedback and human interaction in order to determine the threat the EPOW presents. As stated previously, bravo tasks should be taught at a separate event, and leaders should not expect the COTS game to model this task effectively. This is not to say that a collective task cannot be trained because a few supporting tasks are not modeled well by the game, only that leaders need to plan their expected learning outcome accordingly.

2. Selection Criteria for COTS Software

Based on the findings from our research, we determined a number of recommended benchmarks for selecting a COTS game in order to conduct a squad level training event. The benchmarks are divided into three categories: requirements for infantry squad collective training, requirements for infantry platoon and Combined Arms training, and additional capabilities to support more robust training.

To conduct an infantry squad collective training event as we did for our experiment, our recommendations for a COTS game platform include, but are not limited to the following:

- PC-based
- System requirements that support the computer systems common at the local unit or installation level
- First person perspective
- Multiplayer over a LAN that supports at least 32 players; this would allow up to platoon-level training with 2-3 personnel to act as live OPFOR
- Modeling of modern U.S. weapons and their effects to the extent that it supports the overall training event; includes day and night weapon sights
- An easy to use level (or mission) editor to allow a trained user to quickly create a virtual environment that can support the commander's intent for training in any environment (urban, desert, jungle, etc…); has a robust model library which includes: people, vehicles, foliage and buildings - each with predefined and modifiable attributes
- The ability to script events and non-player characters with basic AI attributes to attack, defend, or other characteristics defined by the commander
- A heads-up display (HUD) that can help the user overcome the lack of peripheral vision (a miniature map that provides local awareness to the user or similar tool)
- A topographical map display of the training area with programmable waypoints
- Player health and ammunition status available through an on-screen HUD indicators
- Spawn or regeneration points to allow players killed during the event to rejoin their team at the trainer's discretion to continue training
- Configurable player characteristics to allow trainers to assign proper weapons and equipment in accordance with duty positions
- Accurate effects by weapons and environmental conditions on the player

- Ability to interact with objects in the environment such as open doors, emplaced weapons and drive vehicles

Although our experiment did not extend beyond a single squad operating in the virtual environment without external support, based on our surveys, interviews, and experience with COTS game software, we present the following recommendations for using COTS to support Combined Arms training:. This list is not intended to be all-inclusive, but a guide for trainers selecting COTS for training:

- Terrain maps of 25 square kilometers; larger for operations involving live, Close Air Support
- Voice over IP or other in-game communication capability to support distributed execution of the training event
- Medical and other Combat Service Support capabilities to include drivable vehicles for convoy support or ambulance capability to evacuate wounded players
- Ability to call for and adjust indirect fire

Finally, we determined some additional capabilities that would enhance the training environment or assist trainers in conducting after action reviews of the event. They include:

- Infrared (IR) aiming/pointing devices
- The ability to import Military Grid Reference System (MGRS) maps and terrain databases into the level editor
- A tool to allow trainers and leaders to create or import operational graphics and display them on the game's topographical map
- Flares and illumination pyrotechnics for signaling and night operations
- Observer view to allow the trainer to see the entire training element or move rapidly through the mission area to observe behavior
- Recording and playback capability for use during the after action review
- High Level Architecture (HLA) compliance

The final recommendation, HLA compliance, would provide the potential for a COTS platform to interact with HLA compliant training systems and simulations used by the Department of Defense. For example, if the game we used for this experiment was HLA compliant, then as a mechanized infantry company trains their Bradley Fighting Vehicle crews in the Close Combat Tactical Trainer (CCTT), the infantry squads could be conducting concurrent training in the same virtual environment. This could take place over a local area network (LAN) that connects the CCTT to the multiplayer game through HLA. This would provide a single training event for the entire company team versus training the vehicle crews in the CCTT and training the infantry squads separately. Finally, HLA capability allows DoD users to be able to leverage future capabilities of the commercial market by having a common language for integration. However, it is highly unlikely that any COTS game will ever be produced with HLA capability unless the military contacts the game developer early in the design process and pays for this capability to be added so that the game can be better used for training.

3. Conduct of the Training Event with COTS Software

We recommend that trainers considering the use of COTS games as a tool approach this simulation event no different than a live event. The only difference in the conduct of the event would be the venue. The orders and planning process, preparation and conduct of observer/controllers, and AAR are the same as for a live event.

The training area would be prepared by a trained mission/level editor, creating the game level as close as possible to support the commander's vision. Once the terrain model is complete, trainers and leaders should conduct a reconnaissance of the virtual training site and the proof the lane to verify the proper sequencing of events involving non-player agents and the look and feel of the terrain.

If the training audience is not familiar with the COTS game controls, we recommend that trainers conduct a block of instruction on the game interface and provide a virtual training area for the multiplayer squad (or platoon) to conduct rehearsals. Trainers should monitor the training events in the game environment, and make spot corrections early to prevent horseplay by the trainees using the game. Just as in live field training, trainers observe game-play to provide feedback and adjudicate events, casualties

and OPFOR actions. At the completion of the game exercise, trainers should conduct an AAR using all available tools (including those provided by the game) to spread the lessons learned by the users. By keeping the COTS game use approach similar to that of a live field exercise, trainers can keep their focus on training infantryman, with only the venue being different for our Soldiers or Marines.

C. CONCLUSIONS AND RECOMMENDATIONS FOR FUTURE RESEARCH

Overall, we found that using COTS software has the potential to be an effective low cost and accessible training tool for training infantry squad collective tasks. Despite our small sample set, our findings and observations demonstrate some interesting possibilities on methods of leveraging COTS software, and implications for use at the unit level. While the data recorded from the subject surveys and comments from the post-FTX interviews do not conclusively demonstrate that infantry squads can use COTS gaming software for training collective tasks, our findings raised many issues that future research could address:

- What is the scope of training that can be accomplished with a COTS game product and what is the best method for integrating it into the training plan?
- Can COTS games provide effective sustainment training to experienced units?
- Can COTS games provide effective training for non-infantry units?
- Can COTS games provide effective training for the platoon or higher?
- What effect would training with a distributed (not co-located) squad have on training effectiveness?
- How do individual learning styles effect user acceptance of simulation use, COTS or otherwise?
- What impact would a multiplayer first person simulation, COTS or otherwise, on unit level training over an extended period of time?
- To what extent can intelligent tutoring systems (ITS) remove the requirement for an instructor to provide AAR?

We hope that future research into this area can begin to explore these areas in order to best determine COTS gaming software's place as a training tool for training units.

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APPENDIX A. OPERATION ORDERS AND GRAPHICS

A. MISSION ONE:

1. OPORD #001-05

CURRENT LOCATION: 2 KM NORTHEAST OF THE TOWN OF KIRKUK AND FIRGRESS RIVER AT CAMP SENTINEL

OPORD #001-05

SITUATION: ELEMENTS OF AL-FARHEED REBELS HAVE BEEN PUSHED OUT OF THE CITY OF MOUSEC DURING THE LAST 48 HOURS DUE TO COALITION FORCES SUCCESS. WE EXPECT THESE INSURGENTS TO MOVE FURTHER WEST AND ATTEMPT TO SECURE POWER AND RADIO STATIONS OF THE TOWN OF KIRTUK (50 MILES WEST OF MOUZEC ALONG THE FIGRESS RIVER). THEY ARE ARMED WITH AK-47S, RPGs AND ARE PROFIECIENT IN THE USE OF FIELD EXPEDIENT EXPLOSIVES.

MPCOA: WE CAN EXPECT AL-FARHEED INSURGENTS ON OBJ RADIO DEFENDING FROM HASTY FIGHTING POSITONS ORIENTED EAST ALONG THE FIRGRESS RIVER. WE EXPECT 6-7 DISMOUNTED INSURGENTS ARMED WITH AK-47'S AND RPG FIRES. THEY DO NOT WANT TO BECOME DECISIVELY ENGAGED WITH U.S. FORCES, BUT WILL CONTINUE TO FIGHT TO BUY TIME FOR THE IEDS TO BE EMPLACED INSIDE THE RADIO TOWER.

FRIENDLY FORCES:

- A CO ATTACKS IN ZONE IN ORDER TO SECURE THE TOWN OF KIRKUK.
- 1ST PLATOON CLEARS IN ZONE TO DESTROY AL-FARHEED REBELS IN AO JAGUAR TO PREVENT ORGANIZED ATTACKS AND LOOTING AGAINST THE PEOPLE OF KIRKUK.
- CIVILIAN: THE MOST OF THE LOCAL POPULATION OF KIRKUK ARE IN SUPPORT OF US ACTION, BUT SOME ARE GROWING WEARY OF OUR PRESENCE, AND MAY SYMPATHIZE WITH THE AL-FARHEED IDEOLOGY. EXPECT REFUGEES TO MOVE EAST FROM KIRKUK TO MOUSEC IN ANTICIPATION OF COALOTION AIR AND GROUND ATTACKS. THEY WILL USE THE TRAIL NETWORK NORTH OF THE FIGRESS RIVER.

MISSION: 1ST SQD ATTACKS TO SIEZE OBJECTIVE RADIO IN ORDER TO DESTROY ENEMY FORCES AND PREVENT THE DESTRUCTION OF THE LOCAL RADIO STATION NLT XXXXXXMAR05.

EXECUTION:

CDR INTENT: TO BE SUCCESSFUL, WE MUST:

1. DESTROY ALL ENEMY FORCES AND EQUIPMENT IN ZONE TO PREVENT AN ORGANIZED ATTACK OR CAMPAIGN OF TERROR AGAINST THE CITIZENS OF KIRKUK

2. PREVENT CIVILIAN CASUALTIES AND DAMAGE TO HOST NATION INFRASTRUCTURE (C2 NODES, SCHOOLS, WATER TREATMENT SITES, CHURCHES, AND RADIO/TV STATIONS)

3. RAPIDLY SIEZE OBJECTIVES IN ZONE TO PREVENT AN ORGANIZED AL-FARHEED ATTACK AGAINST US FORCES

CONCEPT OF THE OPERATION: WE WILL CONDUCT AN AIR MOVEMENT FROM CAMP SENTINEL TO LZ ABLE. FROM LX ABLE, WE WILL MOVE 260 DEGREES FOR ABOUT 400 METERS TO OBJ RADIO. WE WILL CONDUCT A DELIBERATE ATTACK ON OBJ RADIO. ONCE SECURE, WE WILL CALL THE PLATOON LEADER WITH A SALUTE REPORT AND REQUEST EOD TO CLEAR PUMP OF ANY IEDS (BOOBY TRAPS).

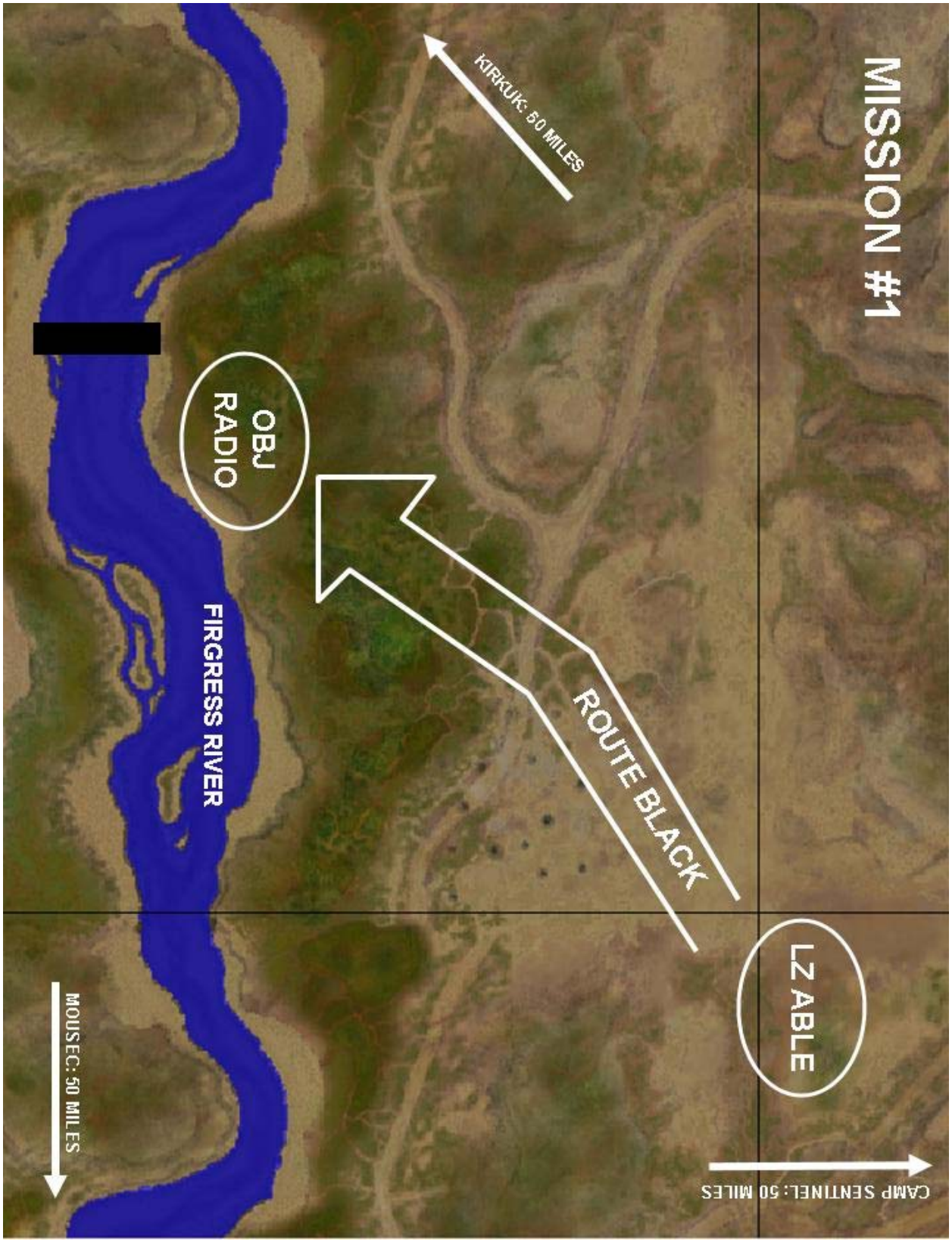
FIRES: NO FIRES ARE AVAILABLE

SERVICE SUPPORT:

REFIT FOLLOWING CONSOLIDATION ON THE OBJECTIVE.

COMMAND AND SIGNAL: NO CHANGE

2. Operational Graphics to OPORD #001-05



B. MISSION TWO:

1. FRAGO 1 TO OPORD #001-05

SITUATION: BECAUSE OF THE SUCCESS OF OUR INITIAL OPERATION, WE EXPECT THE AL-FARHEED INSURGENTS TO CONTINUE TO EXFILTRATE FURTHER INTO THE COUNTRYSIDE AND DESTROY CRITICAL INFRASTRUCTURE NODES CRITICAL TO THE TOWN OF KIRKTUK.

MPCOA: ENEMY INSURGENTS HAVE BEEN DISPLACED SOUTH OF THE FIRGESS RIVER AND SIEZED A LOCAL CRUDE OIL PUMPING STATION. WE EXPECT THEM TO ATTEMPT TO DESTROY THE OIL PUMPS AND RUPTURE THE STORAGE TANKS IN ORDER TO DELAY U.S. FORCES AND TERRORIZE THE LOCAL POPULATION. WE EXPECT 6-7 DISMOUNTED INSURGENTS ARMED WITH AK-47'S AND RPG FIRES. THEY DO NOT WANT TO BECOME DECISIVELY ENGAGED WITH U.S. FORCES, BUT WILL CONTINUE TO FIGHT TO BUY TIME FOR THE IEDS TO BE EMPLACED.

FRIENDLY FORCES: NO CHANGE

MISSION: 1ST SQD ATTACKS TO SIEZE OBJECTIVE PUMP IN ORDER TO DESTROY ENEMY FORCES AND PREVENT THE DESTRUCTION OF THE LOCAL PUMP STATION NLT XXXXXXMAR05.

EXECUTION:

CDR INTENT: NO CHANGE

CONCEPT OF THE OPERATION: WE WILL MOVE 110 DEGREES FOR APPROX 240 METERS TO OBJECTIVE PUMP. ON OBJ PUMP, WE WILL ESTABLISH A SBF POSITION NORTH OF PUMP TO SUPPRESS ENEMY FORCES, AND USE THE ASSAULT FORCE TO SIEZE OBJECTIVE PUMP. ONCE THE ASSAULT FORCE IS ON PUMP, WE WILL CALL THE SBF ELEMENT FORWARD TO CONSOLIDATE AND REORGANIZE ON THE OBJECTIVE. ONCE SECURE, WE WILL CALL EOD TO CLEAR PUMP OF ANY IEDS.

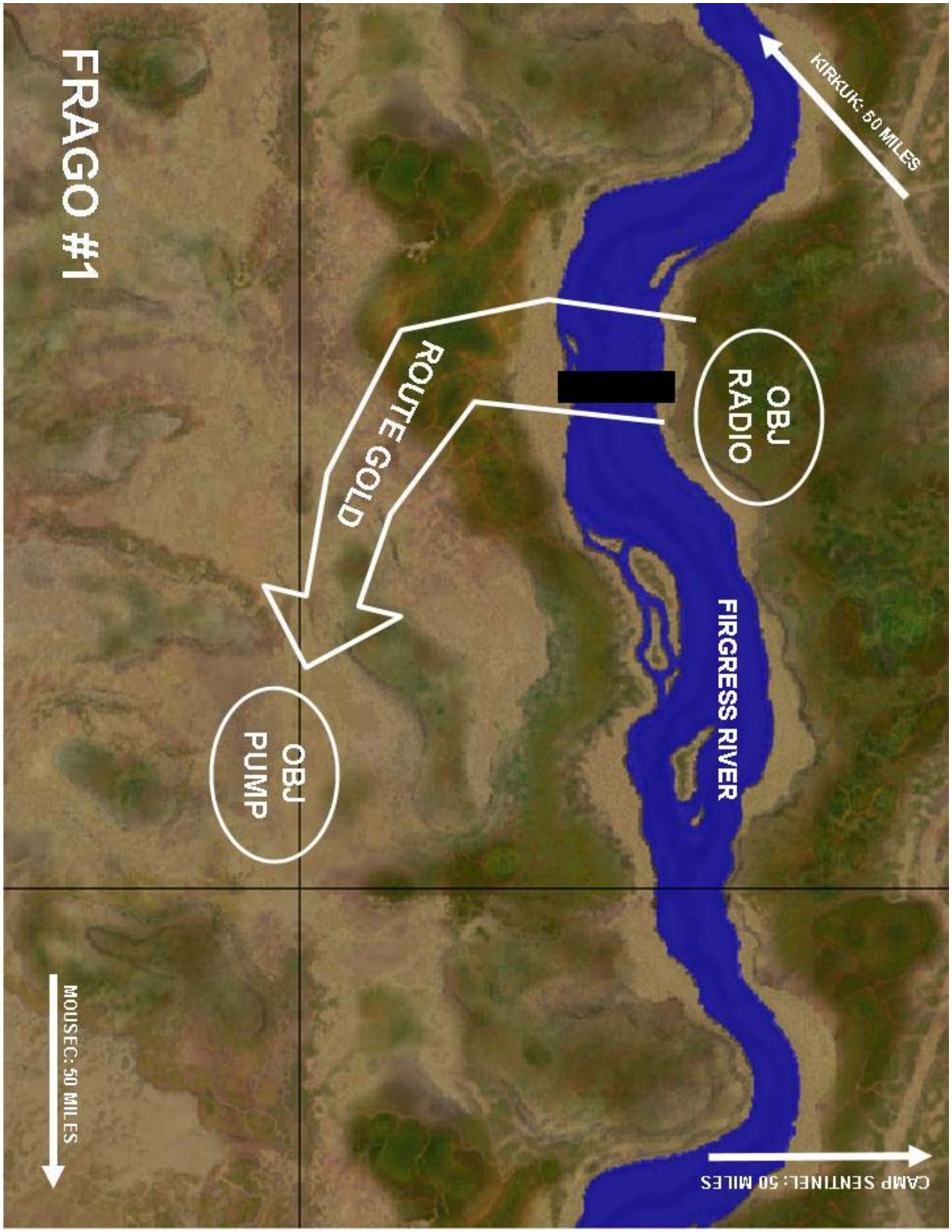
SERVICE SUPPORT:

REFIT AT CHECKPOINT 3

COMMAND AND SIGNAL:

NO CHANGE

2. Operational Graphics to Frago 1 to OPORD #001-05



C. MISSION THREE:

1. FRAGO 2 TO OPORD #001-05

SITUATION: AL-FARHEED INSURGENTS HAVE BEEN ROUTED, AND ARE LOOTING ANY SUPPLIES THEY CAN AND MOVING THEM IN RIVER BOATS ALONG THE FIRGRESS RIVER EAST. THEY ARE ATTEMPTING TO BLEND IN WITH THE LOCAL POPULACE MOVING EAST TO MOUZEC.

MPCOA: ENEMY INSURGENTS ARE ESTABLISHING RIVER LOADING POINTS IN OUR AREA TO RAPIDLY MOVE THEIR LOOTED SUPPLIES UPRIVER TO THEIR LOCAL STRONGPOINT. WE EXPECT 6-7 DISMOUNTED INSURGENTS ARMED WITH AK-47'S AND RPG FIRES. THEY DO NOT WANT TO BECOME DECISIVELY ENGAGED WITH U.S. FORCES, BUT WILL CONTINUE TO FIGHT TO BUY TIME FOR THE IEDS TO BE EMPLACED.

FRIENDLY FORCES: NO CHANGE

MISSION: 1ST SQD ATTACKS TO SIEZE OBJECTIVE PIRATE IN ORDER TO DESTROY ENEMY FORCES AND SECURE SUPPLIES STOLEN FROM THE LOCAL TOWN OF KIRKTUK NLT XXXXXXMAR05.

EXECUTION:

CDR INTENT: NO CHANGE

CONCEPT OF THE OPERATION: WE WILL MOVE TO CHECKPOINT 4 IN ORDER TO REFIT ON CL V & VIII. FROM THERE, WE WILL MOVE 60 DEGREES FOR APPROX 225 METERS TO OBJECTIVE PRIRATE. ON OBJ PIRATE, WE WILL ESTABLISH A SBF POSITION WEST OF PIRATE TO SUPPRESS ENEMY FORCES, AND USE THE ASSAULT FORCE TO SIEZE OBJECTIVE PIRATE. ONCE THE ASSAULT FORCE IS ON PIRATE, WE WILL CALL THE SBF ELEMENT FORWARD TO CONSOLIDATE AND REORGANIZE ON THE OBJECTIVE. ONCE SECURE, WE WILL CALL EOD THE PLT LDR IN ORDER TO GET SUPPORT PLT ON SITE TO EVAC THE LOOTED SUPPLIES

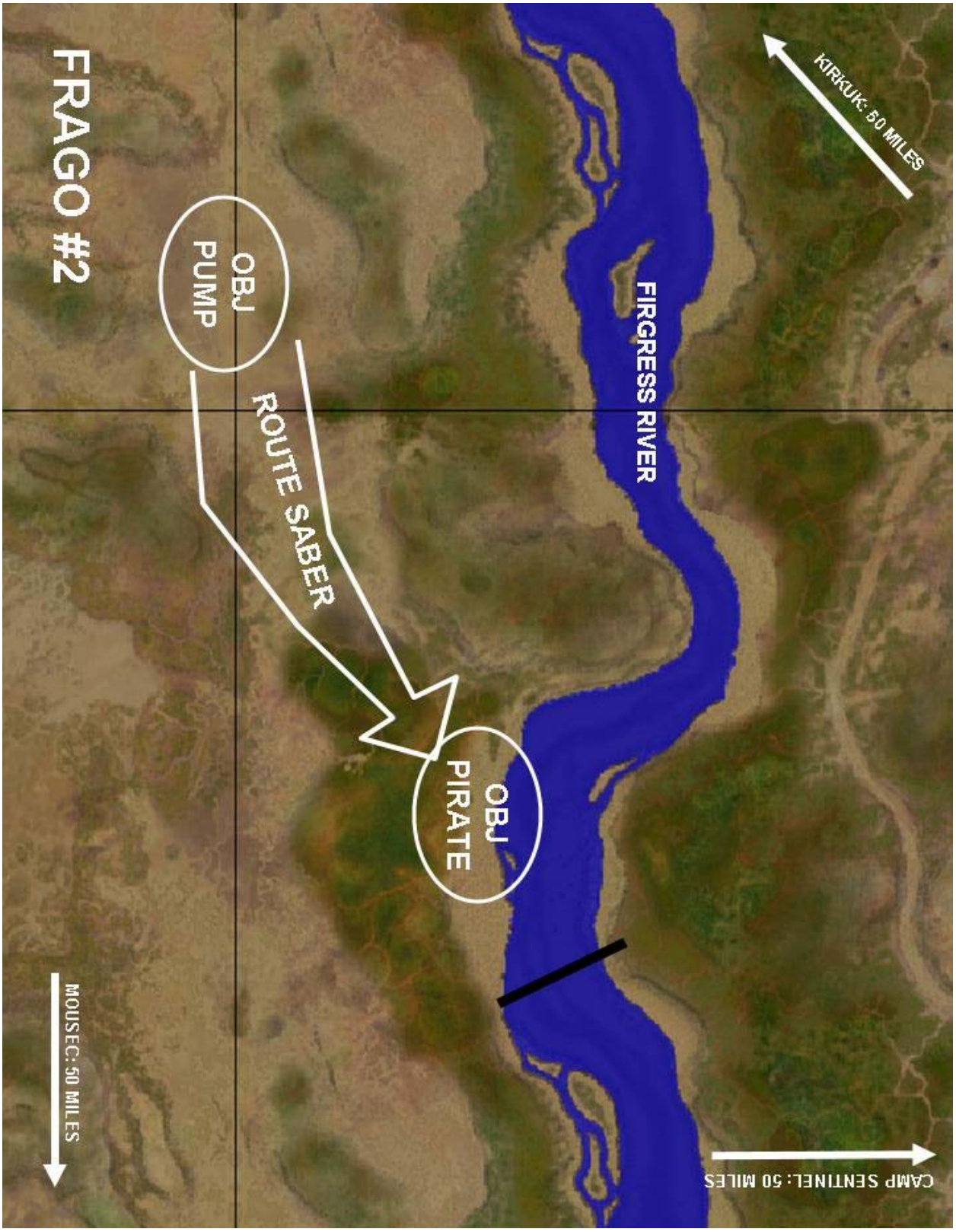
SERVICE SUPPORT:

REFIT AT CHECKPOINT 4

COMMAND AND SIGNAL:

NO CHANGE

2. Operational Graphics to Frago 2 to OPORD #001-05



D. MISSION FOUR:

1. FRAGO 3 TO OPORD #001-05

SITUATION: AL-FARHEED INSURGENTS HAVE BEEN ROUTED, AND ARE CONSOLIDATING AT THEIR LOCAL BASES IN ORDER TO REORGANIZE AND ATTEMPT TO CONDUCT ATTACKS ON CIVILIAN REFUGEES MOVING WEST TO MOZSEC.

MPCOA: ENEMY INSURGENTS HAVE SECURED A LOCAL RIVER WATCH TOWER TO USE AS A STRONGPOINT AND DISRUPT RIVER TRAFFIC MOVING EAST ALONG THE FIRGRESS RIVER. WE EXPECT 6-7 DISMOUNTED INSURGENTS ARMED WITH AK-47'S AND RPG FIRES. WE EXPECT AN EMPLACED MACHINE GUN IN THE TOWER. THEY DO NOT WANT TO BECOME DECISIVELY ENGAGED WITH U.S. FORCES, BUT WILL CONTINUE TO FIGHT TO BUY TIME FOR THE REBELS TO ESCAPE.

FRIENDLY FORCES: NO CHANGE

MISSION: 1ST SQD ATTACKS TO SIEZE OBJECTIVE TOWER IN ORDER TO DESTROY ENEMY FORCES AND PREVENT ATTACKS AGAINST REFUGEES NLT XXXXXXMAR05.

EXECUTION:

CDR INTENT: NO CHANGE

CONCEPT OF THE OPERATION: WE WILL MOVE TO CHECKPOINT 5 IN ORDER TO REFIT ON CL V & VIII. FROM THERE, WE WILL MOVE 85 DEGREES FOR APPROX 325 METERS TO OBJECTIVE TOWER. ON OBJ TOWER, WE WILL ESTABLISH A SBF POSITION WEST OF OBJ TOWER TO SUPPRESS ENEMY FORCES, AND USE THE ASSAULT FORCE TO SIEZE OBJECTIVE TOWER. ONCE THE ASSAULT FORCE IS ON TOWER, WE WILL CALL THE SBF ELEMENT FORWARD TO CONSOLIDATE AND REORGANIZE ON THE OBJECTIVE. ONCE SECURE, WE WILL CALL THE PLT LDR IN ORDER COORDINATE FOR TRANSPORTATION BACK TO CAMP SENTINEL.

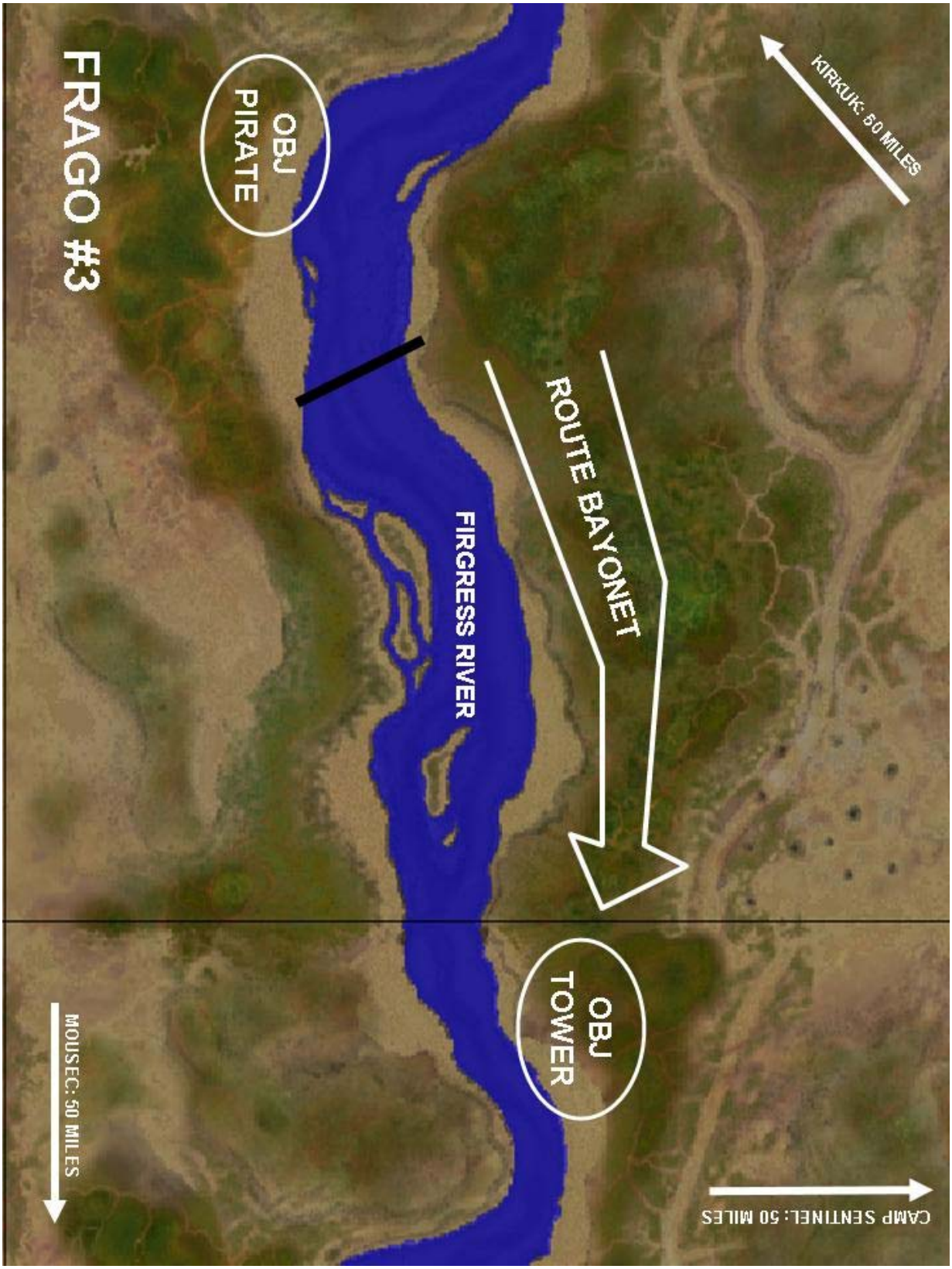
SERVICE SUPPORT:

REFIT AT CHECKPOINT 4

COMMAND AND SIGNAL:

NO CHANGE

2. Operational Graphics to Frago 3 to OPORD #001-05



E. MISSION FIVE:

1. FRAGO 4 TO OPORD #001-05

CURRENT LOCATION: 250 METERS EAST OF THE PERSIAN GULF COAST TOWN OF COROZAL

SITUATION: DUE TO COALITION SUCCESS IN THE NORTH, AL-FARHEED INSURGENTS HAVE MOVED SOUTH ALONG THE WESTERN GULF COASTLINE AND HAVE INCREASED BOMBINGS, MURDER, MORTAR ATTACKS, KIDNAPPING, EXTORTION, HIJACKING, AS WELL AS GUERRILLA AND CONVENTIONAL MILITARY ACTION AGAINST THE HOST NATION. WE EXPECT THEIR STRENGTH IN OUR DIVISION'S SECTOR TO BE APPROXIMATELY 300 TO 1,000 ARMED COMBATANTS AND SEVERAL HUNDRED MORE SUPPORTERS, MOSTLY IN RURAL AREAS. IN OUR IMMEDIATE AO, WE CAN EXPECT TO SEE 20 – 30 AL-FARHEED INSURGENTS.

MPCOA: AL-FARHEED INSURGENTS WILL CONTINUE TO DISRUPT OFF-SHORE OIL PUMPING OPERATIONS BY CONDUCTING ATTACKS AND RAIDING SUPPLIES HEADED FOR THE TOWN OF CORAZOL, WHICH SUPPORTS THE OFF SHORE OIL RIG IN OUR AO. WE EXPECT THE REBELS TO ESTABLISH ROADBLOCKS ON THE MSR INTO CORAZOL TO RAID FOOD AND WATER SHIPMENTS. WE EXPECT 6-7 DISMOUNTED INSURGENTS ARMED WITH AK-47'S, .50 CAL MG'S AND RPG FIRES. THEY DO NOT WANT TO BECOME DECISIVELY ENGAGED WITH U.S. FORCES, BUT WILL CONTINUE TO FIGHT TO BUY TIME FOR LOCAL REINFORCEMENTS IF AVAILABLE.

FRIENDLY FORCES: A CO DEFENDS AO RIG IN ORDER TO SECURE THE TOWN OF CORAZOL AND TO PREVENT THE DISRUPTION OF OFF SHORE OIL OPERATIONS BY AL-FARHEED REBELS. 1ST PLATOON CLEARS IN ZONE TO DESTROY AL-FARHEED REBELS IN AO JAGUAR TO PREVENT ORGANIZED ATTACKS AND LOOTING AGAINST THE PEOPLE OF CORAZOL AND THE LOCAL OIL PUMPING OPERATIONS. THE MOST OF THE LOCAL POPULATION OF CORAZOL ARE IN SUPPORT OF US ACTION IN COLUMBIA, BUT SOME ARE GROWING WEARY OF OUR PRESENCE, AND MAY SYMPATHIZE WITH THE AL-FARHEED IDEOLOGY.

MISSION: 1ST SQD ATTACKS OBJECTIVE GARAGE IN ORDER TO DESTROY ENEMY FORCES AND SECURE STOLEN SUPPLIES INTENDED FOR CORAZOL NLT XXXXXXMAR05.

EXECUTION:

CDR INTENT: TO BE SUCCESSFUL, WE MUST:

- DESTROY ALL ENEMY FORCES AND EQUIPMENT IN ZONE TO PREVENT AN ORGANIZED ATTACK OR CAMPAIGN OF TERROR AGAINST THE CITIZENS OF CORAZOL

- PREVENT CIVILIAN CASUALTIES AND DAMAGE TO HOST NATION INFRASTRUCTURE (C2 NODES, SCHOOLS, WATER TREATMENT SITES, CHURCHES, AND OFF SHORE PUMP FACILITIES)

- RAPIDLY SIEZE OBJECTIVES IN ZONE TO PREVENT AN ORGANIZED AL-FARHEED ATTACK AGAINST US FORCES

CONCEPT OF THE OPERATION: WE WILL CONDUCT AN AIR MOVEMENT TO LZ BEACH. AT LZ BEACH, WE WILL MOVE APPROX 180 DEGREES FOR 400 METERS TO OBJ GARAGE. WE WILL CONDUCT A DELIBERATE ATTACK ON THE OBJECTIVE TO DESTROY ENEMY FORCES AND SECURE ANY STOLEN SUPPLIES HEADED FOR CORAZOL. AFTER WE CONSOLIDATE ON THE OBJECTIVE, WE WILL SUBMIT A SALUTE REPORT TO RED-1 (PLT LDR) AND AWAIT FURTHER INSTRUCTIONS.

COORDINATING INSTRUCTIONS:

1. SECURE CHECKPOINT CHARLIE AT LZ BEACH PRIOR TO CONDUCTING ATTACK ON OBJ GARAGE.

2. REHEARSE TACTICAL MOVEMENT AND ACTIONS ON THE OBJECTIVE AT THE LIVE FIRE RANGE EAST OF CORAZOL.

3. SECURE CHECKPOINT DELTA AFTER CONSOLIDATION ON OBJ GARAGE.

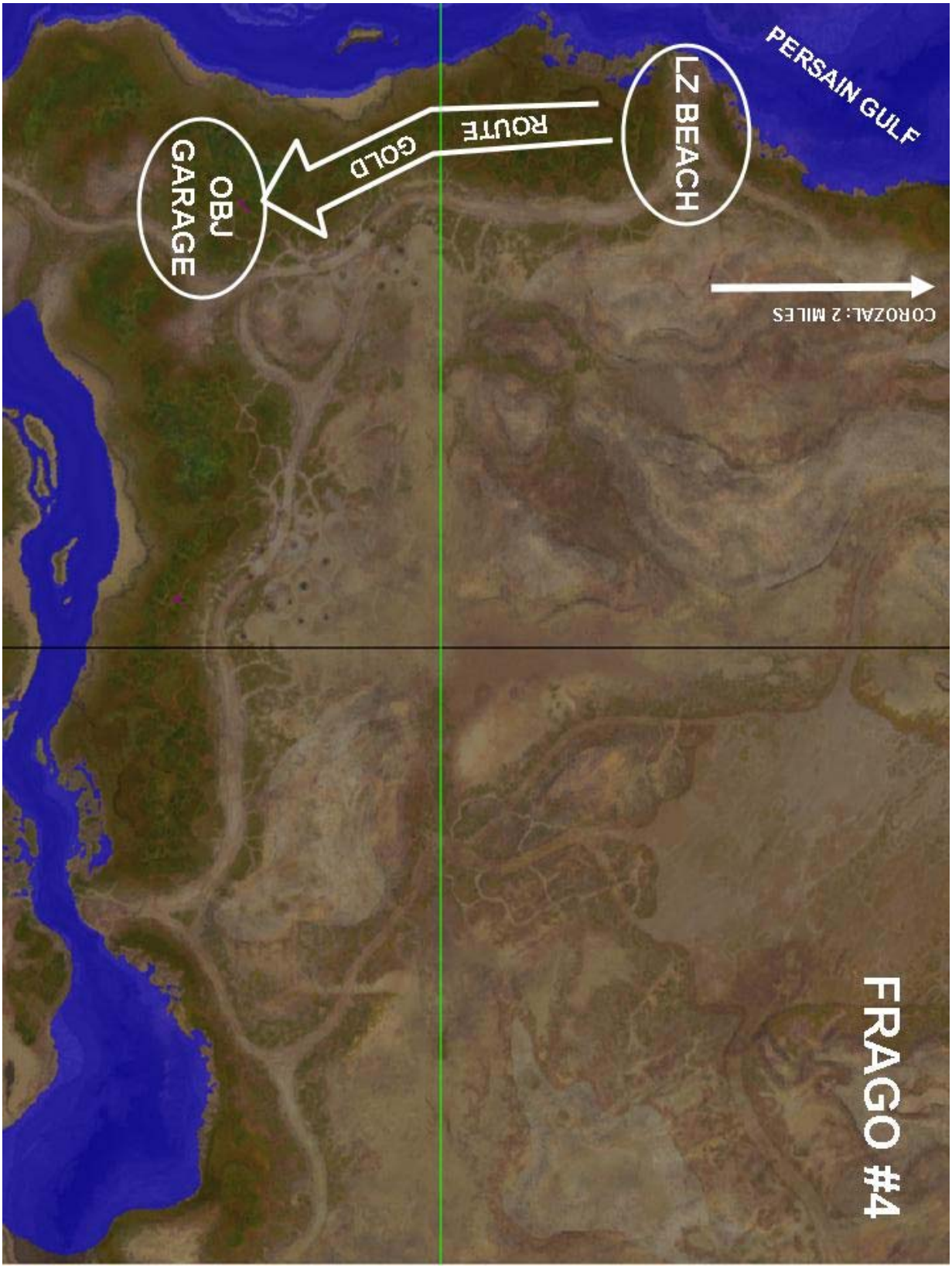
SERVICE SUPPORT:

NO CHANGE

COMMAND AND SIGNAL:

NO CHANGE

2. Operational Graphics to Frago 4 to OPORD #001-05



F. MISSION SIX:

1. FRAGO 5 TO OPORD #001-05

SITUATION: UAV OVERFLIGHT PHOTOS DURING THE LAST MISSION HAVE DETERMINED THE LOCATION OF THE LOCAL AL-FARHEED REBEL BASECAMP. BATTALION S2 HAS ALSO RECEIVED REPORTS FROM THE SIGNAL UNIT ATTACHED TO OUR BATTALION THAT INDICATE THAT THE AL-FARHEED REBELS ARE RAPIDLY EXFILTRATING OUT OF OUR AO DUE TO THE SUCCESS OF OUR RECENT OPERATIONS. THEY WILL BE LOADING SUPPLIES OUT OF THEIR BASECAMP AND ONTO TRUCKS BOUND FOR THE COAST. WE EXPECT THEY WILL LOAD PERSONNEL AND EQUIPMENT ON CIVILIAN BOATS AND MOVE SOUTH TO REGROUP FOR FUTURE OPERATIONS.

MPCOA: AL-FARHEED REBELS WILL DEFEND THEIR BASECAMP (OBJ CLUBHOUSE) IN ORDER TO BUY TIME FOR THEIR FORCES TO FINISH LOADING STOLEN SUPPLIES AND EXFILTRATE OUT OF ZONE. WE EXPECT 6-7 DISMOUNTED INSURGENTS ARMED WITH AK-47'S AND RPG FIRES. THEY DO NOT WANT TO BECOME DECISIVELY ENGAGED WITH U.S. FORCES, BUT WILL CONTINUE TO FIGHT TO BUY TIME FOR THE LAST OF THEIR SUPPLIES TO BE LOADED.

FRIENDLY FORCES: NO CHANGE

MISSION: 1ST SQD ATTACKS TO SIEZE OBJECTIVE CLUBHOUSE IN ORDER TO DESTROY ENEMY FORCES AND SECURE STOLEN SUPPLIES AND EQUIPMENT NLT XXXXXXMAR05.

EXECUTION:

CDR INTENT: NO CHANGE

CONCEPT OF THE OPERATION: WE WILL MOVE TO CHECKPOINT DELTA IN ORDER TO REFIT ON CL V & VIII. WE WILL MOVE APPROX 100 DEGREES FOR 320 METERS TO OBJ CLUBHOUSE. WE WILL CONDUCT A DELIBERATE ATTACK ON THE OBJECTIVE TO DESTROY ENEMY FORCES AND SECURE ANY STOLEN SUPPLIES HEADED FOR CORAZOL. AFTER WE CONSOLIDATE ON THE OBJECTIVE, WE WILL SUBMIT A SALUTE REPORT TO RED-1 (PLT LDR) AND AWAIT FURTHER INSTRUCTIONS.

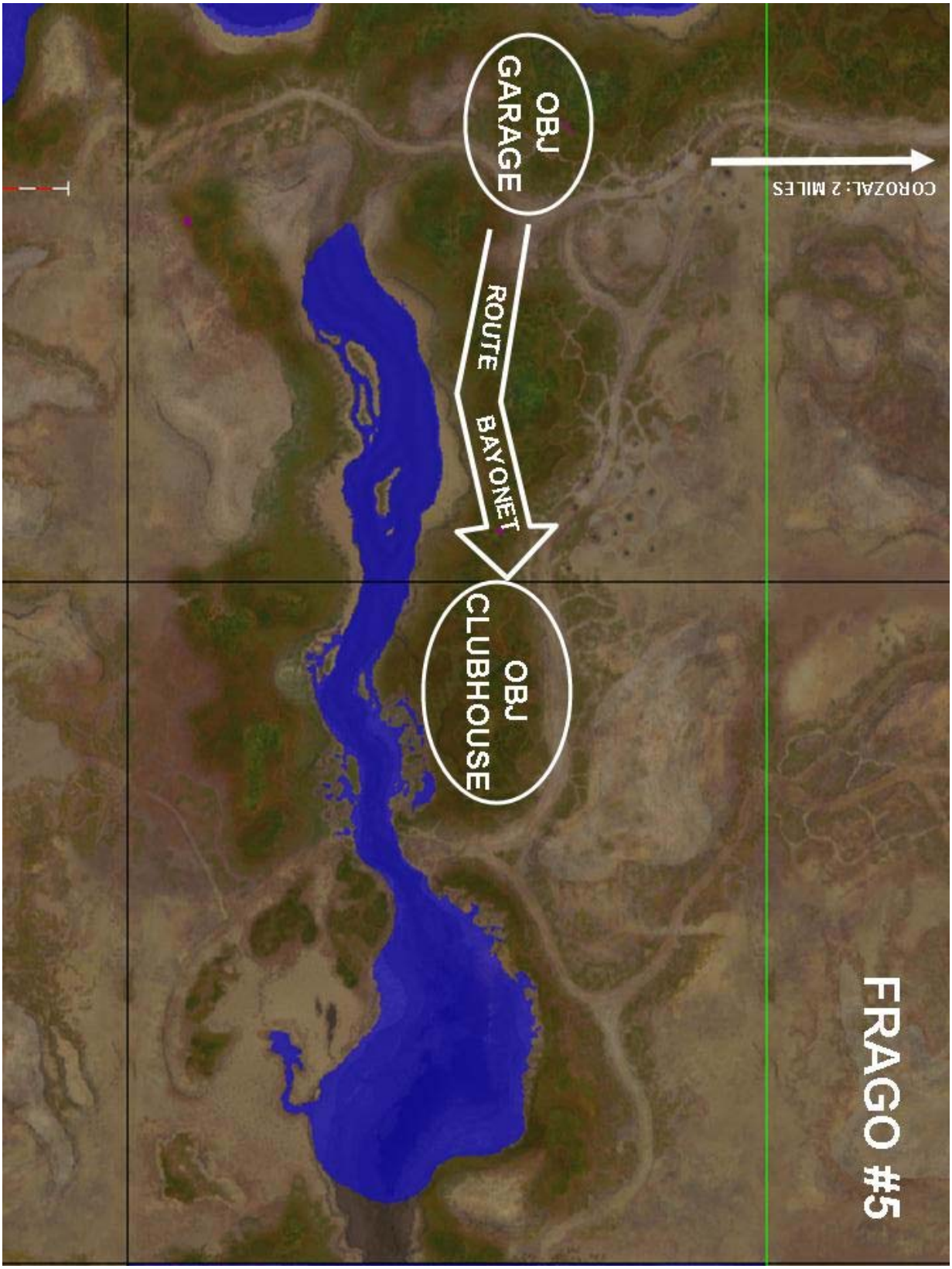
COORDINATING INSTRUCTIONS:

1. SECURE THE CHECK POINT ALPHA AT OBJ CLUBHOUSE AFTER CONSOLIDATION.

SERVICE SUPPORT:REFIT AT CHECKPOINT DELTA PRIOR TO MOVEMENT

COMMAND AND SIGNAL: NO CHANGE

2. Operational Graphics to Frago 5 to OPORD #001-05



G. MISSION SEVEN:

1. FRAGO 6 TO OPORD #001-05

SITUATION: AL-FARHEED REBELS ARE NOW ABANDONING THEIR BASES IN OUR AO, AND ARE RAPIDLY ATTEMPTING TO ESCAPE SOUTH WITH AS MANY STOLEN SUPPLIES AS THEY CAN. THEY WILL EXFILTRATE SOUTH BY BOAT AND TRUCK (MIXING WITH LOCALS SUPPORTERS IF POSSIBLE) TO AVOID US FORCES.

MPCOA: ENEMY INSURGENTS ARE ESTABLISHING TRUCK LOADING POINTS IN OUR AREA TO RAPIDLY MOVE THEIR LOOTED SUPPLIES TO THE COAST FOR EXFILTRATION BY BOAT. WE EXPECT 6-7 DISMOUNTED INSURGENTS ARMED WITH AK-47'S AND RPG FIRES. THEY DO NOT WANT TO BECOME DECISIVELY ENGAGED WITH U.S. FORCES, BUT WILL CONTINUE TO FIGHT TO BUY TIME THEIR SUPPLY TRUCKS TO ESCAPE.

FRIENDLY FORCES: NO CHANGE

MISSION: 1ST SQD ATTACKS TO SIEZE OBJECTIVE LOADING DOCK IN ORDER TO DESTROY ENEMY FORCES AND SECURE SUPPLIES STOLEN FROM CORAZOL NLT XXXXXXMAR05.

EXECUTION:

CDR INTENT: NO CHANGE

CONCEPT OF THE OPERATION: WE WILL MOVE TO CHECKPOINT ALPHA IN ORDER TO REFIT ON CL V & VIII. WE WILL MOVE APPROX 210 DEGREES FOR 320 METERS TO OBJ LOADING DOCK. WE WILL CONDUCT A DELIBERATE ATTACK ON THE OBJECTIVE TO DESTROY ENEMY FORCES AND SECURE ANY STOLEN SUPPLIES HEADED FOR CORAZOL. AFTER WE CONSOLIDATE ON THE OBJECTIVE, WE WILL SUBMIT A SALUTE REPORT TO RED-1 (PLT LDR) AND AWAIT FURTHER INSTRUCTIONS.

COORDINATING INSTRUCTIONS:

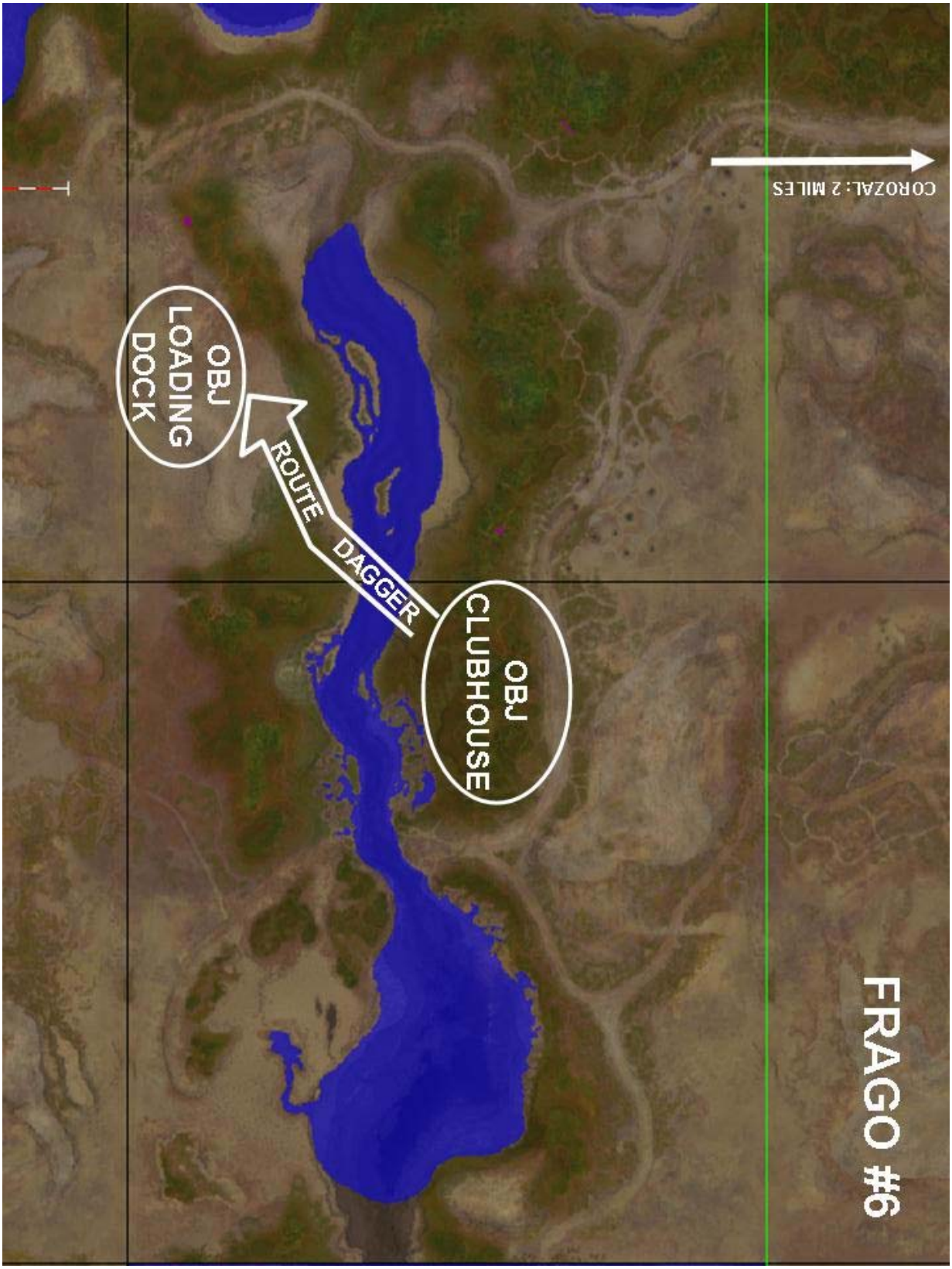
1. SECURE THE CHECK POINT BRAVO AT OBJ LOADING DOCK AFTER CONSOLIDATION.

SERVICE SUPPORT:

REFIT AT CHECKPOINT ALPHA PRIOR TO MOVEMENT

COMMAND AND SIGNAL: NO CHANGE

2. Operational Graphics to Frago 6 to OPORD #001-05



H. MISSION EIGHT:

1. FRAGO 7 TO OPORD #001-05

SITUATION: AL-FARHEED REBELS IN OUR AO ARE HAVE BEEN FULLY ROUTED AND ARE RAPIDLY ESCAPING SOUTH IN SECTOR WITH AS MANY STOLEN SUPPLIES AND PERSONNEL THEY CAN. THEY ARE EXFILTRATING BY BOAT AND TRUCK SOUTH ALONG THE COAST IN ORDER, AND THEN WILL PUSH INLAND TO THEIR RURAL BASE CAMPS.

MPCOA: AL-FARHEED REBELS ARE ESTABLISHING COASTAL LOADING POINTS IN OUR AREA TO RAPIDLY MOVE THEIR LOOTED SUPPLIES SOUTH ALONG THE COAST IN ORDER TO REFIT FOR FUTURE OPERATIONS. WE EXPECT 7-9 DISMOUNTED INSURGENTS ARMED WITH AK-47'S, .50 CAL MG AND RPG FIRES. THEY DO NOT WANT TO BECOME DECISIVELY ENGAGED WITH U.S. FORCES, BUT WILL CONTINUE TO FIGHT ALONG THE SHORE TO BUY TIME FOR THEIR MAIN SUPPLY BOATS TO ESCAPE.

FRIENDLY FORCES: NO CHANGE

MISSION: 1ST SQD ATTACKS TO SIEZE OBJECTIVE MARINA IN ORDER TO DESTROY ENEMY FORCES AND SECURE SUPPLIES STOLEN FROM THE LOCAL TOWN OF CORAZOL NLT XXXXXXMAR05.

EXECUTION:

CDR INTENT: NO CHANGE

CONCEPT OF THE OPERATION: WE WILL MOVE TO CHECKPOINT BRAVO IN ORDER TO REFIT ON CL V & VIII. FROM THERE, WE WILL MOVE 200 DEGREES FOR APPROX 225 METERS TO OBJECTIVE MARINA. WE WILL CONDUCT A DELIBERATE ATTACK ON THE OBJECTIVE TO DESTROY ENEMY FORCES AND SECURE ANY STOLEN SUPPLIES HEADED FOR CORAZOL. AFTER WE CONSOLIDATE ON THE OBJECTIVE, WE WILL SUBMIT A SALUTE REPORT TO RED-1 (PLT LDR) AND AWAIT FURTHER INSTRUCTIONS.

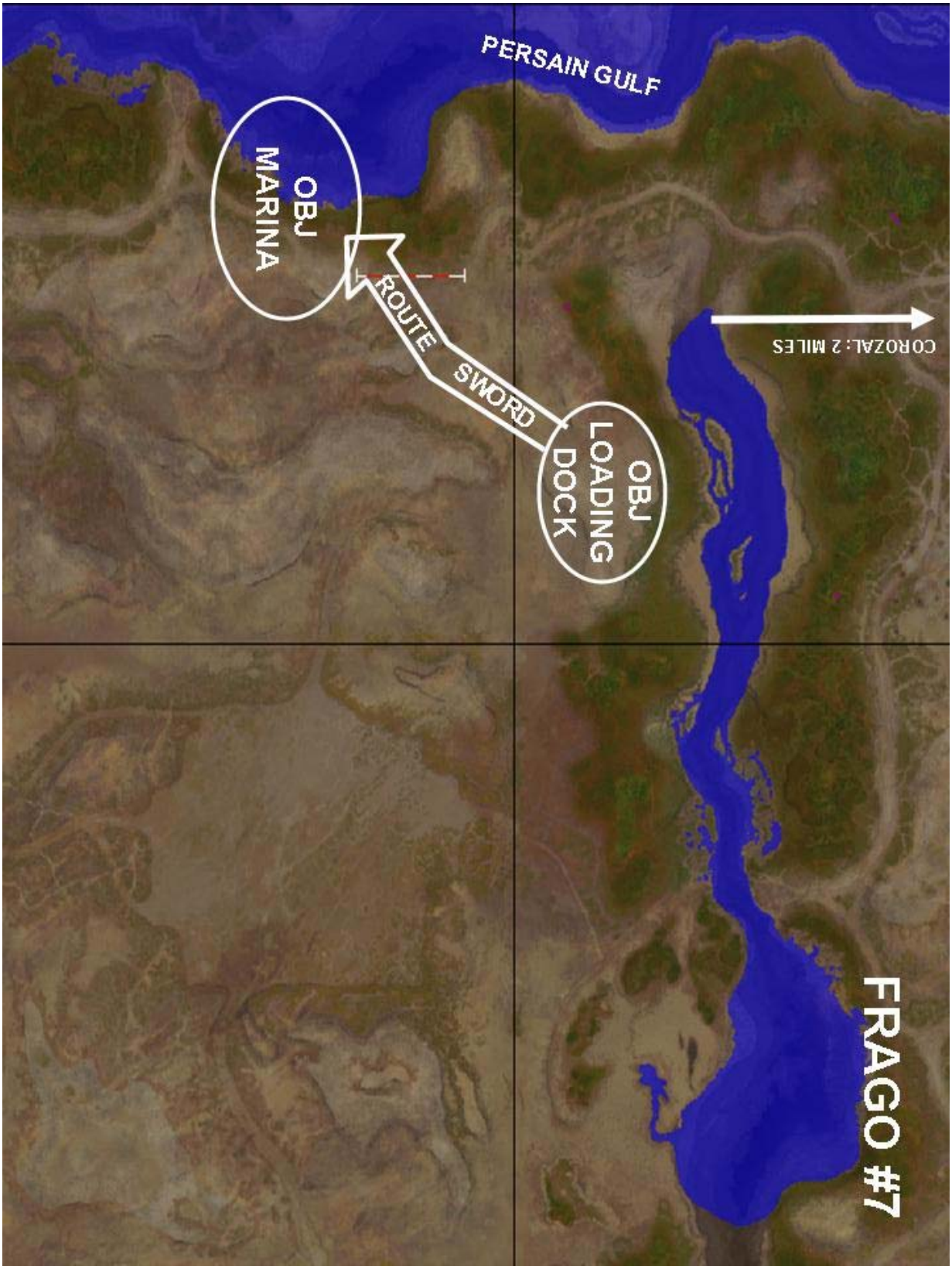
SERVICE SUPPORT:

REFIT AT CHECKPOINT BRAVO PRIOR TO MOVEMENT

COMMAND AND SIGNAL:

NO CHANGE

2. Operational Graphics to Frago 7 to OPORD #001-05



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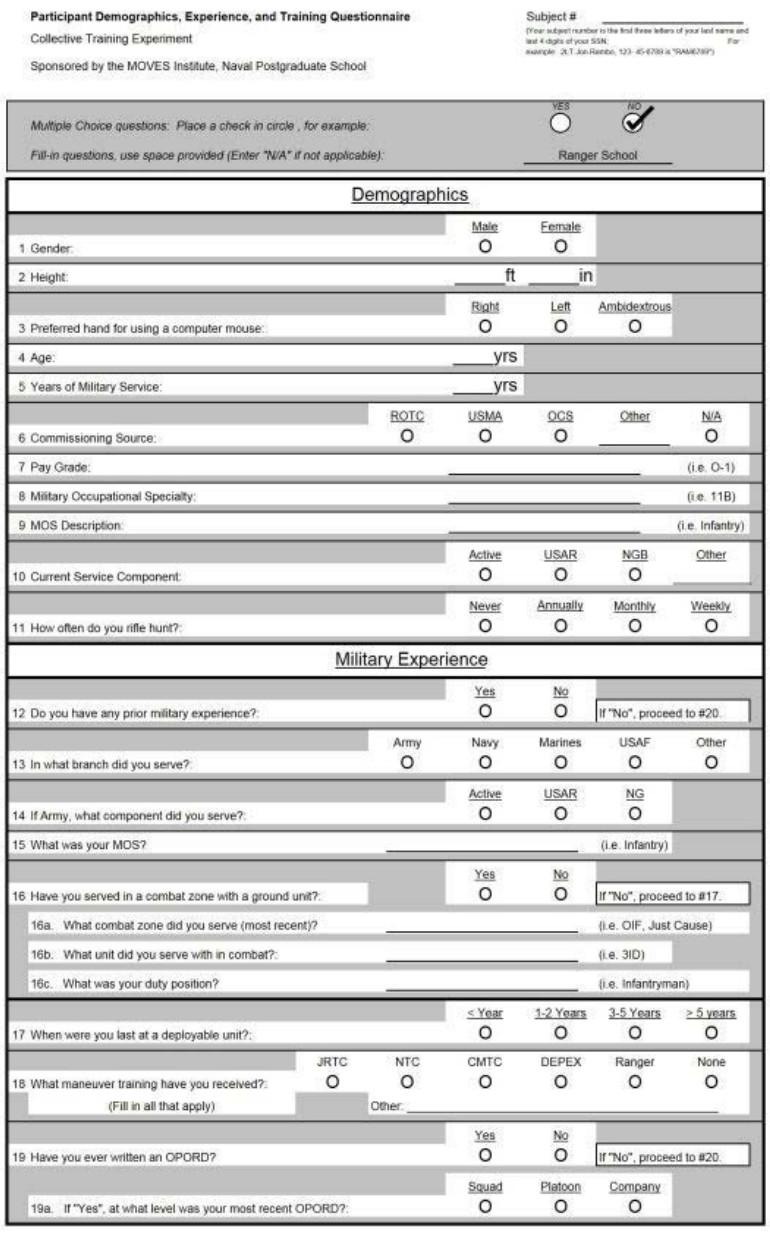
APPENDIX B. SUBJECT SURVEYS

A. DEMOGRAPHICS SURVEY:



Participant Demographics, Experience, and Training Questionnaire

Collective Training Experiment

Sponsored by the MOVES Institute, Naval Postgraduate School

Subject # _____

(Your subject number is the first three letters of your last name and last 4 digits of your SSN; For example: JLT Jon Rambo, 123-45-6789 is "RAM6789")

Multiple Choice questions: Place a check in circle , for example: YES ○ NO ✓

Fill-in questions, use space provided (Enter "N/A" if not applicable): Ranger School

Demographics

1 Gender:	Male ○	Female ○			
2 Height:	_____ft _____in				
3 Preferred hand for using a computer mouse:	Right ○	Left ○	Ambidextrous ○		
4 Age:	_____yrs				
5 Years of Military Service:	_____yrs				
6 Commissioning Source:	ROTC ○	USMA ○	OCS ○	Other _____	N/A ○
7 Pay Grade:	_____ (i.e. O-1)				
8 Military Occupational Specialty:	_____ (i.e. 11B)				
9 MOS Description:	_____ (i.e. Infantry)				
10 Current Service Component:	Active ○	USAR ○	NGB ○	Other _____	
11 How often do you rifle hunt?:	Never ○	Annually ○	Monthly ○	Weekly ○	

Military Experience

12 Do you have any prior military experience?:	Yes ○	No ○	If "No", proceed to #20.		
13 In what branch did you serve?:	Army ○	Navy ○	Marines ○	USAF ○	Other ○
14 If Army, what component did you serve?:	Active ○	USAR ○	NG ○		
15 What was your MOS?:	_____ (i.e. Infantry)				
16 Have you served in a combat zone with a ground unit?:	Yes ○	No ○	If "No", proceed to #17.		
16a. What combat zone did you serve (most recent)?	_____ (i.e. OIF, Just Cause)				
16b. What unit did you serve with in combat?:	_____ (i.e. 3ID)				
16c. What was your duty position?	_____ (i.e. Infantryman)				
17 When were you last at a deployable unit?:	< Year ○	1-2 Years ○	3-5 Years ○	> 5 years ○	
18 What maneuver training have you received?: (Fill in all that apply)	JRTC ○	NTC ○	CMTC ○	DEPEX ○	Ranger ○	None ○
	Other: _____					
19 Have you ever written an OPORD?	Yes ○	No ○	If "No", proceed to #20.		
19a. If "Yes", at what level was your most recent OPORD?:	Squad ○	Platoon ○	Company ○		

Page 1 of 3

Demographics survey (page 1 of 3)

Simulations Experience

	Daily	Weekly	Monthly	Never
20 In the *past two years* , how often did you play video games?:	O	O	O	O
21 How often do you *now* play video games?:	O	O	O	O

For Questions 22, 23, 24, and 25, mark all answers that apply.

	First Person Shooter	Sports	Strategy	Fantasy	None
22 What types of video games do / did you play?:	O	O	O	O	O

22a. If you played First Person Shooter games, list the two most recent _____

	Yes	No
22b. Have you played multiplayer games?:	O	O

	PC / Mac	X-Box	PS2	Other	N/A
23 If you play games,what platform do you prefer?:	O	O	O	O	O

	Keyboard/Mouse	Joystick	Gamepad	Other	N/A
24 If you play PC / Mac games, what controls do you use?:	O	O	O	O	O

	EST-2000	OneSAF	VBS	Other	None
25 What DoD simulations have you used?:	O	O	O	_____	O

General Questions

	Poor	Fair	Averge	Good	Excellent
26 Rate your currnet health?:	O	O	O	O	O

	Yes	No	
27 Have you ever become nauseous or motion sick while playing a video game?:	O	O	If "No", proceed to #28

	Once	Rarely	Seldom	Occasionally	Frequently
27a. How often have you experienced this?:	O	O	O	O	O

	< 2 months	2-6 months	7-12 months	> one year
28 How long have you been with your current squad?:	O	O	O	O

	Yes	No	
29 Have you conducted collective training with your squad?:	O	O	If "No", proceed to #30

	1 to 3	4 to 7	8 or more
29a. If "Yes", how many exercises have you conducted?:	O	O	O

	Never	Rarely	Seldom	Often	Daily
30 Do you socialize with your squad after duty hours?:	O	O	O	O	O

	Never	Rarely	Some	Often	Daily
31 Do you play multi-player games with your squad?:	O	O	O	O	O

	Yes	No	
32 Did you miss any training on Squad Attack?:	O	O	If "No", proceed to #33

	< 1 hour	1-3 hours	3-5 hours	6 -7 hours
32a. How much training did you miss?:	O	O	O	O

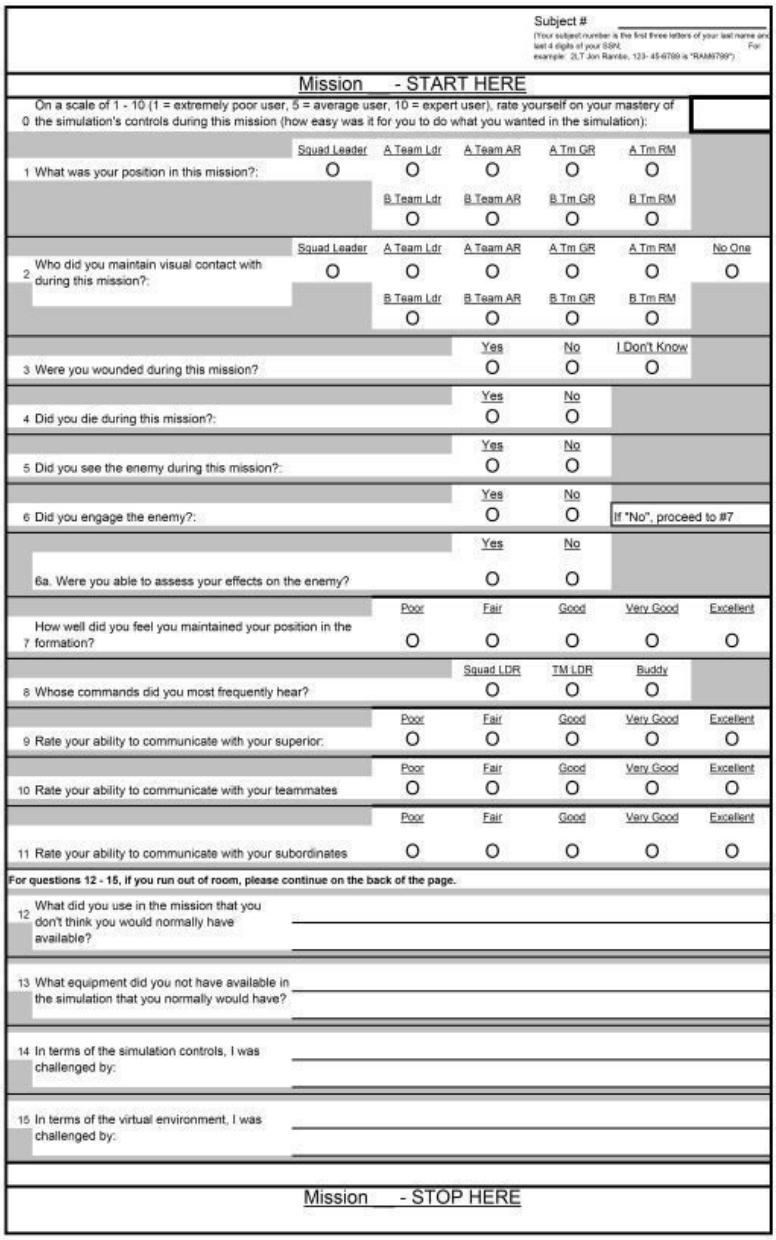
Individual Training Assessment

	Very Unsure	Unsure	Neutral	Confident	Very Confident
33 How confident are ***you*** in your training level to maneuver under enemy fire as a member of a squad?:	O	O	O	O	O
34 How confident are ***you*** in your training level to communicate tactical movement orders under enemy fire?: (i.e. "Alpha Team, lay down suppresive fire on that bunker.")					
34a To my battle buddy	O	O	O	O	O
34b To my fire team	O	O	O	O	O
34c To my squad	O	O	O	O	O
35 How confident are you in ***your*** training level to use available cover to maneuver against an enemy position?:	O	O	O	O	O
36 How confident are you in ***your*** training level to use available concealment to maneuver against an enemy position?:	O	O	O	O	O
37 How confident are you in ***your*** training level to scan, detect and identify enemy positions?:	O	O	O	O	O
38 How confident are you in ***your*** training level to submit tactical reports (ACE, SALT, SALUTE)?:	O	O	O	O	O

Squad Training Assessment

	Very Unsure	Unsure	Neutral	Confident	Very Confident
39 How confident are you in ***your squad's*** training level to maneuver under enemy fire?	O	O	O	O	O
40 How confident are you in ***your squad's*** training level to coordinate direct fires against an enemy position?:	O	O	O	O	O
41 How confident are you in ***your squad's*** training level to move tactically ?:					
41a Traveling	O	O	O	O	O
41b Traveling Overwatch	O	O	O	O	O
41c Bounding Overwatch	O	O	O	O	O
42 How confident are you in ***your squad's*** training level to use available cover to maneuver against an enemy position?:	O	O	O	O	O
43 How confident are you in ***your squad's*** training level to use available concealment to maneuver against an enemy position?:	O	O	O	O	O
44 How confident are you in ***your squad's*** training level to scan, detect and identify an enemy position?:	O	O	O	O	O
45 How confident are you in ***your squad's*** training level to conduct a Squad Attack?	O	O	O	O	O

B. POST MISSION SURVEY (TEST):



Subject # _____

(Your subject number is the first three letters of your last name and last 4 digits of your SSN. For example: 2LT Jon Rambo, 123-45-6789 is "RAM6789")

Mission ___ - START HERE

0 On a scale of 1 - 10 (1 = extremely poor user, 5 = average user, 10 = expert user), rate yourself on your mastery of the simulation's controls during this mission (how easy was it for you to do what you wanted in the simulation): ____

1 What was your position in this mission?:	Squad Leader O	A Team Ldr O	A Team AR O	A Tm GR O	A Tm RM O	
		B Team Ldr O	B Team AR O	B Tm GR O	B Tm RM O	
2 Who did you maintain visual contact with during this mission?:	Squad Leader O	A Team Ldr O	A Team AR O	A Tm GR O	A Tm RM O	No One O
		B Team Ldr O	B Team AR O	B Tm GR O	B Tm RM O	
3 Were you wounded during this mission?			Yes O	No O	I Don't Know O	
4 Did you die during this mission?:			Yes O	No O		
5 Did you see the enemy during this mission?:			Yes O	No O		
6 Did you engage the enemy?:			Yes O	No O	If "No", proceed to #7	
6a. Were you able to assess your effects on the enemy?			Yes O	No O		
7 How well did you feel you maintained your position in the formation?		Poor O	Fair O	Good O	Very Good O	Excellent O
8 Whose commands did you most frequently hear?			Squad LDR O	TM LDR O	Buddy O	
9 Rate your ability to communicate with your superior:		Poor O	Fair O	Good O	Very Good O	Excellent O
10 Rate your ability to communicate with your teammates		Poor O	Fair O	Good O	Very Good O	Excellent O
11 Rate your ability to communicate with your subordinates		Poor O	Fair O	Good O	Very Good O	Excellent O

For questions 12 - 15, if you run out of room, please continue on the back of the page.

12 What did you use in the mission that you don't think you would normally have available? _____

13 What equipment did you not have available in the simulation that you normally would have? _____

14 In terms of the simulation controls, I was challenged by: _____

15 In terms of the virtual environment, I was challenged by: _____

Mission ___ - STOP HERE

Post mission survey (page 1 of 1)

C. POST SIMULATION SURVEY (TEST):

Post-Simulation Questionnaire

1 What squad positions did you hold during the exercise?: (Fill in all that apply)	Squad Leader O	A Team Ldr O	A Team AR O	A Tm GR O	A Tm RM O
		B Team Ldr O	B Team AR O	B Tm GR O	B Tm RM O
2 How well did you understand ***your*** duties & responsibilities?:	Poor O	Fair O	Good O	Very Good O	Excellent O
3 How well did you feel ***your squad*** understood the mission?:	Poor O	Fair O	Good O	Well O	Very Well O
4 How well did you understand the ***other squad members*** duties and responsibilities?:	Poor O	Fair O	Good O	Well O	Very Well O
5 How well did you feel ***you*** understood the mission?:	Poor O	Fair O	Good O	Well O	Very Well O
6 How confident are ***you*** in your training level to maneuver under enemy fire as a member of a squad?:	Very Unsure O	Unsure O	Neutral O	Confident O	Very Confident O
7 How confident are ***you*** in your training level to communicate tactical movement orders under enemy fire?:	Very Unsure	Unsure	Neutral	Confident	Very Confident
7a. To my battle buddy	O	O	O	O	O
7b. To my fire team	O	O	O	O	O
7c. To my squad	O	O	O	O	O
8 How confident are you in ***your*** training level to use available cover to maneuver against an enemy position?:	Very Unsure O	Unsure O	Neutral O	Confident O	Very Confident O
9 How confident are you in ***your*** training level to use available concealment to maneuver against an enemy position?:	Very Unsure O	Unsure O	Neutral O	Confident O	Very Confident O
10 How confident are you in ***your*** training level to scan, detect and identify an enemy position?:	Very Unsure O	Unsure O	Neutral O	Confident O	Very Confident O
11 How confident are you in ***your*** training level to submit tactical reports (ACE, SALT, SALUTE)?:	Very Unsure O	Unsure O	Neutral O	Confident O	Very Confident O
12 How confident are you in ***your squad's*** training level to maneuver under enemy fire?	Very Unsure O	Unsure O	Neutral O	Confident O	Very Confident O
13 How confident are you in ***your squad's*** training level to coordinate direct fires against an enemy position?:	Very Unsure O	Unsure O	Neutral O	Confident O	Very Confident O
14 How confident are you in ***your squad's*** training level to move tactically in the following movement formations?	Very Unsure	Unsure	Neutral	Confident	Very Confident
14a. Traveling	O	O	O	O	O
14b. Traveling Overwatch	O	O	O	O	O
14c. Bounding Overwatch	O	O	O	O	O
15 How confident are you in ***your squad's*** training level to use available cover to maneuver against an enemy position?:	Very Unsure O	Unsure O	Neutral O	Confident O	Very Confident O
16 How confident are you in ***your squad's*** training level to use available concealment to maneuver against an enemy position?:	Very Unsure O	Unsure O	Neutral O	Confident O	Very Confident O
17 How confident are you in ***your squad's*** training level to scan, detect and identify an enemy position?:	Very Unsure O	Unsure O	Neutral O	Confident O	Very Confident O
18 How confident are you in ***your squad's*** training level to conduct actions on contact in a FTX/LFX?	Very Unsure O	Unsure O	Neutral O	Confident O	Very Confident O

Post simulation survey (page 1 of 2)

19	Rate the simulation's ability to provide ***audio*** cues that allowed you to identify the location of enemy fires?:	Poor O	Fair O	Good O	Well O	Very Well O
20	Rate the simulation's ability to provide ***visual*** cues that allowed you to identify the location of enemy fires?:	Poor O	Fair O	Good O	Well O	Very Well O
21	Rate the simulation's ability to provide ***audio*** cues that allowed you to determine the location of your squad members?:	Poor O	Fair O	Good O	Well O	Very Well O
22	Rate the simulation's ability to provide ***visual*** cues that allowed you to determine the location of your squad members?:	Poor O	Fair O	Good O	Well O	Very Well O
23	Rate the simulation exercise's effectiveness to train ***you*** to conduct a Squad Attack?	Poor O	Fair O	Good O	Well O	Very Well O
24	Rate the simulation exercise's effectiveness to train ***your squad*** to conduct a Squad Attack?	Poor O	Fair O	Good O	Well O	Very Well O
25	Rate the simulation exercise's effectiveness to provide ***you*** with situational awareness? (How I see myself & the enemy)	Poor O	Fair O	Good O	Well O	Very Well O
26	Rate this statement's description of your experience: *"During this exercise, I felt like my actions in the virtual environment had no consequences."*	Not True O	Somewhat True O	Neutral O	True O	Very True O
27	Rate this statement's description of your experience: *"During this exercise, I felt like I was playing a game."*	Not True O	Somewhat True O	Neutral O	True O	Very True O
28	Rate this statement's description of your experience: *"During this exercise, I felt like I was conducting training."*	Not True O	Somewhat True O	Neutral O	True O	Very True O

For questions 29 - 31 please continue on the back of the page if you run out of room.

29 This training would be more effective if it included…

30 If I could add anything to this training, I would add…

31 If I could add anything to this simulation, I would add…

32 Any additional comments:

Post simulation survey (page 2 of 2)

D. POST FTX SURVEY (CONTROL):

Post Squad FTX Survey
Collective Training Experiment
Sponsored by the MOVES Institute, Naval Postgraduate School

Subject # _____
(Your subject number is the first three letters of your last name and last 4 digits of your SSN;
For example: 2LT Jon Rambo, 123-45-6789 is "RAM6789")

Multiple Choice questions: Place a check in circle , for example: YES ○ NO ✓

Fill-in questions, use space provided (Enter "N/A" if not applicable): Ranger School

FTX Individual Assessment Survey

		Squad Leader	Team Ldr	AR	GR	RM
1	What squad positions did you hold during the blank fire exercise?	O	O	O	O	O

		Poor	Fair	Good	Well	Very Well
2	How well did you understand ***your*** duties & responsibilities?:	O	O	O	O	O
3	During the FTX missions, on average, how well did you feel ***you*** understood the mission?:	O	O	O	O	O

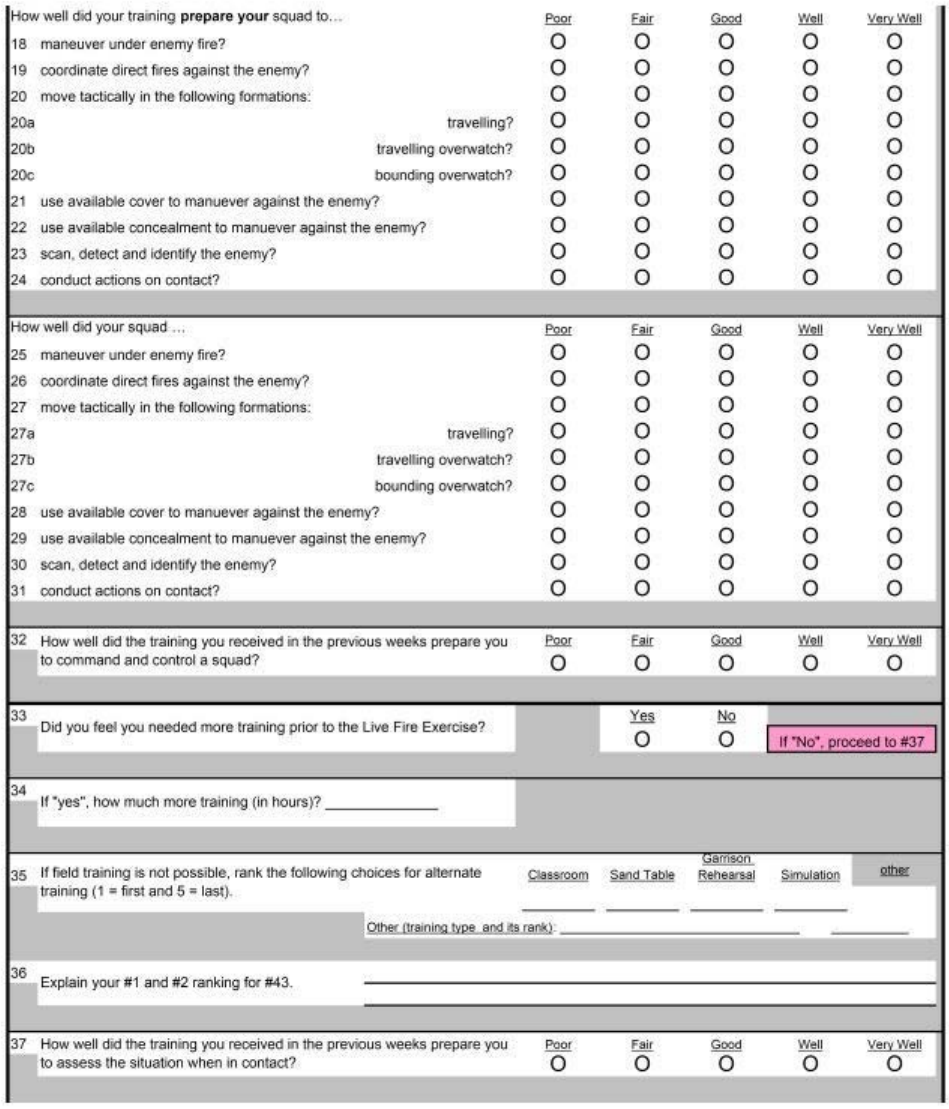
How well did your training **prepare you** to…			Poor	Fair	Good	Well	Very Well
4	maneuver under enemy fire as a member of a squad?:		O	O	O	O	O
5	communicate tactical movement orders to your …		O	O	O	O	O
5a	(All positions)	battle buddy?	O	O	O	O	O
5b	(Team Leaders)	fire team?	O	O	O	O	O
5c	(Squad Leader)	squad?	O	O	O	O	O
6	use available cover to manuever against the enemy?		O	O	O	O	O
7	use available concealment to manuever against the enemy?		O	O	O	O	O
8	scan, detect and identify the enemy?		O	O	O	O	O
9	submit tactical reports (ACE, SALULTE)?		O	O	O	O	O

How well did you…			Poor	Fair	Good	Well	Very Well
10	maneuver under enemy fire as a member of a squad?:		O	O	O	O	O
11	communicate tactical movement orders to your …		O	O	O	O	O
11a	(All positions)	battle buddy?	O	O	O	O	O
11b	(Team Leaders)	fire team?	O	O	O	O	O
11c	(Squad Leader)	squad?	O	O	O	O	O
12	use available cover to manuever against the enemy?		O	O	O	O	O
13	use available concealment to manuever against the enemy?		O	O	O	O	O
14	scan, detect and identify the enemy?		O	O	O	O	O
15	submit tactical reports (ACE, SALULTE)?		O	O	O	O	O

FTX Squad Assessment Survey

		Poor	Fair	Good	Well	Very Well
16	How well did you feel ***your squad*** understood the mission?:	O	O	O	O	O
17	How well did you understand the ***other squad members'*** duties and responsibilities?:	O	O	O	O	O

Post FTX survey (control) (page 1 of 2)



How well did your training **prepare your** squad to…	Poor	Fair	Good	Well	Very Well
18 maneuver under enemy fire?	O	O	O	O	O
19 coordinate direct fires against the enemy?	O	O	O	O	O
20 move tactically in the following formations:	O	O	O	O	O
20a travelling?	O	O	O	O	O
20b travelling overwatch?	O	O	O	O	O
20c bounding overwatch?	O	O	O	O	O
21 use available cover to manuever against the enemy?	O	O	O	O	O
22 use available concealment to manuever against the enemy?	O	O	O	O	O
23 scan, detect and identify the enemy?	O	O	O	O	O
24 conduct actions on contact?	O	O	O	O	O

How well did your squad …	Poor	Fair	Good	Well	Very Well
25 maneuver under enemy fire?	O	O	O	O	O
26 coordinate direct fires against the enemy?	O	O	O	O	O
27 move tactically in the following formations:	O	O	O	O	O
27a travelling?	O	O	O	O	O
27b travelling overwatch?	O	O	O	O	O
27c bounding overwatch?	O	O	O	O	O
28 use available cover to manuever against the enemy?	O	O	O	O	O
29 use available concealment to manuever against the enemy?	O	O	O	O	O
30 scan, detect and identify the enemy?	O	O	O	O	O
31 conduct actions on contact?	O	O	O	O	O

32 How well did the training you received in the previous weeks prepare you to command and control a squad?	Poor	Fair	Good	Well	Very Well
	O	O	O	O	O

33 Did you feel you needed more training prior to the Live Fire Exercise?	Yes	No	
	O	O	If "No", proceed to #37

34 If "yes", how much more training (in hours)? _____

35 If field training is not possible, rank the following choices for alternate training (1 = first and 5 = last).	Classroom	Sand Table	Garrison Rehearsal	Simulation	other
	_____	_____	_____	_____	
Other (training type and its rank): _____					_____

36 Explain your #1 and #2 ranking for #43. _____

37 How well did the training you received in the previous weeks prepare you to assess the situation when in contact?	Poor	Fair	Good	Well	Very Well
	O	O	O	O	O

E. POST FTX SURVEY (TEST):

Post Squad FTX Survey
Collective Training Experiment
Sponsored by the MOVES Institute, Naval Postgraduate School

Subject # _____
(Your subject number is the first three letters of your last name and last 4 digits of your SSN;
For example: 2LT Jon Rambo, 123-45-6789 is "RAM6789")

Multiple Choice questions: Place a check in circle , for example: YES ○ NO ✓

Fill-in questions, use space provided (Enter "N/A" if not applicable): Ranger School

FTX Individual Assessment Survey

		Squad Leader	Team Ldr	AR	GR	RM
1	What squad positions did you hold during the blank fire exercise?	O	O	O	O	O

		Poor	Fair	Good	Well	Very Well
2	How well did you understand ***your*** duties & responsibilities?:	O	O	O	O	O
3	During the FTX missions, on average, how well did you feel ***you*** understood the mission?:	O	O	O	O	O

How well did your training **prepare you** to…			Poor	Fair	Good	Well	Very Well
4	maneuver under enemy fire as a member of a squad?:		O	O	O	O	O
5	communicate tactical movement orders to your …		O	O	O	O	O
5a	(All positions)	battle buddy?	O	O	O	O	O
5b	(Team Leaders)	fire team?	O	O	O	O	O
5c	(Squad Leader)	squad?	O	O	O	O	O
6	use available cover to manuever against the enemy?		O	O	O	O	O
7	use available concealment to manuever against the enemy?		O	O	O	O	O
8	scan, detect and identify the enemy?		O	O	O	O	O
9	submit tactical reports (ACE, SALULTE)?		O	O	O	O	O

How well did you…			Poor	Fair	Good	Well	Very Well
10	maneuver under enemy fire as a member of a squad?:		O	O	O	O	O
11	communicate tactical movement orders to your …		O	O	O	O	O
11a	(All positions)	battle buddy?	O	O	O	O	O
11b	(Team Leaders)	fire team?	O	O	O	O	O
11c	(Squad Leader)	squad?	O	O	O	O	O
12	use available cover to manuever against the enemy?		O	O	O	O	O
13	use available concealment to manuever against the enemy?		O	O	O	O	O
14	scan, detect and identify the enemy?		O	O	O	O	O
15	submit tactical reports (ACE, SALULTE)?		O	O	O	O	O

FTX Squad Assessment Survey

		Poor	Fair	Good	Well	Very Well
16	How well did you feel ***your squad*** understood the mission?:	O	O	O	O	O
17	How well did you understand the ***other squad members'*** duties and responsibilities?:	O	O	O	O	O

Post FTX survey (test) (page 1 of 3)

How well did your training **prepare your** squad to…		Poor	Fair	Good	Well	Very Well
18	maneuver under enemy fire?	O	O	O	O	O
19	coordinate direct fires against the enemy?	O	O	O	O	O
20	move tactically in the following formations:	O	O	O	O	O
20a	travelling?	O	O	O	O	O
20b	travelling overwatch?	O	O	O	O	O
20c	bounding overwatch?	O	O	O	O	O
21	use available cover to manuever against the enemy?	O	O	O	O	O
22	use available concealment to manuever against the enemy?	O	O	O	O	O
23	scan, detect and identify the enemy?	O	O	O	O	O
24	conduct actions on contact?	O	O	O	O	O

How well did your squad …		Poor	Fair	Good	Well	Very Well
25	maneuver under enemy fire?	O	O	O	O	O
26	coordinate direct fires against the enemy?	O	O	O	O	O
27	move tactically in the following formations:	O	O	O	O	O
27a	travelling?	O	O	O	O	O
27b	travelling overwatch?	O	O	O	O	O
27c	bounding overwatch?	O	O	O	O	O
28	use available cover to manuever against the enemy?	O	O	O	O	O
29	use available concealment to manuever against the enemy?	O	O	O	O	O
30	scan, detect and identify the enemy?	O	O	O	O	O
31	conduct actions on contact?	O	O	O	O	O

		Poor	Fair	Good	Well	Very Well
32	How well did the training you received in the previous weeks prepare you to command and control a squad?	O	O	O	O	O

		Yes	No	
33	Did you feel you needed more training prior to the Live Fire Exercise?	O	O	If "No", proceed to #37

34 If "yes", how much more training (in hours)? _____

		Classroom	Sand Table	Garrison Rehearsal	Simulation	other
35	If field training is not possible, rank the following choices for alternate training (1 = first and 5 = last).	_____	_____	_____	_____	
	Other (training type and its rank): _____					_____

36 Explain your #1 and #2 ranking for #43. _____

		Poor	Fair	Good	Well	Very Well
37	How well did the training you received in the previous weeks prepare you to assess the situation when in contact?	O	O	O	O	O

	What effect did the simulation training have on …	Very Negative	Negative	No Effect	Positive	Very Well
38	your performance?	O	O	O	O	O
39	your ability to assess the situation when in contact?	O	O	O	O	O
40	your ability to maneuver under enemy fire as a member of a squad?:	O	O	O	O	O
	your ability to communicating and receive tactical movement orders under fire…					
41	to your battle buddy?	O	O	O	O	O
42	to your fire team?	O	O	O	O	O
43	to your squad?	O	O	O	O	O
44	your ability to use available cover to maneuver against the enemy?	O	O	O	O	O
45	your ability to use available concealment to maneuver against the enemy?	O	O	O	O	O
46	your ability to scan, detect and identify the enemy?	O	O	O	O	O
47	your understanding of squad manuevers?	O	O	O	O	O
48	your squad's performance?	O	O	O	O	O
49	your squad's ability to communicate information?	O	O	O	O	O
50	your squad's ability to control direct fires?	O	O	O	O	O
51	your squad's ability to maneuever under fire?	O	O	O	O	O

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APPENDIX C. FM 7-8 REACT TO CONTACT BATTLE DRILL

TASK: React to Contact (Platoon/Squad) (07-3-D9103)

CONDITIONS: The platoon/squad is halted or moving. The enemy initiates fires on the platoon/squad with an individual or crew-served weapon.

STANDARDS: The unit returns fire immediately. The unit locates and engages the enemy with well-aimed fire and causes at least one enemy casualty. The leader can point out at least one-half of the enemy positions and identify the types of weapons (such as small-arms, light machine gun).

SUPPORTING INDIVIDUAL TASKS: See also Appendix A, "Individual Task-to-Drill Matrix."

References	Task Number	Task Title
STP 21-1-SMCT	071-311-2007	EngageTargets with an M16A1 or M16A2 Rifle
	071-311-2027	Load an M16A1 or M16A2 Rifle
	071-311-2029	Correct Malfunctions of an M16A1 or M16A2 Rifle
	071-311-2127	Load an M203 Grenade Launcher
	071-311-2129	Correct Malfunctions of an M203 Grenade Launcher
	071-311-2130	Engage Targets with an M203 Grenade Launcher
	071-312-3029	Correct Malfunctions of an M60 Machine Gun
	071-312-3031	Engage Targets with an M60 Machine Gun
	071-325-4407	Employ Hand Grenades
	071-326-0502	Move Under Direct Fire
	071-326-0503	Move Over, Through, or Around Obstacles (Except Minefields)
	071-326-0511	React to Flares
	071-326-0513	Select Temporary Fighting Positions
	181-906-1505	Conduct Combat Operations According to the Law of War
	181-906-1505-A	Conduct Combat Operations According to the Law of War
STP 7-11BC1-SM-TG	071-052-0006	Engage Targets with an M47 Medium Antitank Weapon
	071-054-0004	Engage Targets with an M136 Launcher
	071-312-4027	Load an M249 Machine Gun
	071-326-0501	Move as a Member of a Fire Team
STP 7-11BC24-SM-TG	071-052-0006	Engage Targets with an M47 Medium Antitank Weapon
	071-054-0004	Engage Targets with an M136 Launcher
	071-312-4027	Load an M249 Machine Gun
	071-326-0501	Move as a Member of a Fire Team
	071-326-5611	Conduct the Maneuver of a Squad
	071-326-5630	Conduct Movement Techniques by a Platoon
	071-420-0005	Conduct the Maneuver of a Platoon
STP 7-11BCHM1-SM	071-052-0006	Engage Targets with an M47 Medium Antitank Weapon

References	Task Number	Task Title
	071-054-0004	Engage Targets with an M136 Launcher
	071-312-4027	Load an M249 Machine Gun
	071-326-0501	Move as a Member of a Fire Team
STP 7-11BCHM24-SM-TG	071-326-5611	Conduct the Maneuver of a Squad
	071-326-5630	Conduct Movement Techniques by a Platoon
	071-420-0005	Conduct the Maneuver of a Platoon

ILLUSTRATIONS: N/A

TASK STEPS AND PERFORMANCE MEASURES:

1. Soldiers immediately assume the nearest covered positions.
2. Soldiers return fire immediately on reaching the covered positions.
3. Squad/team leaders locate and engage known or suspected enemy positions with well-aimed fire, and pass information to the platoon/squad leader.
4. Fire team leaders control the fire of their soldiers by using standard fire commands (initial and supplemental) containing the following elements:
   a. Alert.
   b. Direction.
   c. Description.
   d. Range.
   e. Method of fire (manipulation and rate of fire).
   f. Command to commence firing.
5. Soldiers maintain contact (visual or oral) with the soldiers on their left or right.
6. Soldiers maintain contact with the team leader and indicate the location of the enemy positions.
7. The leaders (visually or orally) check the status of their personnel.
8. The squad/fire team leaders maintain visual contact with the platoon/squad leader.
9. The platoon/squad leader moves up to the squad/fire team in contact and links up with its leader.
   a. The platoon leader brings his RATELO, platoon FO, the squad leader of the nearest squad, and one machine gun team.
   b. The squad leader of the trail squad moves to the front of his lead fire team.
   c. The platoon sergeant moves forward with the second machine gun team and links up with the platoon leader, ready to assume control of the base-of-fire element.
10. The platoon/squad leader determines whether or not his unit must move out of the engagement area.
11. The platoon/squad leader determines whether or not his unit can gain and maintain suppressive fires with the element already in contact (based on the volume and accuracy of enemy fires against the element in contact).

TASK STEPS AND PERFORMANCE MEASURES:

12. The platoon/squad leader makes an assessment of the situation. He identifies--
    a. The location of the enemy position and obstacles.
    b. The size of the enemy force engaging the unit in contact. (The number of enemy automatic weapons, the presence of any vehicles, and the employment of indirect fires are indicators of enemy strength.)
    c. Vulnerable flanks.
    d. Covered and concealed flanking routes to the enemy positions.
13. The platoon/squad leader determines the next course of action (for example, fire and movement, assault, breach, knock out bunker, enter and clear a building or trench).
14. The platoon/squad leader reports the situation to the company commander/platoon leader and begins to maneuver the unit.
15. The platoon leader calls for and adjusts indirect fire (mortars or artillery). (squad leaders relay request through the platoon leader.)
16. Leaders relay all commands and signals from the platoon chain of command.
17. The platoon sergeant positions the BFVs to observe and to provide supporting fires.

NOTE: Once the platoon has executed the React to Contact Drill, the platoon leader makes a quick assessment of the situation (for example, enemy size, location). He decides on a course of action. The platoon leader reports the situation to the company commander.

SUPPORTED T&EO'S

ARTEP NUMBER	T&EO NUMBER	T&EO TASK TITLE
ARTEP 7-10-MTP	07-2-1045	Conduct a Defense (Infantry Company)
	07-2-1081	Conduct a Link-up (Infantry Company)
	07-2-1090	Conduct a Movement to Contact (Antiarmor/Infantry Company)
	07-2-1135	Conduct a Raid (Infantry Company)
	07-2-1270	Conduct an Infiltration or Exfiltration (Infantry Company)
	07-2-1279	Conduct Convoy Escort (Antiarmor/Infantry Company)
	07-2-1315	Conduct Patrol Operations (Infantry Company)
	07-2-1342	Conduct Tactical Movement (Infantry Company)
	07-2-1369	Cross a Water Obstacle (Dismounted) (Infantry Company)
	07-2-1468	Take Action on Contact (Infantry Company)
	07-2-1477	Breach an Obstacle (Infantry Company)
	07-2-1486	Conduct Operations with Armored or Mechanized Infantry Vehicles in an Urban Environment (Infantry Company)
	07-2-2009	Conduct a Route Reconnaissance (Infantry Company)
	07-2-2027	Establish Observation Posts (Infantry Company)
ARTEP 7-12-MTP	07-2-1045	Conduct a Defense (Infantry Company)
	07-2-1081	Conduct a Link-up (Infantry Company)
	07-2-1090	Conduct a Movement to Contact (Antiarmor/Infantry Company)
	07-2-1135	Conduct a Raid (Infantry Company)
	07-2-1270	Conduct an Infiltration or Exfiltration (Infantry Company)
	07-2-1279	Conduct Convoy Escort (Antiarmor/Infantry Company)
	07-2-1315	Conduct Patrol Operations (Infantry Company)
	07-2-1342	Conduct Tactical Movement (Infantry Company)
	07-2-1369	Cross a Water Obstacle (Dismounted) (Infantry Company)

SUPPORTED T&EO'S

ARTEP NUMBER	T&EO NUMBER	T&EO TASK TITLE
	07-2-1468	Take Action on Contact (Infantry Company)
	07-2-1477	Breach an Obstacle (Infantry Company)
	07-2-1486	Conduct Operations with Armored or Mechanized Infantry Vehicles in an Urban Environment (Infantry Company)
	07-2-2009	Conduct a Route Reconnaissance (Infantry Company)
	07-2-2027	Establish Observation Posts (Infantry Company)
ARTEP 7-4-MTP	07-3-1081	Conduct a Link-up (Infantry/Mortar/Reconnaissance Platoon/Squad)
	07-3-1090	Conduct a Movement to Contact (Infantry/Reconnaissance Platoon/Squad)
	07-3-1144	Conduct a Screen (Infantry/Reconnaissance Platoon/Squad)
	07-3-1153	Conduct a Security Patrol (Infantry/Reconnaissance Platoon/Squad)
	07-3-1189	Conduct Actions at Danger Areas (Infantry/Reconnaissance Platoon)
	07-3-1216	Conduct an Infiltration or Exfiltration (Infantry/Reconnaissance Platoon/Squad)
	07-3-1270	Conduct Tactical Movement (Mounted or Dismounted) (Antiarmor/Infantry/Mortar/Reconnaissance Platoon/Squad)
	07-3-1288	Cross a Water Obstacle (Dismounted) (Infantry/Reconnaissance Platoon/Squad)
	07-3-1432	Take Action on Contact (Infantry/Mortar/Reconnaissance Platoon/Squad)
	07-3-2000	Conduct a Route Reconnaissance (Infantry/Reconnaissance Platoon/Squad)
ARTEP 7-5-MTP	07-3-1027	Breach an Obstacle (Infantry Platoon/Squad)
	07-3-1054	Conduct a Defense (Infantry Platoon/Squad)
	07-3-1081	Conduct a Link-up (Infantry/Mortar/Reconnaissance Platoon/Squad)
	07-3-1090	Conduct a Movement to Contact (Infantry/Reconnaissance Platoon/Squad)
	07-3-1126	Conduct a Raid (Infantry Platoon/Squad)
	07-3-1144	Conduct a Screen (Infantry/Reconnaissance Platoon/Squad)
	07-3-1153	Conduct a Security Patrol (Infantry/Reconnaissance Platoon/Squad)
	07-3-1189	Conduct Actions at Danger Areas (Infantry/Reconnaissance Platoon)
	07-3-1216	Conduct an Infiltration or Exfiltration (Infantry/Reconnaissance Platoon/Squad)
	07-3-1225	Conduct Convoy Escort (Infantry Platoon/Squad)
	07-3-1243	Conduct Operations with Armored or Mechanized Vehicles in an Urban Environment (Infantry Platoon/Squad)
	07-3-1270	Conduct Tactical Movement (Mounted or Dismounted) (Antiarmor/Infantry/Mortar/Reconnaissance Platoon/Squad)
	07-3-1288	Cross a Water Obstacle (Dismounted) (Infantry/Reconnaissance Platoon/Squad)
	07-3-1432	Take Action on Contact (Infantry/Mortar/Reconnaissance Platoon/Squad)
	07-3-2000	Conduct a Route Reconnaissance (Infantry/Reconnaissance Platoon/Squad)
ARTEP 7-7J-MTP	07-3-1027	Breach an Obstacle (Infantry Platoon/Squad)
	07-3-1054	Conduct a Defense (Infantry Platoon/Squad)
	07-3-1081	Conduct a Link-up (Infantry/Mortar/Reconnaissance Platoon/Squad)
	07-3-1090	Conduct a Movement to Contact (Infantry/Reconnaissance Platoon/Squad)
	07-3-1126	Conduct a Raid (Infantry Platoon/Squad)
	07-3-1144	Conduct a Screen (Infantry/Reconnaissance Platoon/Squad)
	07-3-1153	Conduct a Security Patrol (Infantry/Reconnaissance Platoon/Squad)
	07-3-1189	Conduct Actions at Danger Areas (Infantry/Reconnaissance Platoon)
	07-3-1216	Conduct an Infiltration or Exfiltration (Infantry/Reconnaissance Platoon/Squad)
	07-3-1225	Conduct Convoy Escort (Infantry Platoon/Squad)
	07-3-1243	Conduct Operations with Armored or Mechanized Vehicles in an Urban Environment (Infantry Platoon/Squad)
	07-3-1270	Conduct Tactical Movement (Mounted or Dismounted) (Antiarmor/Infantry/Mortar/Reconnaissance Platoon/Squad)
	07-3-1288	Cross a Water Obstacle (Dismounted) (Infantry/Reconnaissance Platoon/Squad)

SUPPORTED T&EO'S

ARTEP NUMBER	T&EO NUMBER	T&EO TASK TITLE
	07-3-1432	Take Action on Contact (Infantry/Mortar/Reconnaissance Platoon/Squad)
	07-3-2000	Conduct a Route Reconnaissance (Infantry/Reconnaissance Platoon/Squad)
ARTEP 7-8-MTP	07-3-1027	Breach an Obstacle (Infantry Platoon/Squad)
	07-3-1054	Conduct a Defense (Infantry Platoon/Squad)
	07-3-1081	Conduct a Link-up (Infantry/Mortar/Reconnaissance Platoon/Squad)
	07-3-1090	Conduct a Movement to Contact (Infantry/Reconnaissance Platoon/Squad)
	07-3-1126	Conduct a Raid (Infantry Platoon/Squad)
	07-3-1144	Conduct a Screen (Infantry/Reconnaissance Platoon/Squad)
	07-3-1153	Conduct a Security Patrol (Infantry/Reconnaissance Platoon/Squad)
	07-3-1171	Conduct a Tactical Road March (Dismounted) (Infantry/Reconnaissance Platoon/Squad)
	07-3-1189	Conduct Actions at Danger Areas (Infantry/Reconnaissance Platoon)
	07-3-1216	Conduct an Infiltration or Exfiltration (Infantry/Reconnaissance Platoon/Squad)
	07-3-1243	Conduct Operations with Armored or Mechanized Vehicles in an Urban Environment (Infantry Platoon/Squad)
	07-3-1270	Conduct Tactical Movement (Mounted or Dismounted) (Antiarmor/Infantry/Mortar/Reconnaissance Platoon/Squad)
	07-3-1288	Cross a Water Obstacle (Dismounted) (Infantry/Reconnaissance Platoon/Squad)
	07-3-1432	Take Action on Contact (Infantry/Mortar/Reconnaissance Platoon/Squad)
	07-3-2000	Conduct a Route Reconnaissance (Infantry/Reconnaissance Platoon/Squad)
ARTEP 7-90-MTP	07-3-1081	Conduct a Link-up (Infantry/Mortar/Reconnaissance Platoon/Squad)
	07-3-1270	Conduct Tactical Movement (Mounted or Dismounted) (Antiarmor/Infantry/Mortar/Reconnaissance Platoon/Squad)
	07-3-1432	Take Action on Contact (Infantry/Mortar/Reconnaissance Platoon/Squad)
ARTEP 7-91-MTP	07-2-1036	Conduct a Defense (Antiarmor Company/Platoon)
	07-2-1090	Conduct a Movement to Contact (Antiarmor/Infantry Company)
	07-2-1279	Conduct Convoy Escort (Antiarmor/Infantry Company)
	07-2-1459	Take Action on Contact (Antiarmor Company/Platoon)
	07-3-1270	Conduct Tactical Movement (Mounted or Dismounted) (Antiarmor/Infantry/Mortar/Reconnaissance Platoon/Squad)
ARTEP 7-92-MTP	07-3-1081	Conduct a Link-up (Infantry/Mortar/Reconnaissance Platoon/Squad)
	07-3-1090	Conduct a Movement to Contact (Infantry/Reconnaissance Platoon/Squad)
	07-3-1144	Conduct a Screen (Infantry/Reconnaissance Platoon/Squad)
	07-3-1153	Conduct a Security Patrol (Infantry/Reconnaissance Platoon/Squad)
	07-3-1171	Conduct a Tactical Road March (Dismounted) (Infantry/Reconnaissance Platoon/Squad)
	07-3-1189	Conduct Actions at Danger Areas (Infantry/Reconnaissance Platoon)
	07-3-1216	Conduct an Infiltration or Exfiltration (Infantry/Reconnaissance Platoon/Squad)
	07-3-1270	Conduct Tactical Movement (Mounted or Dismounted) (Antiarmor/Infantry/Mortar/Reconnaissance Platoon/Squad)
	07-3-1288	Cross a Water Obstacle (Dismounted) (Infantry/Reconnaissance Platoon/Squad)
	07-3-1432	Take Action on Contact (Infantry/Mortar/Reconnaissance Platoon/Squad)
	07-3-2000	Conduct a Route Reconnaissance (Infantry/Reconnaissance Platoon/Squad)
ARTEP 7-93-MTP	07-5-1001	Conduct Surveillance (LRS Team)
	07-5-1002	Reconnoiter Area (LRS)
	07-5-1003	Reconnoiter Zone (LRS)
	07-5-1004	Assess Damage
	07-5-1101	Conduct Airborne Insertion
	07-5-1102	Conduct Helicopter Insertion/Extraction
	07-5-1103	Conduct Ground Infiltration/Exfiltration
	07-5-1107	Move Tactically (LRS)

SUPPORTED T&EO'S

ARTEP NUMBER	T&EO NUMBER	T&EO TASK TITLE
	07-5-1108	Cross Danger Area
	07-5-1109	Cross Water Obstacle (LRS)
	07-5-1110	Establish Hide Site
	07-5-1111	Establish Surveillance Site
	07-5-1112	Conduct Linkup (LRS Team)
	07-5-1115	Establish a Patrol Base
	07-5-1201	Acquire a Target
	07-5-1401	Evade and Recover
	07-5-1406	React to Indirect Fire (LRS)
	07-5-1502	Establish/Recover a Cache
	07-5-1605	Consolidate and Reorganize (LRS)

APPENDIX D. INSTITUTIONAL REVIEW BOARD DOCUMENTS

A. MEMORANDUM REQUESTING IRB APPROVAL

Jason M. Jones, Major, U.S. Army **831-656-3067**
Joseph M. Nolan, Major, U.S. Army **jmjones@nps.edu**
Naval Postgraduate School **jmnolan@nps.edu**
Monterey, California 93943

To: Protection of Human Subjects Committee

Subject: Application for Human Subjects Review for Games for Training: Examining the Use of Multiplayer, First-Person Perspective Commercial Games to Train Infantry Squads

1. Attached is a set of documents outlining a proposed experiment to be conducted over the next eight months for our thesis project.

2. We are requesting approval of the described experimental protocol. An experimental outline is included for your reference that describes the methods and measures we plan to use.

3. We include the consent forms, privacy act statements, all materials and forms that a subject will read or fill-out, and the debriefing forms (if applicable) we will be using in the experiment.

4. We understand that any modifications to the protocol or instruments/measures will require submission of updated IRB paperwork and possible re-review. Similarly, we understand that any untoward event or injury that involves a research participant will be reported immediately to the IRB Chair and NPS Dean of Research.

Jason M. Jones Joseph M. Nolan

B. APPLICATION FOR IRB APPROVAL

APPLICATION FOR HUMAN SUBJECTS REVIEW (HSR)	HSR NUMBER *(to be assigned)*
PRINCIPAL INVESTIGATOR(S) *(Full Name, Code, Telephone)* Jason M. Jones, MAJ, U.S. Army, (831) 277-9582 Joseph M. Nolan, MAJ, U.S. Army, (831) 901-5462	
APPROVAL REQUESTED [X] New [ ] Renewal	
LEVEL OF RISK [ ] Exempt [X] Minimal [ ] More than Minimal Justification:	
WORK WILL BE DONE IN (Site/Bldg/Rm) Classroom XXI, Fort Benning, GA	ESTIMATED NUMBER OF DAYS TO COMPLETE 10 Days
MAXIMUM NUMBER OF SUBJECTS 40 Subjects	ESTIMATED LENGTH OF EACH SUBJECT'S PARTICIPATION 12 Hours
SPECIAL POPULATIONS THAT WILL BE USED AS SUBJECTS [ ] Subordinates [ ] Minors [ ] NPS Students [ ] Special Needs (e.g. Pregnant women) Specify safeguards to avoid undue influence and protect subject's rights:	
OUTSIDE COOPERATING INVESTIGATORS AND AGENCIES U.S. Infantry Officer Basic Course, Fort Benning, GA 31905 [ ] A copy of the cooperating institution's HSR decision is attached.	
TITLE OF EXPERIMENT AND DESCRIPTION OF RESEARCH (attach additional sheet if needed). Games for Training: Examining the Use of Multiplayer, First-Person Perspective Commercial Games to Train Infantry Squads. Using squads of students from the Infantry Officer Basic Course we will measure the effectiveness of using networked games to train dismounted tactics.	
I have read and understand NPS Notice on the Protection of Human Subjects. If there are any changes in any of the above information or any changes to the attached Protocol, Consent Form, or Debriefing Statement, I will suspend the experiment until I obtain new Committee approval. SIGNATURE_____ DATE_____	

C. PARTICIPANT CONSENT FORM

1. **Introduction.** You are invited to participate in a study on the use of commercially available simulations to train dismounted tactics at the squad level. With information gathered from you and other participants, we want to see how effective training in the virtual environment is compared to traditional instruction. We ask you to read and sign this form indicating that you agree to be in the study. Please ask any questions you may have before signing.

2. **Background Information.** We are conducting this study as part of our master's degree thesis at the Naval Postgraduate School.

3. **Procedures.** If you agree to participate in this study, the researcher will explain the tasks in detail. There will be two sessions: 1) simulation familiarization phase and 2) mission execution phase. Each will last approximately five hours. During these phases you will execute individual and squad actions at a computer work station.

4. **Risks and Benefits**. This research involves no risks or discomforts greater then those encountered when using a computer keyboard and mouse. The benefits to the participants are improving your knowledge of tactics, techniques and procedures for tactical operations and contributing to research on the effectiveness of training techniques.

5. **Compensation.** No tangible reward will be given. A copy of the results will be available to you at the conclusion of the experiment.

6. **Confidentiality.** The records of this study will be kept confidential. No information will be publicly accessible which could identify you as a participant.

7. **Voluntary Nature of the Study.** If you agree to participate, you are free to withdraw from the study at any time without prejudice. You will be provided a copy of this form for your records.

8. **Points of Contact.** If you have any further questions or comments after the completion of the study, you may contact the research supervisor, Dr. Rudolph P. Darken (831) 656-4072 darken@nps.navy.mil.

9. **Statement of Consent.** I have read the above information. I have asked all questions and have had my questions answered. I agree to participate in this study.

---------- ----------
Participant's Signature Date

---------- ----------
Researcher's Signature Date

D. MINIMAL RISK CONSENT STATEMENT

MINIMAL RISK CONSENT STATEMENT
NAVAL POSTGRADUATE SCHOOL, MONTEREY, CA 93943

Participant: VOLUNTARY CONSENT TO BE A RESEARCH PARTICIPANT IN: Games for Training: Examining the Use of Multiplayer, First-Person Perspective Commercial Games to Train Infantry Squads

1. I have read, understand and been provided "Information for Participants" that provides the details of the below acknowledgments.

2. I understand that this project involves research. An explanation of the purposes of the research, a description of procedures to be used, identification of experimental procedures, and the extended duration of my participation have been provided to me.

3. I understand that this project does not involve more than minimal risk. I have been informed of any reasonably foreseeable risks or discomforts to me.

4. I have been informed of any benefits to me or to others that may reasonably be expected from the research.

5. I have signed a statement describing the extent to which confidentiality of records identifying me will be maintained.

6. I have been informed of any compensation and/or medical treatments available if injury occurs and is so, what they consist of, or where further information may be obtained.

7. I understand that my participation in this project is voluntary, refusal to participate will involve no penalty or loss of benefits to which I am otherwise entitled. I also understand that I may discontinue participation at any time without penalty or loss of benefits to which I am otherwise entitled.

8. I understand that the individual to contact should I need answers to pertinent questions about the research is Professor Rudy Darken, Principal Investigator, and about my rights as a research participant or concerning a research related injury is Prof. Jim Eagle, Operations Research Dept. Chairman. A full and responsive discussion of the elements of this project and my consent has taken place. *NPS Medical Monitor:* CAPT Nick Davenport, MC, USN, Flight Surgeon, Naval Postgraduate School (831) 656-7876, nadavenp@nps.navy.mil

_____
Signature of Principal Investigator Date

_____
Signature of Volunteer Date

E. PRIVACY ACT STATEMENT

PRIVACY ACT STATMENT

NAVAL POSTGRADUATE SCHOOL, MONTEREY, CA 93943

PRIVACY ACT STATEMENT

1. Purpose: Data on my opinions, observations and performance will be collected to enhance knowledge, and to develop simulations, procedures, and equipment to improve the development of Virtual Environments.

2. Use: My opinions, observations and performance data will be used for statistical analysis by the Departments of the Navy and Defense, and other U.S. Government agencies, provided this use is compatible with the purpose for which the information was collected. Use of the information may be granted to legitimate non-government agencies or individuals by the Naval Postgraduate School in accordance with the provisions of the Freedom of Information Act.

3. Disclosure/Confidentiality:

   a. I have been assured that my privacy will be safeguarded. I will be assigned a control or code number which thereafter will be the only identifying entry on any of the research records. The Principal Investigator will maintain the cross-reference between name and control number. It will be decoded only when beneficial to me or if some circumstances, which is not apparent at this time, would make it clear that decoding would enhance the value of the research data. In all cases, the provisions of the Privacy Act Statement will be honored.

   b. I understand that a record of the information contained in this Consent Statement or derived from the experiment described herein will be retained permanently at the Naval Postgraduate School or by higher authority. I voluntarily agree to its disclosure to agencies or individuals indicated in paragraph 3 and I have been informed that failure to agree to such disclosure may negate the purpose for which the experiment was conducted.

   c. I also understand that disclosure of the requested information, including my Social Security Number, is voluntary.

_____ Name,

Grade/Rank (if applicable) DOB SSN
[Please print]

_____

Signature of Volunteer Date

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APPENDIX E. EXPERIMENT SET UP USING THE MISSION EDITOR

A. OVERVIEW

This section describes the use of the *Delta Force: Black Hawk Down – Team Sabre*™ MED that is included with this COTS game. The mission editor (MED) is a GUI based tool that allows the user to create robust virtual environments for game play on the *Delta Force: Black Hawk Down – Team Sabre*™ platform. The software includes a MED manual as an Adobe™ Acrobat™ document, and the manual includes a basic tutorial for learning the GUI and creating basic game levels. Although we will defer to the MED for specifics on how to create a game level, we will present screen captured images and basic details for the creation of the eight lanes we created for our experiment. A full copy of the MED manual can be found at the following web site (last accessed September 2005):

http://www.dfbarracks.com/downloads/index.php?action=df&fid=217

B. GAME MISSION AREAS

In the following section, we will provide a brief description of each event area, key events, and any other pertinent data required to recreate this experiment.

1. Mission One Area

The first four missions we created replicated a day time desert environment that covered approximately three square miles of virtual terrain and was based on the current contemporary operating environment. The starting point for the mission was a forward operating base located two miles north of a prominent east-west river and five miles outside a notional local city (Figure 9). The forward operating base included an airplane hangar, maneuver and live fire lanes for subjects to practice movement and weapon coordination, and a UH-60 helicopter for insertion into the objective areas. Additional items included a wooden platform for the group to use when rehearsing entering the helicopter, a truck (programmed to drive to the objective area if the helicopter failed), and other associated models to create a look and feel of the forward operating base (Figure 10).

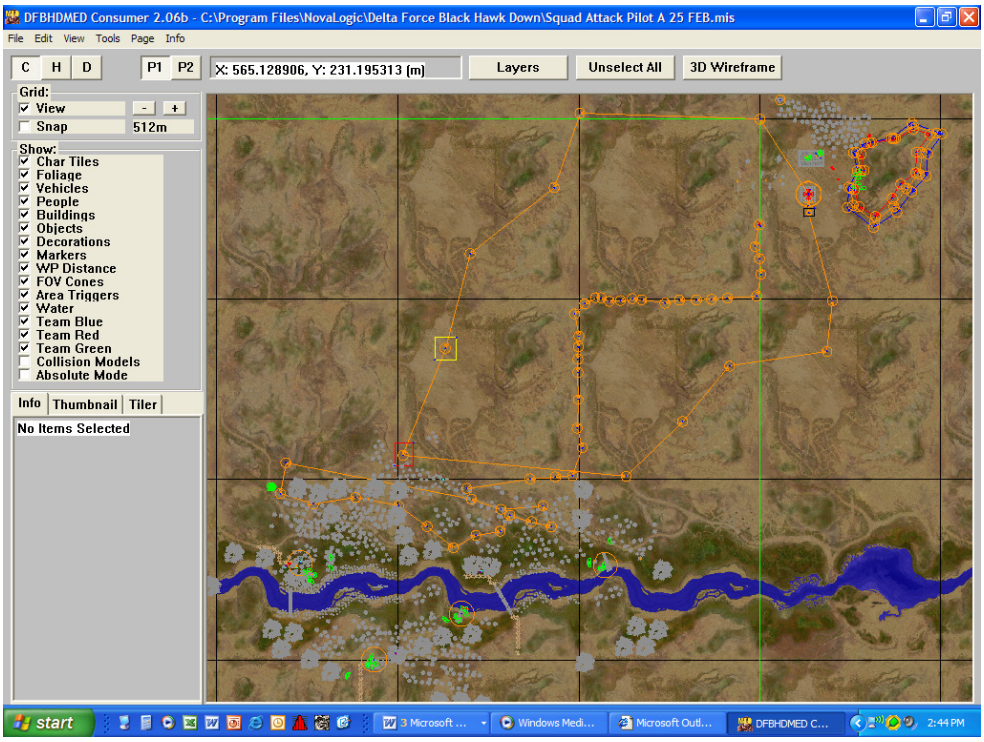

Figure 9. Mission One Area

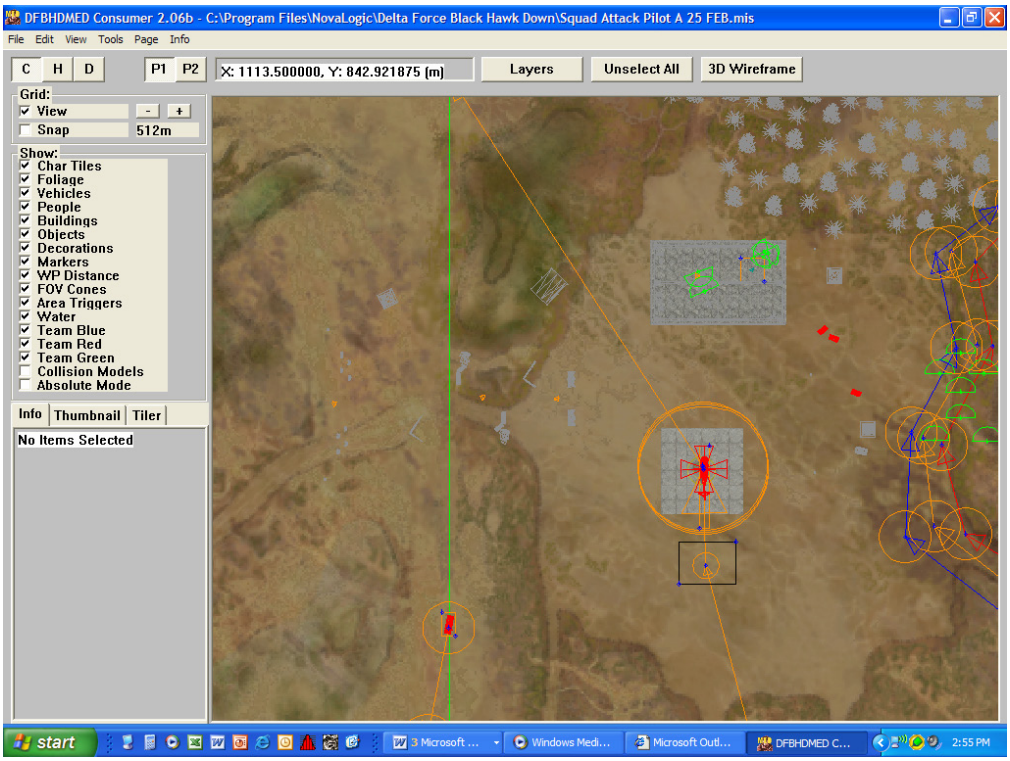

Figure 10. Forward operating Base: Mission One Area

The first objective in the Mission One Area was a radio tower located along the northern edge of the east-west river in sector. Seven enemy personnel were placed on the objective with a combination of AK-47 rifles and rocket propelled grenade (RPG) launchers. The accuracy of the AI for the enemy agents was set to 60%, and all agents engaged from a fixed location (meaning no agents maneuvered against the subjects) (Figure 11). We added a fence line adjacent to the radio tower to replicate a hasty defensive perimeter, and added a truck behind the radio tower to as an enemy escape method. Finally, we added a spawn point on the objective to allow subjects killed during the exercise to quickly link up with their squad, and resupply items for players to refit after seizing the objective.

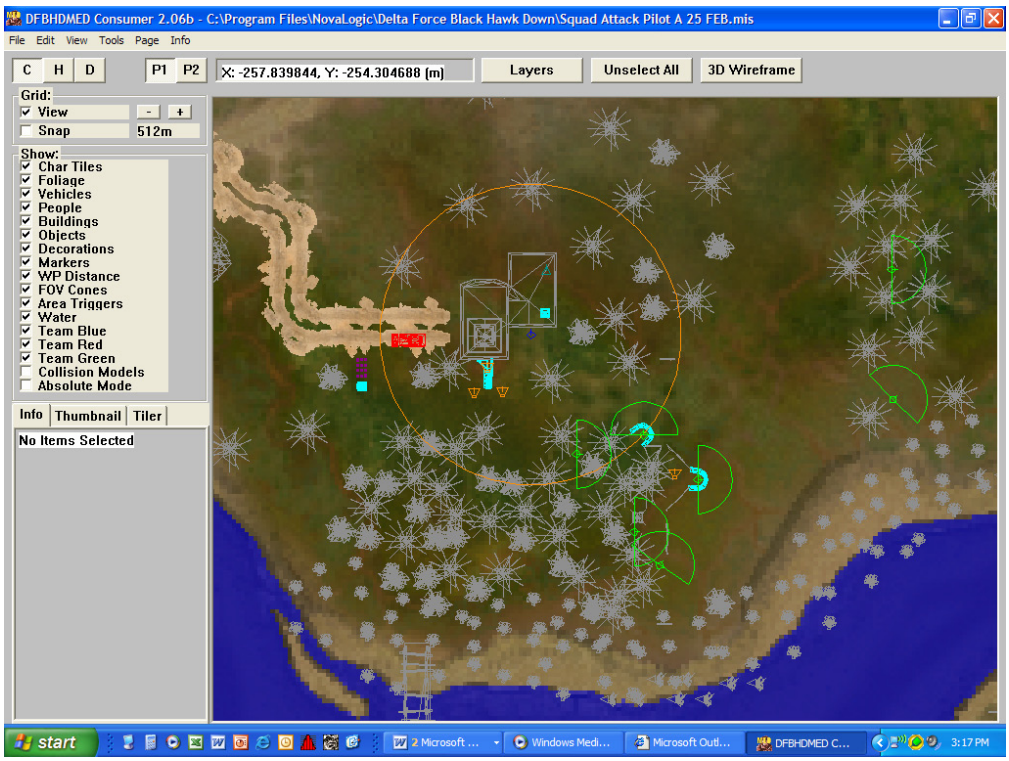

Figure 11. First Objective: Mission One Area

The second objective in the Mission One Area was an oil refinery located along the southern edge of the east-west river in sector. Seven enemy personnel were placed on the objective with a combination of AK-47 rifles and RPG launchers. The accuracy of the AI for the enemy agents was set to 60%, and all agents engaged from a fixed location (Figure 12). We added a bunker on a hill top near the oil pumps to provide overwatch on the objective, and to provide a scenario where our subjects would have to As before, we added a spawn point on the objective to allow subjects killed during the exercise to quickly link up with their squad, and resupply items for players to refit after seizing the objective.

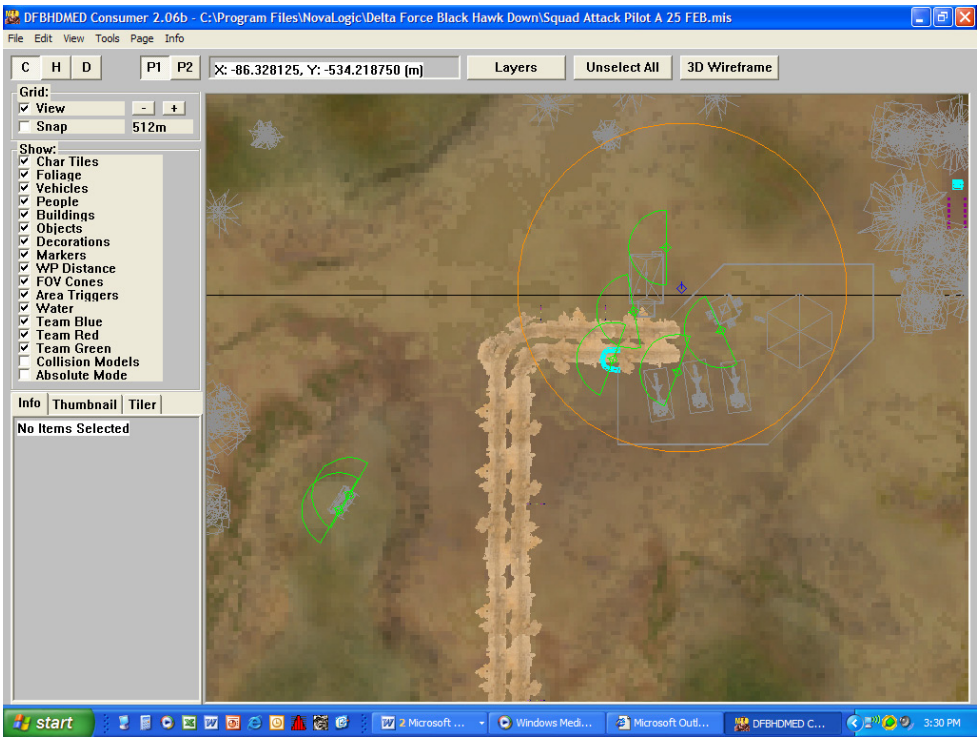

Figure 12. Second Objective: Mission One Area

The third objective in the Mission One Area was an enemy river boat launch site located along the southern edge of the east-west river in sector. Seven enemy personnel were placed on the objective with a combination of AK-47 rifles, .50 caliber machine guns and RPG launchers. The accuracy of the AI for the enemy agents was set to 60%, and all agents engaged from a fixed location (Figure 13). On this objective, three of the agents were placed in a defile (along the river) that forced the maneuvering squad to use grenade and area weapons fire to set conditions for success. On this objective, we placed the spawn point and resupply items on the opposite bank of the river in order to provide an opportunity for the squad to exercise methods for clearing a linear danger area as the unit crossed the river on the adjacent bridge following mission completion.

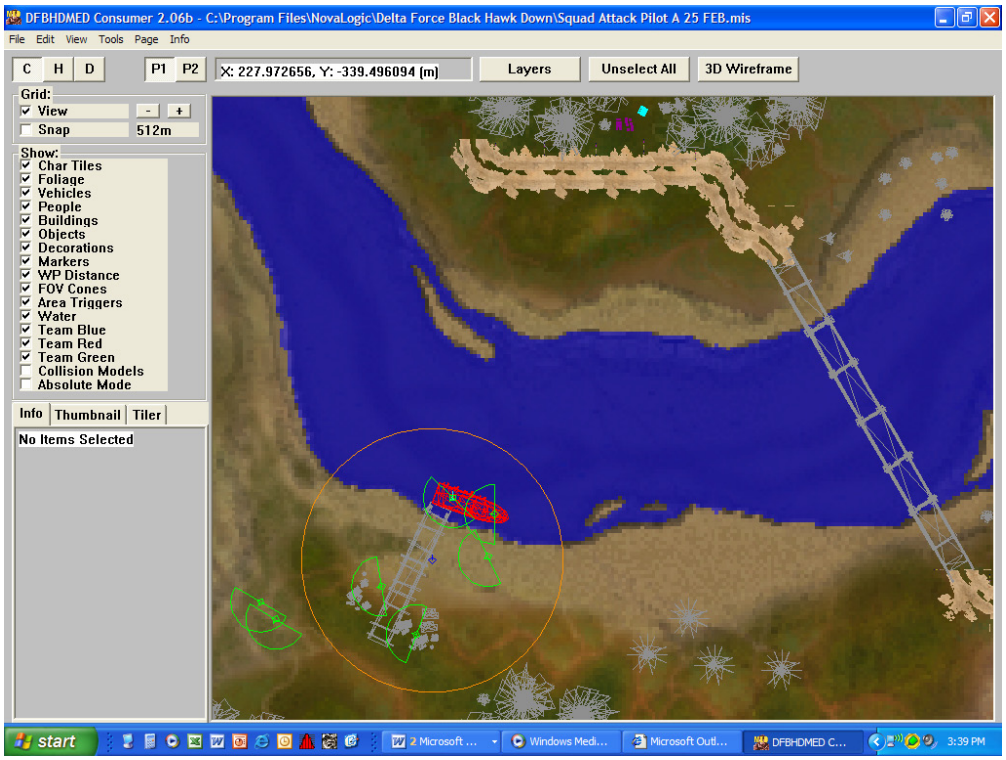

Figure 13. Third Objective: Mission One Area

The forth (and final) objective in the Mission One Area was an enemy river boat launch site with a watchtower manned with a .50 caliber machine gun located along the northern edge of the east-west river in sector. Six enemy personnel were placed on the objective with a combination of AK-47 rifles, RPG launchers as well as the machine gun

position. The accuracy of the AI for the enemy agents was set to 70%, and all agents engaged from a fixed location (Figure 14). On this objective, three of the agents were placed in a defile (along the river) that forced the maneuvering squad to use grenade and area weapons fire to set conditions for success. We placed the tower in the defile so that the top of the tower (with manned machine gun position) crested the ridgeline in order for the enemy agent to have effective grazing fires against the maneuvering squad. Finally, we kept the vegetation near the objective to minimum in order to force the maneuver squad to think creatively about their approach to the site.

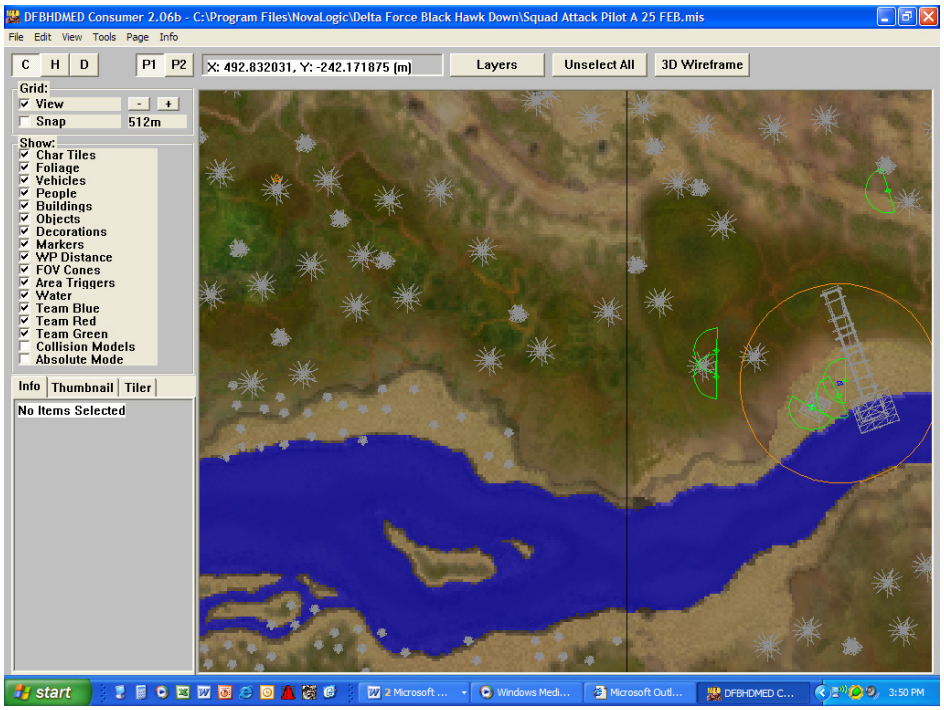

Figure 14. Fourth Objective : Mission One Area

2. Mission Area Two

The next four missions we created replicated a day time ocean coastal environment that covered approximately three square miles of virtual terrain and was based on the current contemporary operating environment. The starting point for the mission was a populated town located approximately two miles north of the objective areas (Figure 15). The town was populated with eleven civilian agents and four friendly Soldier agents to replicate a civil affairs team deployed in support of SASO operations (Figure 16). In the scenario, the residents of the coastal town provided support to the host nation's off shore oil platform. To create this environment, we added boat docks and an off shore refinery that the maneuver squad would fly past during the helicopter insertion into the objective areas. The intent for this environment was to create a sense of operating in a civilian populated area where squad members had to use caution when using lethal force.

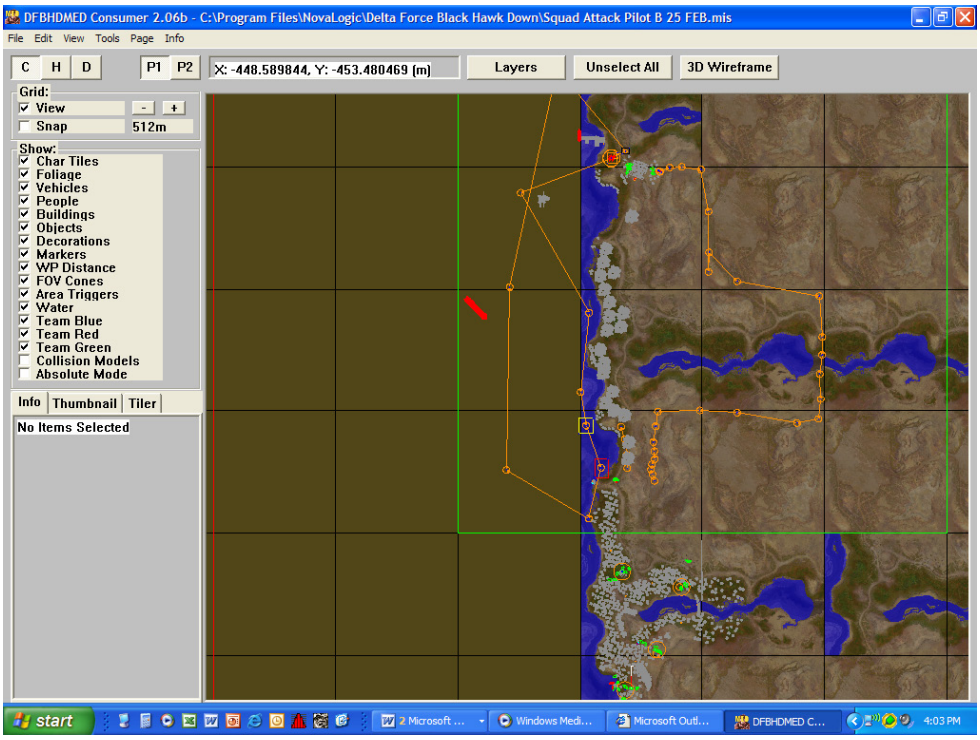

Figure 15. Mission Two Area

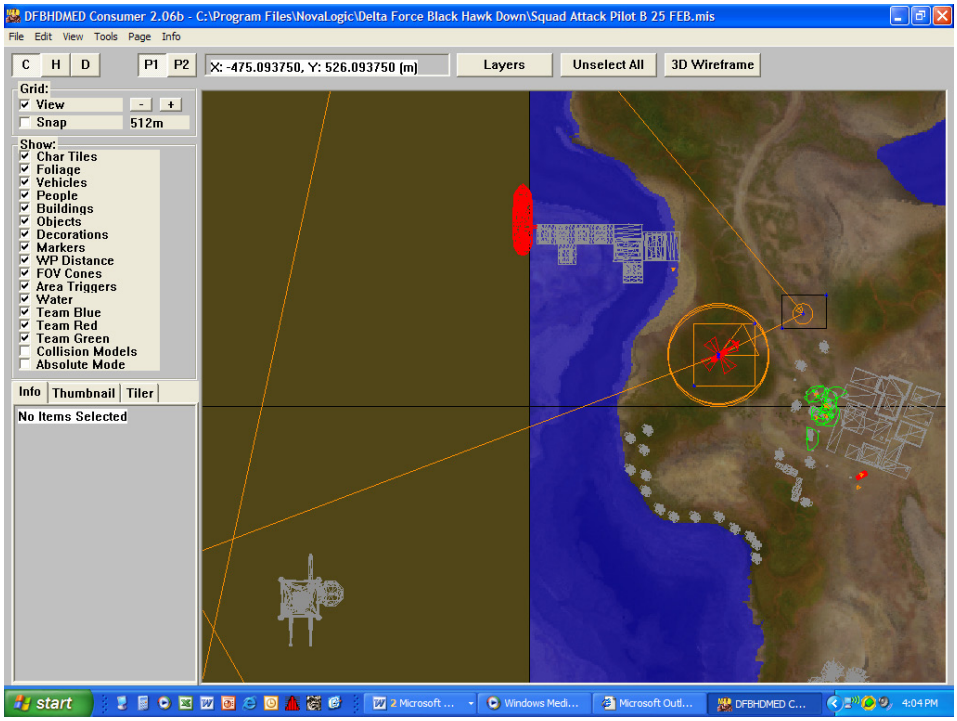

Figure 16. Civilian Town: Mission Two Area

The first objective in the Mission Two Area was a civilian auto repair shop located along the western coast. Six enemy personnel were placed on the objective with a combination of AK-47 rifles, .50 caliber machine guns and RPG launchers. The accuracy of the AI for the enemy agents was set to 75%, and all agents engaged from a fixed location (Figure 17). We added two machine gun positions on this objective with the intent of covering both avenues of approach: the ocean coast and the north-south dirt road. Finally, we added a spawn point and resupply items inside the auto repair garage.

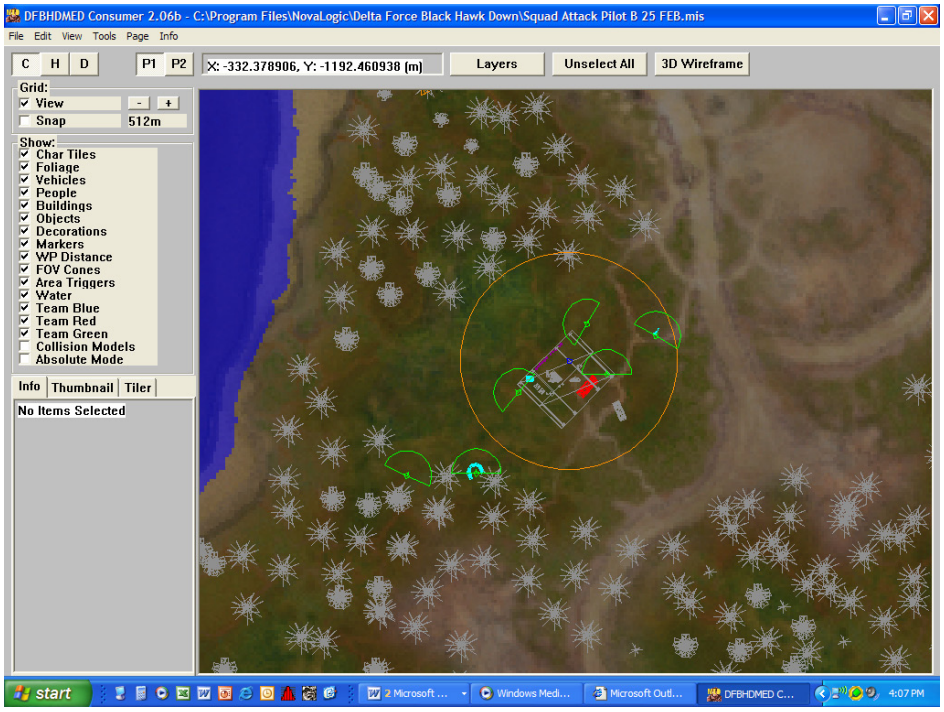

Figure 17. First Objective: Mission Two Area

The second objective in the Mission Two Area was an enemy safe-house located east of the auto repair shop. Seven enemy personnel were placed on the objective with a combination of AK-47 rifles, .50 caliber machine guns and RPG launchers. Three of the seven agents were placed in a counter attack position and were triggered to engage after the squad seized the objective. The counter attack force was placed in this scenario in order to exercise the squad's effectiveness to pull all around security after seizing the objective. The accuracy of the AI for the enemy agents on the objective was set to 75%, and the counter attack force was set to 100% (Figure 18). As before, we placed a spawn point and resupply items near the objective area.

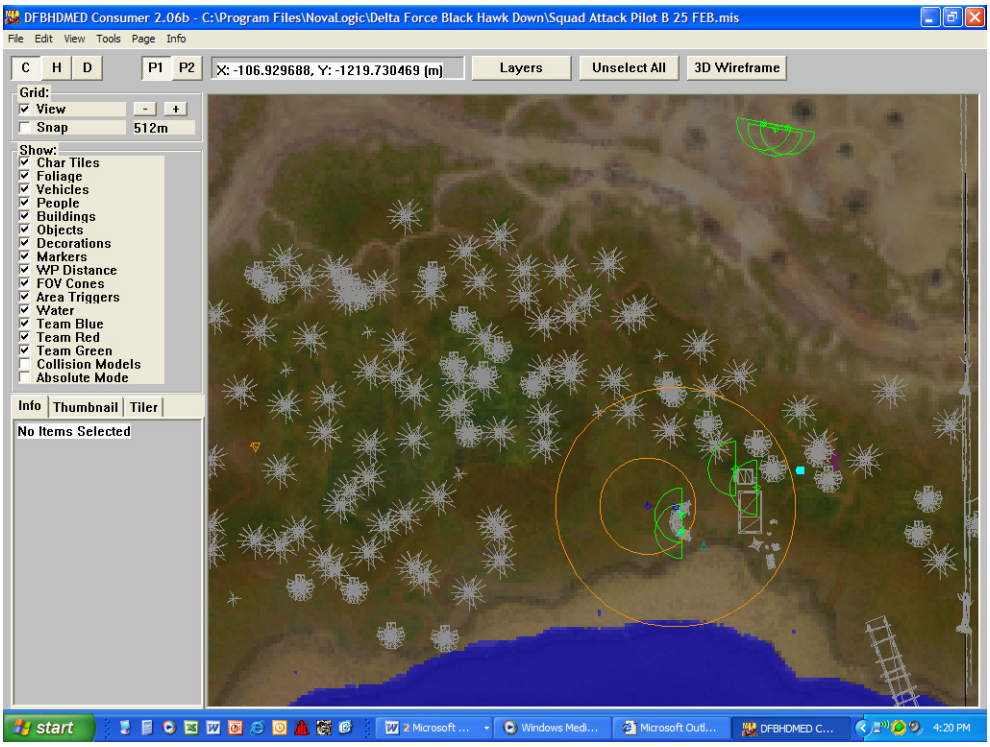

Figure 18. Second Objective: Mission Two Area

The third objective in the Mission Two Area was an enemy vehicle resupply point located south of the safe-house. Seven enemy personnel were placed on the objective with a combination of AK-47 rifles, and RPG launchers. The challenge of this objective was the terrain in which the maneuver squad had to negotiate to attack the enemy. The hill masses forced the squad to visual contact in order to maneuver. By forcing the squad leader to lose visual contact with his base of fire element, we hoped to exercise command and control, as well as communication tasks at all levels. The accuracy of the AI for the enemy agents on the objective was set to 75% (Figure 19). The spawn point and resupply items were placed west of the objective.

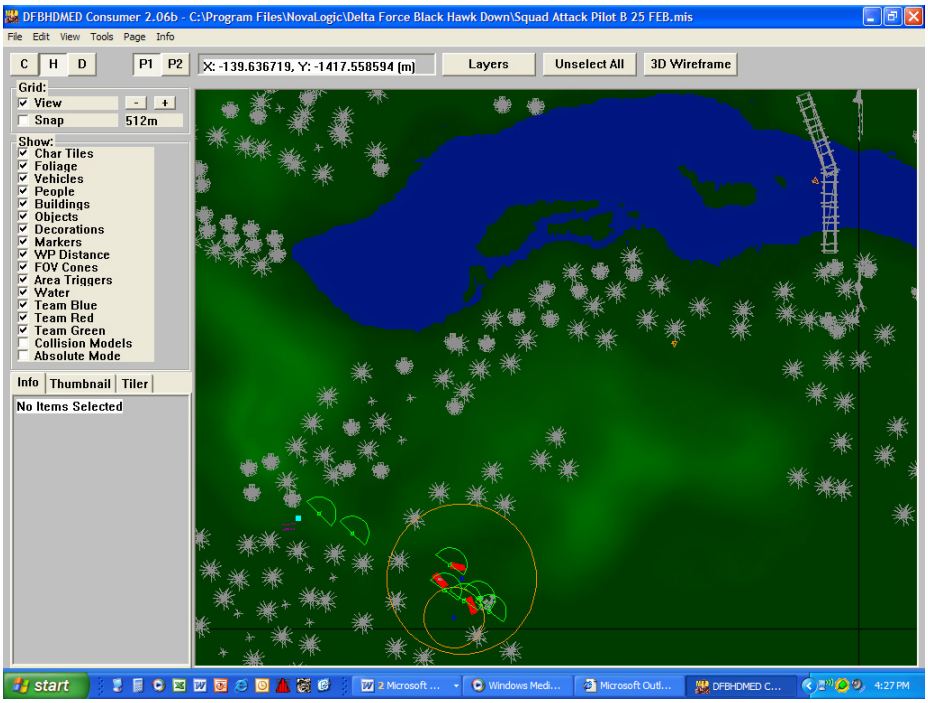

Figure 19. Third Objective: Mission Two Area

The last objective in the Mission Two Area was an enemy river boat launch site located along the western. Nine enemy personnel were placed on the objective with a combination of AK-47 rifles, .50 caliber machine guns and multiple RPG launchers providing overlapping fires of the main avenue of approach. The accuracy of the AI for the enemy agents was set to 80%, and all agents engaged from a fixed location (Figure 20). On this objective, four of the agents were placed in a defile (along the river) that forced the maneuvering squad to use grenades, smoke and area weapons fire to set conditions for success.

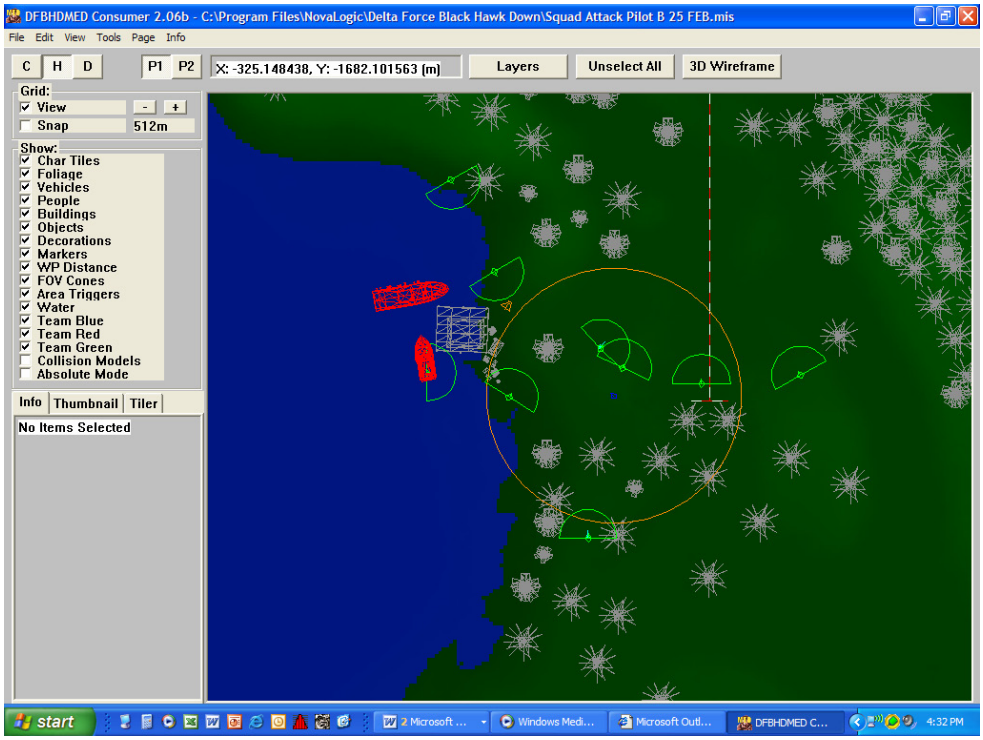

Figure 20. Fourth Objective: Mission Two Area

APPENDIX F. COGNITIVE TASK ANALYSIS

A. OVERVIEW

We conducted this task analysis to identify the human abilities required to conduct the squad "React to Contact" battle drill and map those human abilities to the COTS game *Delta Force: Black Hawk Down – Team Sabre*™ by Novalogic™. For the task analysis, we conducted a small scale experiment executing cooperative missions in multiplayer mode to determine the skill requirements for the COTS game and those of the battle drill. We found that potential training value exists to train infantry collective tasks, but the degree differs between cognitive leader tasks and individual Soldier skills. We determined that the networked COTS game cannot be used to train individual skills, but that the COTS game can be used as a training venue for unit collective training.

B. TASK ANALYSIS OF "REACT TO CONTACT"

In an effort to standardize our task analysis, we used the Occupational Information Network's O*NET Descriptors of human abilities (Occupational Information Network, 2005). Using these descriptors we thoroughly examined each performance measure of the squad "React to Contact" battle drill outlined in ARTEP 7-8 Drill to determine which human abilities were required to accomplish the task. Because our hypothesis concerned using the COTS game as a collective training tool, we selected only those performance measures unique to the collective task and did not focus effort analyzing in detail any individual skills. Nested individual tasks such as "Load, Unload and Reduce Stoppage on an M16A2 Rifle" that support collective tasks are required to be trained prior to conducting any collective training event. By making this assumption, we could feel confident that the trainees would not incur a negative training transfer by conducting tasks in a virtual environment that differed from reality.

Not to discount individual skills entirely, we planned to use a participant survey during our experiment to get feedback from the users to determine the ability of the COTS game to replicate sensory cues required to perform individual skills that we did not address with O*NET Descriptors. Doing so allowed us to focus on cognitive leader performance measures, which are often difficult to train without dedicated resources,

using the O*NET to determine if the required human abilities can be mapped to a COTS game platform. Based on our assessment, we determined the following human abilities required to conduct selected squad "React to Contact" performance measures (Table 24):

Table 24. "React to Contact" Task Analysis using O*NET Descriptors

1. Soldiers immediately assume the nearest covered positions. (Individual Task – Survey)			
2. Soldiers return fire immediately on reaching the covered positions. (Individual Task – Survey)			
3. Squad/team leaders locate and engage known or suspected enemy positions with well-aimed fire, and pass information to the platoon/squad leader.			
• Oral Expression • Indeductive Reasoning • Information Ordering • Flexibility of Closeure	• Visualization • Selective Attention • Rate Control • Arm – Hand Steadiness	• Far Vision • Peripherial Vision • Depth Perception • Hearing Sensitivity	• Sound Localization • Near Vision • Spatial Orientation
4. Fire team leaders control the fire of their soldiers by using standard fire commands (initial and supplemental) containing the following elements:			
4a. Alert.			
• Oral Expression	• Speech Clarity		
4b. Direction.			
• Oral Expression	• Speech Clarity	• Fluency of Ideas	
4c. Description.			
• Oral Expression • Speech Clarity	• Information Ordering • Flexibility of Closure		
4d. Range.			
• Oral Expression • Speech Clarity	• Depth Perception	• Information Ordering	• Spatial Orientation
4e. Method of fire (manipulation and rate of fire).			
• Oral Expression	• Rate Control	• Speech Clarity	
4f. Command to commence firing			
• Oral Expression	• Speech Clarity		
5. Soldiers maintain contact (visual or oral) with the soldiers on their left or right. (Individual Task – Survey)			
6. Soldiers maintain contact with the team leader and indicate the location of the enemy positions. (Individual Task – Survey)			
7. The leaders (visually or orally) check the status of their personnel.			
• Oral Expression • Speech Clarity	• Information Ordering • Depth Perception	• Spatial Orientation • Inductive Reasoning	• Category Flexibility
8. The squad/fire team leaders maintain visual contact with the platoon/squad leader.			
• Spatial Orientation • Visualization • Selective Attention	• Near Vision • Far Vision • Peripherial Vision	• Depth Perception • Hearing Sensitivity	• Sound Localization
9. The platoon/squad leader moves up to the squad/fire team in contact and links up with its leader. (Not Evaluated)			
9a. The platoon leader brings his RATELO, platoon FO, the squad leader of the nearest squad, and one machine gun team.			
9b. The squad leader of the trail squad moves to the front of his lead fire team.			
9c. The platoon sergeant moves forward with the second machine gun team and links up with the platoon leader, ready to assume control of the base-of-fire element.			
10. The platoon/squad leader determines whether or not his unit must move out of the engagement area.			
• Indeductive Reasoning	• Visualization	• Depth Perception	• Spatial Orientation
• Information Ordering	• Selective Attention	• Hearing Sensitivity	• Peripherial Vision
11. The platoon/squad leader determines whether or not his unit can gain and maintain suppressive fires with the element already in contact (based on the volume and accuracy of enemy fires against the element in contact).			
• Indeductive Reasoning	• Spatial Orientation	• Far Vision	• Sound Localization
• Information Ordering	• Visualization	• Peripherial Vision	• Hearing Sensitivity
• Category Flexibility	• Selective Attention	• Depth Perception	• Near Vision
• Flexibility of Closeure			
12. The platoon/squad leader makes an assessment of the situation. He identifies—			
12a. The location of the enemy position and obstacles.			
• Spatial Orientation	• Near Vision	• Depth Perception	• Sound Localization
• Visualization	• Far Vision	• Hearing Sensitivity	• Peripherial Vision
• Selective Attention			
12b. The size of the enemy force engaging the unit in contact. (The number of enemy automatic weapons, the presence of any vehicles, and the employment of indirect fires are indicators of enemy strength.)			
• Indeductive Reasoning	• Near Vision	• Depth Perception	• Sound Localization
• Information Ordering	• Far Vision	• Hearing Sensitivity	• Peripherial Vision
• Speed of Closeure			
12c. Vulnerable flanks.			
• Indeductive Reasoning	• Near Vision	• Peripherial Vision	• Depth Perception
• Information Ordering	• Far Vision		
12d. Covered and concealed flanking routes to the enemy positions.			
• Indeductive Reasoning	• Near Vision	• Peripherial Vision	• Depth Perception
• Information Ordering	• Far Vision		

Our next step was selection of a COTS game platform (See Chapter III for selection criteria). The game we chose was *Delta Force: Black Hawk Down – Team Sabre*™ by Novalogic®. This game is a first person shooter game with multiplayer capability that is controlled using a keyboard and mouse configuration. The video display screen is broken into three main areas: environment image, HUD, and messages. The environment image displays the environment in the direction you are facing, a cross hair for aiming your weapon, your "hands" and an image of the weapon you currently have selected. The HUD features a compass, waypoint indicator, an image of the selected weapon, ammunition remaining, and an image representing your current posture (prone, crouching, or standing). The message section displays the last three text messages the player received and their character name.

We conducted a limited experiment using two collaborative mission scenarios created using the *Delta Force: Black Hawk Down – Team Sabre*™ MED. We fought the both scenarios several times under different conditions to determine the optimal training setting. For tactical orders preparation, we pulled the intelligence scenario, maps and friendly situation from the MED. Using this information, we constructed a map of the entire battle-space, defined our area of operations, and went through a condensed orders process. We produced a set of enemy and friendly graphics with a fragmentary tactical order for use in the scenario. Upon completion of a rehearsal run (to become familiar with the controls and key mapping), we conducted our final iterations and used our "React to Contact" performance measures with the human abilities table to capture our results. We based our assessment on the game's ability to provide sensory cues to support specific physical human abilities and how the structured scenario we developed provided other cues to support cognitive human abilities. For example, we assessed the ability of the game to support "Peripheral Vision", and the scenario's ability to provide enough cues to support "Information Ordering". We used a five point Likert scale as our rating to map the human abilities to the COTS game platform with 1 being a low or poor matching and a 5 being high or a very good match (Table 25).

Table 25. Human Abilities Assessment of COTS Game

Rating Scale					
O*NET Human Ability	Very Low	Low	Average	High	Very High
Arm - Hand Steadiness	**X**				
Depth Perception		**X**			
Far Vision	**X**				
Hearing Sensitivity			**X**		
Near Vision				**X**	
Peripheral Vision	**X**				
Sound Localization			**X**		
Spatial Orientation			**X**		
Category Flexibility				**X**	
Deductive Reasoning				**X**	
Flexibility of Closure				**X**	
Fluency of Ideas				**X**	
Inductive Reasoning				**X**	
Information Ordering				**X**	
Oral Comprehension				**X**	
Oral Expression				**X**	
Rate Control			**X**		
Selective Attention				**X**	
Speech Clarity				**X**	
Speed of Closure				**X**	
Visualization				**X**	

C. COTS GAME ANALYSIS USING ELEMENTS OF COMBAT POWER

In addition to the human abilities defined by O*NET Descriptors, we examined elements of combat power that are nested within the "React to Contact" battle drill and how they could be trained with a COTS game in a structured training scenario. We defined these elements in the following categories:

- Unit Specific Standard Operating Procedures
- Tactical Reporting
- Tactical Movement
- Small Unit Fire Control and Distribution and Direct Fire Planning
- Intelligence Preparation of the Battlefield
- Command and Control

By looking further that the performance measures and human abilities, we were able to develop a broader picture of the ability of *Delta Force: Black Hawk Down – Team*

Sabre™ to be used as a networked training platform. We defined these elements of combat power as it related to the COTS game trainer in the following manner:

- Unit Specific Standard Operating Procedures (SOPs): The training system must be able to support a variety of small unit SOPs. From techniques for crossing a linear danger area to procedures for entering a building and clearing a room, the trainer must be able to support training these skills by allowing every member of the unit to have an avatar in the virtual environment. With every member of the unit in the virtual environment (VE), the whole team can see and hear the task performed. Every member of the unit can also participate in the procedure and place himself in relation to his team members, the enemy and the environment. The system must also support different conditions to allow for training in all types of environments.
- Tactical Reporting: The training system must be able to provide sufficient cues for leaders to send detailed tactical reports to the higher headquarters. The more robust the virtual environment, the better it will be to train subordinate leaders on the ability to pick out the critical information required and filter the sensory static.
- Tactical Movement: The system must be able to reinforce basic tactical movement techniques. By placing the individual users in the VE with assigned avatars, the trainer must be able to provide enough sensory cues to allow small unit tactical movement. The cues must provide the individual user with sufficient signals to let him know where he is in relation to his flank team member, squad leader and platoon leader. The goal for reinforcing this task is to ensure proper spacing while moving through a series of different environments and under differing conditions.
- Small Unit Fire Control and Distribution and Direct Fire Planning (DFP): The training system must provide a fluid event scenario with a scalable enemy force in order to properly train a small units' ability to control subordinate rates of weapon fire and the distribution of those fires in a real-time tactical environment. The system should also provide a ground tactical scenario and maps in order to

allow for leader orders process, and generation of graphic control measures that support his direct fire plan.

- Intelligence Preparation of the Battlefield (IPB): The tactical scenario from the training system must also provide enough of an intelligence picture, in addition to the aforementioned maps, to allow the leader to generate his own intelligence picture of his sector for use in developing the ground tactical plan.
- Command and Control: The system needs to allow for the small unit leadership the ability to maneuver his forces in a virtual environment as he would on real terrain. The platoon/squad leader's ability to direct subordinate unit leaders movements in the VE in accordance with unit SOPs and the ground tactical plan is critical for training control. Communications must be replicated (or augmented with unit assigned equipment, for example: AN/PRC-119 SINCGARS radios) in the VE to force proper radio procedures and discourage the artificiality of calling a subordinate leader from one workstation to another sans radio.

We found that the true training value for an infantry squads lies with the leadership in the squad (squad and team leaders) and only somewhat with the individual Soldier. The squad leadership in the game scenario is faced with decisions they are likely to make in a combat scenario: "Where are enemy forces?", "Which route is best?", "I see the enemy, should I engage now or wait?", "Now that we're in contact, what should we do?" All of these questions draw on the leader's cognitive ability to recognize and react to a given situation.

Without guidance and enforcing use of unit standards by leaders, it is unlikely that an individual soldier would walk away from a session better trained. The individual abilities within the game do not match well to the performance of actual dismounted tactics (i.e. there is no left-mouse button to push on my weapon), but within the context of collective training, there is an assumption that individual soldiers are trained on their individual skills. The lack of individual skill training isn't as critical though, as it's unlikely that there would be much positive transfer of training for a soldier using a keyboard and mouse to replicate their individual combat tasks.

Where this platform provides its best individual training is in reinforcing procedures. By putting the soldier in a situation that requires proper use of their unit's Standard Operating Procedures (SOPs) the game is stressing the player's cognitive abilities. For effective training on these SOPs though, it is critical that the squad's leadership enforce proper procedures. Crossing danger areas (i.e. open terrain); providing suppressive fire; clearing an objective; reporting in status, enemy sightings, and other information to leaders, are all critical components of the individual soldier's real world mission. Within the realm of this game, there is ample opportunity to execute these SOPs. Within the context of the elements of combat, we determined the following positive implications and areas of concern for COTS game use.

1. Positive Potential Uses for COTS Games

a. Performance of Unit SOPs.

Having never worked together in a tactical environment, we began to develop SOPs as situations would present themselves. We would then use those SOPs throughout the exercise (i.e. crossing danger areas and assigning quadrants of fires on objectives) with positive success. The importance of this finding is, in conjunction with other live and constructive training events, this platform demonstrated the ability for units to train and rehearse SOPs well with a moderate level of fidelity in a VE.

b. Brevity and Completeness of Tactical Reports.

As the scenario unfolded, we became increasing reminded of the need for timely, concise and accurate reporting. We quickly develop a standard report format (which we enforced during game play) that was based on the standard Army SALUTE (Size, Activity, Location, Unit/Uniform, Time, and Equipment) format with brevity code words for ease of reporting. The result was rapid and concise reports that allowed us to constantly update our common operational picture. The COTS game provided a good tactical environment with adequate sensory (visual and auditory) cues to gather information and turn it into intelligence.

c. *Moderate Level of Support for Tactical Movement*.

Although the game provided some measure of spatial orientation, we did find that we had moderate cues from the VE to permit good training on tactical

movement IAW terrain, weather and the enemy. A larger study group will be required for further analysis.

d. Direct Fire Plan (DFP) and Intelligence Preparation of the Battlefield (IPB).

Although the game does not outright have the ability to export ground tactical information and an enemy template, the tools for developing the DFP and IPB can be gleaned from the game scenario ahead of time to develop a training exercise. This will require units taking screenshots of the scenario map ahead of time to develop independent graphics, IPB and a ground tactical plan.

e. Command and Control.

We found that the Delta Force provided a synthetic environment large enough to adequately maneuver small units IAW a ground tactical plan. This skill must be brought to the training system (as Delta Force alone will not train C^2), but with this skill trained, the networked FPS platform could provide a good training tool for a user unit.

2. Concerns for COTS Game Use as a Training Tool

a. Communication.

We found that tactical chat, the game's replicated hand and arm signals and the lack of a voice over IP (VoIP) tool did not adequately support required communication methods. These shortcomings can be resolved by forcing units to use organic radio equipment for verbal communication or placing workstations close together to allow squad members to hear audio commands over the game's sound effects.

b. Audio.

Performance of the Sound Localization and Hearing Sensitivity human abilities, as defined by the O*NET Descriptors, was improved dramatically with the use of stereo headphones. Without these, the ability to localize sounds was problematic.

c. Map Reading.

Delta Force's map function shows real-time locations of all player units. Although helpful for IFF (Identification of Friendly Forces), it lends itself to encourage users to rely more on the map's IFF than keeping track of squad members through visual and auditory cues. The augmented map is a good example of a tool that could be a

scaffold, and ratcheted down as the players become familiar with tracking unit members in the virtual environment.

d. Navigation Waypoints Display:

The HUD display for navigation waypoints in Delta Force provides an adequate replication of the display of the AN/PSN-11 PLGR (Precision Lightweight (GPS) Receiver); however, only key leaders in an infantry unit carry a PLGR, not every Soldier. Again, this could be used as a scaffold for team members to be removed once a level of confidence is built in navigation of the VE.

e. Weapon Performance.

Delta Force's weapons effects and performance do not accurately reflect real life performance. First and foremost, the weapons are uncharacteristically accurate at long distances. The weapon has an uncanny "first round on target" capability that does not reflect the real world conditions of Soldier fatigue, wind, obstacles, weapon malfunction and numerous other weapons performance limitations. Additionally, every round of ammunition fired (enemy and friendly) is a tracer. In reality, only key leaders carry magazines of tracers (for identification of key targets to engage for their team members and crew served weapons) and the M249 SAW (Squad Automatic Weapon) basic load consists of 3:1 mix (ball/tracer) of 5.56-linked ammunition. Although these shortcomings do not adversely affect the platform's ability to train collective tasks, there is a real concern that users will become overconfident in their real weapons performance based on the level of accuracy of the game.

f. Graphics. There is no natural environmental visual static to draw attention away from a hidden or unmoving enemy. As a result, the only moving objects in the VE are enemy or friendly forces. For conducting defensive operations, this could be a potential problem where a defending force will have an unrealistic advantage in scanning without having to contend with blowing sand, animals, glare, or swaying of grass or trees.

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