Training "Shoot House" Tactics Using a Game

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Since the time of Ed Link, interactive simulators that replicated the critical components of the task and its environment have been cornerstones of highly specialized task training, such as pilot training. Today commercial off-the-shelf games promise similar realism. Yet, because of the dissimilarity between the traditional gaming interface and actual human motor activities, games have had only limited application to training where human motor skills are the dominant means of propulsion through manipulation of, and communications within, the environment. This research explores the possibility of expanding the paradigm of using games with traditional interfaces for these serious tasks. Specifically, this research evaluates the training transfer associated with the game *Close Combat: First to Fight*™ as part of a "shoot house" training regime for Marine Corps infantry. The research explores whether or not traditional field training is equivalent to field training combined with virtual training. Results include the measurements of the subjects' objective performance in live training and self assessment questionnaires.

Keywords: Game, training

1. Introduction

Ed Link's 1929 aviation trainer is often cited as being the first modern era flight simulator. Yet few know that by the time the United States Navy bought its first trainer in 1931, nearly fifty "pilot makers" had been sold for use in amusement parks [1]. Perhaps reflective of that earlier era, today some off-the-shelf games that first found success commercially as entertainment games have later found serious use in education and training tasks of the Department of Defense (DoD). The notion of using games for training is appealing in many dimensions. Promises of reduced cost, greater access, wider distribution, more frequent use, and "just-in-time" training all stimulate further research.

The realism of visual and dynamics aspects of entity models in some of these entertaining games has caught the attention of the not only the DoD training community but others. For example, X-Plane, a flight simulation game, is currently approved by the FAA to drive an approved Level 2 Flight Training Device [2]. Device realism can still be expensive, particularly if building a replication of the system interface is necessary for effective training to take place.

A traditional game interface may not be sufficient for team training [3] or individual training [4], depending on the task. For team training, Proctor et al. [3] found that the traditional gaming technique of using a "hat" or button on the joystick to pan the view both left and right on a single monitor was not sufficient to portray to the pilot the necessary queues for situation awareness from the surrounding helicopters in a unit combat mission. For individual training, Proctor, et al. [4] evaluated expanding the use of X-Plane to drive three different interface configurations for helicopter simulator flight training. The least expensive of the interfaces in this experiment was the X-Plane game on a simple PC with a 19-inch desk-mounted monitor, joystick, collective, and pedals. The degree to which the three interface configurations contributed to

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learning did vary. Specifically, both the simulator with a generic Helicopter Cabin replica equipped with a 60-inch screen and 2-degree of freedom Motion platform as well as the generic Helicopter Cabin replica equipped with a 60-inch screen but without Motion demonstrated a statistically significant level of learning on the tasks given. On the other hand, the PC Desktop interface, even when augmented with collective and pedals, did not demonstrate learning. In addition to insights on the interfaces, the experiment also identified no issues with the underlying X-Plane software by either participants or evaluating experts though the fidelity of the terrain model did surface as an issue.

Not all uses of computer games are as adversely affected by the interface as the helicopter piloting task cited above. Computer-based games like "role player" Combat Mission: Beyond Overlord and the "first-person shooter" game Steel Beasts have been successfully used by ROTC detachments and the United States Military Academy (USMA), respectively, for military small unit tactics education [5]. As demonstration of their confidence in computer games, the USMA Department of Military Instruction Warfighting Simulation Center continues to use the following games in military instruction: *America's Army, Steel Beasts 2 Pro, Battle Command 2010, Virtual Battlespace Systems 1, Rainbow Six 3—Athena Sword,* and *The Operational Art of War* [6]. Other national armed forces have investigated games such as use of the first-person shooter *Operation Flashpoint* in a competitive team environment within the Australian Defence Force Academy [7] and of *Virtual Battlefield Systems* as a tactical training system [8].

While application of games in an educational environment is expected to expand, questions arise about the further scope and effectiveness of games for training where traditional gaming interface devices are applied. X-Plane has shown that games coupled with replicating cockpit interfaces do work for numerous aircraft pilot tasks. But what of tasks where devices such as weapons, chemical, biological, and/or radiological devices are used by humans in a less structured environments than an aircraft cockpit? What about skill training involving human physical touch, exertion, and motor skills within or between other entities, natural, and/or man-made environments? Notionally moving one's avatar through a synthetic environment using a joystick interface common to most games is considerably different from human self-propulsion, item handling, and environment interaction in the real world.

Hence questions remain. What motor-skills–dominated, individual task can be accomplished or even advanced through games with traditional gaming interfaces? If the whole task cannot be supported using a game, are some subtasks more amenable to the use of games than others? If so, where might games fit into a program of instruction? Is the time spent learning the game worth the time lost from traditional training? We had the opportunity to investigate these questions and evaluate the training transfer associated with a game as applied with a regime of Marine Corps Close Quarters Battle (CQB) within an urban "shoot house."

This research explores the possibility of expanding the paradigm of using games for the serious tasks of training in a man-made environment, other than a cockpit, where motor skills dominate. Specifically, this research evaluates the training transfer associated with the game *Close Combat: First to Fight* in urban "shoot house" training. *Close Combat: First to Fight* is a "first-person–shooter" game where the traditional mouse interface has been modified to support tasks associated with Marine Corps infantry involved in clearing rooms in a "shoot house" as part of an urban warfare training regime. The research explores whether or not traditional field training is equivalent to field training combined with virtual training. Results include the evaluator measurement of the subjects' performance in live training as well as self-assessment questionnaires.

2. Background

Current demographic trends indicate that during the 21st century an ever-increasing percentage of the world's population will reside in urban areas. The USMC has identified the potential for conflict in urban areas and is attempting to rectify its deficiencies in this arena. "We have been working diligently to ensure that we can fight the three-block war, because we believe in our heart and souls that that is the conflict of the 21st century" [9]. The current focus of the Marine Corps Warfighting Laboratory's (MCWL) experiments is to develop tactics, techniques, and procedures for urban environments that can reduce the casualty percentage below 30%, a historical threshold for unit ineffectiveness. "The urban environment is the most likely battlefield in the near future. Developing means to deal with this unique environment is essential" [10].

> Daily rates of casualty and illness incidence sustained in the retaking of the city of Hue during the North Vietnamese Tet offensive of 1968 were examined. The daily wounded rate for the U.S. Marine battalions involved was 17.5 per 1,000 strength, and ranged from 1.6 to 45.5. The killed-in-action rate per 1,000 strength per day was 2.2, and ranged from 0.0 to 9.6. The wounded rate during the urban warfare of Hue was three times higher than during the high intensity battle for Okinawa and sixfold

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> the wounded rate during normal Marine operations at the peak of the Vietnam conflict. The disease and non-battle injury rate remained steady over the course of the Hue operation at approximately 1.0 per 1,000 strength per day. [11]

While units are deployed aboard ship as part of a Marine Expeditionary Unit, they need a tool to keep the Marines’ skills refreshed, as they tend to atrophy during long deployments at sea. As stated in the 2001 Report of the Defense Science Board (DSB) Task Force on Training Superiority & Training Surprise, “future training must be delivered to the individual, to units, and to joint forces, when it is needed, not in the schoolhouse after which there is time for proficiency to decay. Training must be applied over and over again as the composition of the units and joint forces changes and as skills erode over time” [12]. Further, a training system that is so enjoyed by the Marines that they would use their off-duty hours to take advantage of it would supplement the training hours available.

The other major constraint on any infantry training system (in fact, any USMC training system) is cost.

> Advanced modeling and simulations for games, entertainment, manufacturing, education, the U.S. Department of Defense, finance, and other applications will grow with the development of integrated media systems incorporating software and hardware development at many levels. [13]

Computer games may fill all of these operational requirements, yet in the past computer simulation games and simulations were judged to be low on fidelity, interface, and immersion dimensions [14]. Some question whether games can be directly applied to training tasks with a positive effect.

> From this research, computer games in general do not appear to offer a pedagogic environment. The focus for the player is to play and win the game—the research subjects were concerned to know “how to win.” The notion of learning whilst playing was never explicit or implicit in anything the students said. [15]

The most noticeable advances in PC games have come in the area of computer graphics. “Images on today’s $400 game consoles rival or surpass those on $50,000 computers from only a few years ago” [16]. Artificial intelligence (AI) is resulting in more realistic modeling of game characters such as tactical enemies, partners, support characters, and even units of individuals, such as platoons [17]. Several studies have suggested that PC simulation games can produce a transfer of cognitive skills that have application to a wide variety of domain-specific tasks. Pillay, Brownlee, and Wilss [18], noticing that recreational computer games were becoming an increasingly significant part of students’ lives, conducted an exploratory study aimed at understanding the cognitive processes that students engage in when playing computer games. Using Nintendo’s *Pilot Wings,* they demonstrated that players practiced “complex cognitive processes such as interpreting explicit and implicit information, inductive reasoning, metacognitive analysis, and problem solving.” They went on to say that PC games have been shown to enhance soldiers’ decision-making skills through practice with variation. Players get faster at responding to both expected and unexpected stimuli. [19]

3. Research Methodology

The purpose of this research is to evaluate the training transfer associated with a tactical decision-making game, using *Close Combat: First to Fight* as a case study (see Figure 1). The null hypothesis to be tested is that traditional field training is equivalent to field training combined with virtual training.

Figure 1. *Close Combat: First to Fight*

3.1 Approach

The approach to this research is to examine a single game as a case study using the Yin [20] case study research methodology. The game is focused (in the single-player mode) on a gamer who acts as a Marine fire team leader who leads a four-man fire team in close-quarters urban combat in the streets and buildings of Beirut. Those buildings that are accessible have highly detailed interiors with cultural features such as pictures on the walls, carpets, and furniture. The doors can be opened and closed, and windows can be fired through; however, most of the static items cannot be manipulated. Game scenarios replicate, as closely as possible, the CQB Tactical Performance Evaluation in the live fire shoot house facility at Chesapeake, Virginia.

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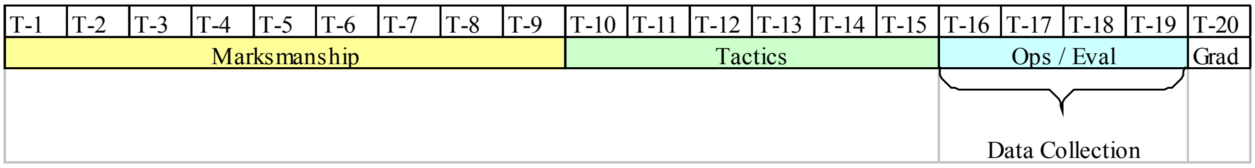

Figure 2. CQB course timeline

The full CQB course consists of twenty training days: nine days for marksmanship, six days for tactics, four days for operations and tactical evaluation, and one day for graduation (see Figure 2) [21]. In our experiment, the control group and the experimental group completed the marksmanship and tactics phases together. The experiment was conducted during the operations and tactical evaluation (Ops/Eval) phase.

Familiarization of commands and controls of the game for the experimental group was performed for those not already familiar with *Close Combat: First To Fight* over roughly 45 minutes. Additionally, all sixteen Marines were given an opportunity during the 45-minute familiarization to use the new Marine Combat Pad (see Figure 3), an input device designed to simplify entering commands with one hand while using the other for the mouse inputs.

The experimental group was given two hours of computer gaming during this final study and practice period. The time spent gaming was taken from the time that would have been devoted to study and practice as shown in Table 1 (not necessarily in the listed sequence).

3.2 Design of the Experiment

The experiment consisted of one control group of sixteen Marines with one observation per Marine and one experimental group consisting of sixteen Marines with one observation per Marine. The Mann-Whitney Test, a non-parametric test is used to compare two independent groups of sampled data. This test uses the ranks of the data rather than their raw values to calculate the statistic. The hypotheses for the experiment were as follows:

- H_0: The two samples come from identical populations; traditional field training is equivalent to field training combined with virtual training.
- H_a: The two samples come from different populations; there is a difference between traditional field training alone and field training combined with virtual training.

Table 1. Control and experimental group treatments

Control Group		Experimental Group	
		Computer Gaming	2 hrs.
Examination Study	3 hrs.	Examination Study	2 hrs.
Shoot House	3 hrs.	Shoot House	2 hrs.

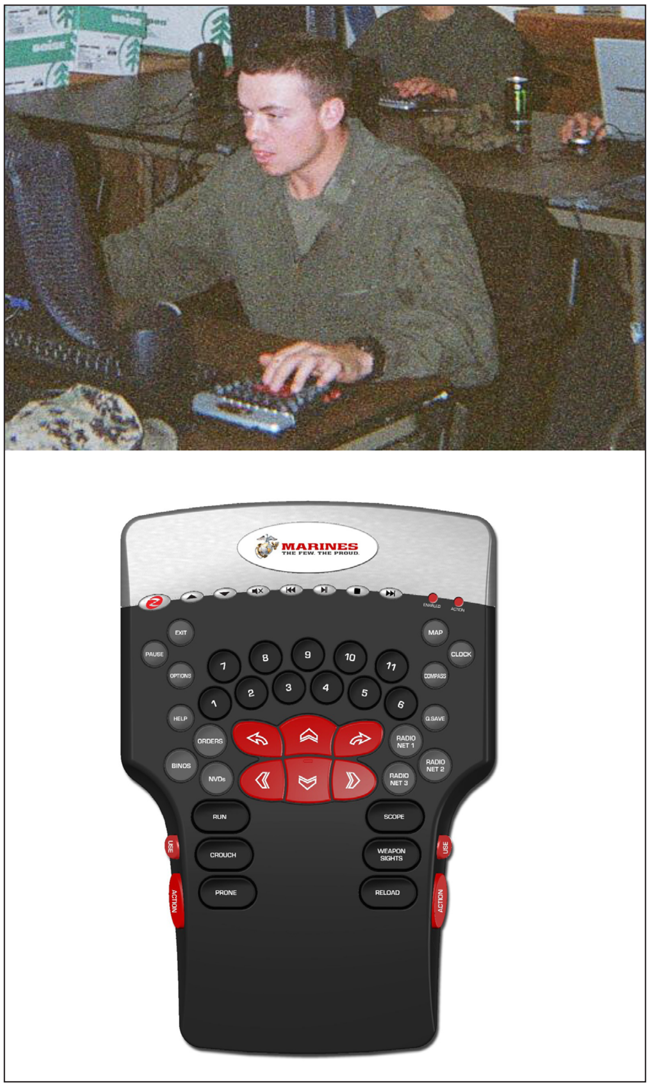

Figure 3. CQB Marine in action; Marine Combat Pad

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3.3 Assessment

Events-based approach to training as provided by Fowlkes, et al. [22] was the basis for developing the training transfer evaluation. Tasks shown in Table 2 are shaped around the events associated with the CQB scenario. Those areas that had corresponding training objectives in the gaming experiment are highlighted in gray.

3.4 The Experiment

In the computer gaming phase of the experiment two instructors played the role of the opposing force with half of the experimental group, as shown in Figure 4. The first half of the experimental group showed up while the other half of the experimental group and the control group alternated between supervised studying for the written final exam and conducting mentored walk-throughs of the final tactical evaluation. After completion of the gaming phase, the first half of the experimental group swapped activities with the second half.

Experimental group treatment: The experimental groups then proceeded through a series of missions following the pattern of: (1) mission brief and planning, (2) execution, and (3) after action review.

3.5 Demographics

The "average" Marine experimental subject was a 19 ½ year old Lance Corporal with fourteen months in the Marine Corps who plays 4 ½ hours of video games per week. All subjects stated that they had played a "first person shooter," and nearly all had played "role playing games" and "real-time strategy" games. About one third admitted to playing one or more of these types of video games regularly.

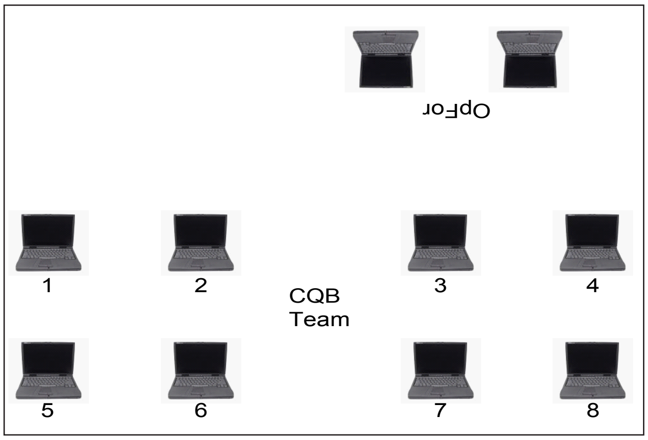

Figure 4. Computer layout

Table 2. CQB Tactical Performance Evaluation [23]

Test #1, 2, 3	Name:
	Class:
Score:	Date:

Task	Points	Score
ROOM 1 (Open Door)		
Proper Hallway Assessment/ Coordination	-2	
Conducts Proper 5-Step Entry	-5	
Immediate Action	-2	
Shot Delivery	-2	
Shot Placement (Flyer -4)	-4	
Conducts Door Check	-1	
Conducts Dead Check	-2	
Conducts Proper Marking	-1	
Maintains Tactical Advantage/ IBT	-3	
Reload	-2	
Stairwell Up/Down	-2	
POST ASSAULT		
Reports Objective Secure	-3	
Establishes Strongpoints	-1	
Submits a Proper Situation Report	-2	
Links Up With Guard Force	-1	
Conduct Walk-Through/ Change Over	-1	
Request to Evacuate Assault Force	-1	
Link Up With DM (Mark/ Confirmation)	-1	
Security Shooter	-3	
Evacuate Assault Force From Objective	-1	
SAFETY VIOLATIONS		
Live Fire N.D.	F	
Live Fire Muzzling	F	
Finger on Trigger	-15	
Door Check at the Index	-10	
Weapon on Fire	-5	
Failure to Decock	-10	
Failure to Abide By The Six-Foot Rule	-10	
RAW SCORE		100
SAFETY/TACTICAL VIOLATIONS		
FINAL SCORE (Passing 80/100)		

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4. The Tactical Evaluation

Each student was evaluated on his performance in conducting CQB in the live-fire shoot house. Each student was placed into a four-man CQB team (one student with three instructors), the same three instructors running each of the 32 Marines through the tactical evaluation. This ensured that any variability in performance was directly attributable to the student and not to the other team members, as could be the case in a team evaluation. Additionally, an instructor O/C followed behind the team, and another instructor observed remotely via video cameras. Students who completed their evaluation were kept segregated from the students who were waiting their turns. Each student was confronted with the same mission, rooms to clear, and targets to engage.

Marines who failed the tactical evaluation were given a second opportunity to pass; however, their original scores were used for this experiment. Eight Marines (two in the Experimental Group and six in the Control Group) failed the tactical evaluation as a result of safety violations the first time through and received scores of 0. Only one of the eight Marines passed on his second try; the others were dropped from the class.

5. Objective Results

Results were approached from four different perspectives: total scores for all 32 Marines, total scores for the 24 Marines without safety failures, tactical scores (without safety violation deductions) for the 24 Marines, and TDS-related scores (those scoring categories that had related training objectives during the TDS exercise) for the 24 Marines. Each case was analyzed with both the Mann-Whitney non-parametric test and the Fisher's exact probability test.

The first examination includes all 32 Marines in the test population, including the eight who failed out of the course. The raw scores can vary between 0 and 100. Table 3 shows the results of the Mann-Whitney test for $n_a = 16$; $n_b = 16$.

The sum of the ranks for the experimental group, $T_A = 280.5$. $T_{A[\max]} = 392$. The difference between T_A and $T_{A[\max]}$ (U_A) is 111.5. Based on the table of critical values of U for $n_a = 16$; $n_b = 16$, the lower limit for a .05 level of significance for a directional test is 83. In order to reject the null hypothesis, the value of T_A would have to be less than 83. Therefore, the null hypothesis cannot be rejected for this examination even though the average scores appear to be quite different (74.06 versus 53.69).

Table 3. Mann-Whitney test for all 32 Marines

	Ranks		Scores	
	Experi-mental Group	Control Group	Experi-mental Group	Control Group
1	10.5	9	77	73
2	18	4.5	84	0
3	24.5	13	88	81
4	14.5	22	82	87
5	22	31	87	92
6	10.5	29.5	77	91
7	16	18	83	84
8	24.5	27	88	89
9	20	14.5	86	82
10	4.5	29.5	0	91
11	32	27	95	89
12	22	4.5	87	0
13	18	4.5	84	0
14	12	4.5	78	0
15	27	4.5	89	0
16	4.5	4.5	0	0
Sum:	280.5	247.5	Avg.: 74.06	53.69

The Fisher's exact probability test, to determine if the difference in the number of Marines in the experimental group who passed the tactical evaluation, was significantly different from the number of Marines in the control group who passed it. The table of frequency values follows in Table 4.

Table 4. Fisher's exact probability test for all 32 marines

Test Status	TDS	Control	Combined
Pass	14	10	24
Fail	2	6	8
Totals:	16	16	32

The result of this test is 0.11, so the number of Marines in the experimental group that passed the tactical evaluation versus the number of Marines in the control group that passed is not statistically significant.

Additional differences between the control and experimental groups for the 24 Marines without safety failures were examined. Though differences approached statistical significance, they were not found significant for total scores, total tactical scores (total scores minus scores on safety-oriented tasks), or highlighted tasks trained in the *Close Combat: First To Fight*.

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6. Subjective Self-Assessment

Marines of the experimental group provided self-assessment of the usefulness *Close Combat: First To Fight* on a scale: 1 = not at all useful; 2 = not very useful; 3 = neutral; 4 = useful; 5 = very useful for: planning, situational awareness; intra-team communications; tactical awareness; movement techniques; weapons employment, and rules of engagement. Situational awareness ($p = 0.02$), intra-team communications ($p = 0.027$), tactical awareness ($p = 0.004$), and movement techniques ($p=0.034$) all proved to be statistically different from neutral using a t-test.

All these skills can be related directly back to the four items in the tactical evaluation that are in the assault phase that were also practiced in *Close Combat: First To Fight:*

- "Proper hallway assessment/coordination" (situational awareness, intra-team communications),
- "Conducts proper 5-step entry" (tactical awareness, movement techniques),
- "Maintains tactical advantage/IBT" (situational awareness, tactical awareness), and
- "Stairwell up/down" (tactical awareness, movement techniques).

While the self-assessment indicated the students thought that the training in the game helped them on these tasks, an examination of objective scores for these tasks for the 24 Marines of the test population who did not fail the course because of safety infractions did not reveal any statistical difference between the control group's or the experimental group's performance.

7. Conclusions, Limitations, Lessons Learned, and Future Research

The purpose of this research was to evaluate the training transfer associated with a tactical decision-making game using *Close Combat: First to Fight* as a case study. The null hypothesis that was tested was that traditional field training is equivalent to field training combined with virtual training. Measurements of the subjects' performance in live training were recorded. Additionally, self-assessment questionnaires were administered. This experimentation compared, assessed, and reported on training value achieved through traditional field training versus the benefits of field training combined with virtual training. In order to explore this question a field experiment was conducted using the *Close Combat: First to Fight* software to train sixteen Marines in the tactical tasks associated with Close Quarters Battle (CQB). The extent of the training using the simulation involved one familiarization session for approximately 45 minutes and two training sessions with eight Marines in each two-hour session.

While the experimental group numerically outperformed the control group on the live fire tactical evaluation, no statistical differences at $p = .05$ between the control group and experimental group were found in terms of objective performance in the live exercise. Though self-assessment evaluations did result in statistically significant results for situational awareness, intra-team communications, tactical awareness, and movement techniques, these same four measures did not show a statistical difference in the objective scores between the control and the experimental group. Clearly, substitution of a portion of field training with virtual training did not harm the performance of Marines either objectively or subjectively when compared to the performance of Marines receiving regular field training alone. At the same time, the virtual training treatment did not demonstrate a statistically significant positive improvement in the objective performance measures. Some possible explanations for the lack of statistical differences in terms of improving the objective performance of the control group are listed as limitations and cited below.

Only two hours of virtual training were included in a four-week, 160+ hour course of instruction. This relatively minor training period, being such a small percentage of the overall course, had little opportunity to make a statistical impact.

In a CQB environment, where darkness and noise may impede visual and auditory communication, physical interaction becomes vital. Among these are "stacking," the "leg bump," "dead checks," and the *Hostages, Unidentified, Terrorists, and Shooters* (HUTS) report. Stacking involves Marines lining up outside the door prior to entering, where each Marine in the stack has a specific task, based on his position in the stack, once inside the room. Because of an issue with collision detection in the game, the Marines had a difficult time stacking before entering rooms that were to be cleared. The leg bump is done by the number-two man in the stack, where he uses his knee to bump the lead Marine in his hamstring to signify that the team is ready to execute. The number-two man normally also announces the number of Marines in the stack so that the lead Marine knows what tactics are to be employed (tactical responsibilities inside the room to be cleared are dependent on the number of Marines entering). Without the physical bump, the verbal announcement of "You've got two!" or "You've got three!" was the only way to replicate this action. Given the inconsistency between indicating team

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readiness in the game by using a verbal announcement versus using the leg bump in real life, the potential for negative training exists. However, no negative behavior occurred during the experiment, as we did not observe any verbal announcements instead of leg bumps during the experiment. Dead check is used after clearing a room and consists of the Marines conducting a "dead check" on any opponents that have been shot to ensure that they are dead. This consists of sweeping the body for weapons and performing an "eye thump," thumping the eyeball with a finger to check for any reaction. There is no procedure for replicating this in the computer game, and it must be assumed that any opponents who are down are dead. A HUTS report is performed after clearing the assigned area; the team consolidates and the team leader touches each Marine on the head (who then kneels down) to get an accurate accounting of the "shooters." This is followed by each Marine holding up a hand with the number of fingers extended representing the number of dead opponents personally checked, with the team leader touching each Marine's hand to get a physical count of dead opponents. Again, there is no procedure for replicating this in the computer game other than to convey the information verbally.

A possible lesson learned for all future researchers is that physical aspects of tactics in the real environment may greatly reduce the effectiveness of traditional game interfaces such as mice, keyboard, or joystick controllers. The particular scenarios to be trained may be an indicator as to the appropriateness of the interface that is planned to be used. For example, clearing a building does not employ the same tactics as other urban terrain tactics. This may make a significant difference in the suitability of the game given a traditional interface. *Close Combat: First To Fight* appears to be as suitable as similar games in planning, evaluating, and selecting from a wide set of possible small-unit tactical operations. Future research should explore this hypothesis. The CQB implementation of the room clearing operations, on the other hand, tends to deal more with execution of well-honed techniques involving physical interaction with other people as well as the environment. The traditional mouse interface, even when modified for the task, did not improve performance as hoped.

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Author Biographies

Dr. Michael Proctor *currently is an Associate Professor with the University of Central Florida Industrial Engineering and Management Systems Department. Dr. Proctor currently conducts research on embedding physically and virtually embodied agents within Human-Agent teams. Additional current research areas include games as simulation surrogates within training systems as well as human-simulation interface design. As part of the Interdisciplinary Modeling and Simulation program at UCF, Dr. Proctor teaches Interactive Simulation, Real-Time Simulation Agents, and Simulation Based Life Cycle Engineering. As a Lieutenant Colonel, Dr. Proctor previously served as Director of the Training and Doctrine Analysis Center Research Activities in Monterey California on the grounds of the Naval Postgraduate School where he retired from active service in 1994. Dr. Proctor received his Ph.D. in Industrial Engineering from North Carolina State University in 1991 and is a Certified Modeling and Simulation Professional (2002).*

Dr. Michael Woodman *is the Program Manager for AV-8B flight simulators for Indra Systems, Inc. Formerly a Project Manager for the Science and Technology Division of the USMC Program Manager for Training Systems, his projects included the Marine Corps family of Tactical Decision-making Simulations (game-based training systems). Prior to that he was Program Manager for various game-based training systems in private industry, as well as conducting Independent Research and Development on Network Centric Operations for Training. He previously served as a Marine Corps aviator, flying F-4 Phantoms, and retired after 20 years of active service in 1998.*

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