Assessing the Potential of Massive Multi-Player Games to be Tools for Military Training

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ABSTRACT

Global network connectivity has made it possible for individuals distributed around the world to interact in common virtual environments. Commercially available Massive Multi-Player Games (MMPG) allow dozens to hundreds of participants to work together in simulated locations, often displaying high degrees of coordination to accomplish complex goals. The potential of this type of interaction to be used for training purposes has not gone unnoticed. Individuals who are unable to gather physically for training can assemble more easily in a virtual environment. DARWARS, an initiative that aims to support a diverse array of distributed simulation-based military instruction, is being developed to take advantage of the opportunities afforded by wide-spread network connectivity. The current project, Gorman's Gambit, was designed to investigate the capability of existing MMPGs to support training, and to identify resources that would need to be developed to increase the training effectiveness of such applications. We conducted an exercise using an existing Commercial Off-the-Shelf (COTS) game. A scenario was designed to support behaviors indicative of effective teamwork. Forty members of the U.S. Army infantry at Ft. Benning, GA participated. The attributes of the in-game characters controlled by each soldier were manipulated to encourage coordination among participants. Trained observers monitored performance in three thirty minute sessions, and recorded instances of teamwork using a template based on the existing team performance literature. Collectively, results indicate that the MMPG genre may be a functional model to emulate for distributed multi-user military training. However, the results also highlight several inherent challenges with using COTS gaming systems for assessment-intensive applications such as military teamwork training. Our results strengthen the argument that MMPGs are a plausible platform for training. However, it is clear that additional training components would need to be developed. The lessons learned will inform development of Massive Multi-Player Training technology.

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INTRODUCTION

Commercial computer games in general – and Massive Multi-Player Games (MMPG) in particular – are influencing the design of future training systems. MMPGs can support large numbers of simultaneous users (40 – 1000+), who populate virtual worlds that can persist over time (i.e., actions taking place in one session impact future sessions). Players interact with other players and synthetic agents to accomplish tasks and goals. As training systems, MMPG technologies have the potential to facilitate learning by providing opportunities that are available anytime, anywhere, and that are low cost, widely distributed, and engaging. This is a primary goal of DARWARS, a DARPA-funded initiative that aims to establish warfighter training superiority through a new generation of training systems. DARWARS is being developed as an integrated training platform that brings together a unified pedagogical infrastructure with advanced PC-based training and simulation systems. Within DARWARS – and in military training in general – MMPG technologies could provide unique opportunities for training by supporting extensive capabilities for visualization, replay, and illustration of key concepts. MMPG technologies therefore promise to advance simulation-based training by enabling distributed training at a level of participation, intensity, and fidelity previously unrealized.

MMPG technologies may be particularly useful for training teamwork skills. In today's commercial MMPGs, individual players interact with the simulated environment, computer-controlled characters, and with characters – or avatars – controlled by other online players. While different games involve different degrees of cooperation among players, these games often require multiple players with complementary skills to form ad-hoc teams that need to coordinate and communicate in a complex manner to succeed. Through the process of experiencing the game together over multiple sessions, gameplay may inculcate effective teamwork skills. This realization is critical, for effective team training is at the heart of successful performance in military operations both now and in the foreseeable future. Technologies that can render team training more effective, more affordable, and more available have tremendous potential for increasing military readiness. These items suggest that it is advantageous to capitalize on existing MMPG technologies, since MMPGs bring the capability for large numbers of individuals to interact in an engaging environment that has a capacity to foster operationally-relevant team behaviors.

GORMAN'S GAMBIT

The objective of the work reported here, Gorman's Gambit, is to explore the use of MMPG technologies to support military training, thereby informing the development of DARWARS and related simulation-based training programs (Weil et al., 2004). In particular, the Gorman's Gambit project aims to answer the following questions:

- To what extent can existing MMPGs support military training?
- What needs to be done to augment existing MMPGs for military training?

In asking these questions, we focus on the ability of MMPG technologies to support teamwork skills training as an example domain. We do so in large part based on a thesis put forward by General Paul Gorman (U.S. Army, Ret.): teamwork skills can be taught effectively using modern COTS MMPGs, as the software supports the fundamental behaviors. Furthermore, there is no need for the game to be realistic with regard to modern military operations. Although the level of technology and the obstacles faced are very different, the elements of teamwork may be similar for the "Siege of Camelot" and for some modern military operations. The crux of the idea is that many available games have the potential to provide an experience that has pedagogical value, even though they may not have been initially designed with this in mind. This thesis has a firm ground in cognitive theory, in that learning by analogy is an effective means of obtaining skills that will be applied in unrelated contexts (Gentner, 1989).

We concentrate on teamwork skills because of their central importance for distributed military operations in the information age. Because MMPG technologies support the interaction of multiple individuals working collaboratively from remote locations, MMPGs offer a solid starting point for military teamwork skills training environments. We argue that it is critical – and advantageous – to understand the capabilities that current commercial, off-the-shelf (COTS) gaming technologies offer, as well as the critical gaps that remain. Based on this understanding, we can make progress toward requirements, so that new technologies being developed build on real capabilities and fill in real capability gaps. Thus, before an MMPG with specific training tools is created, the evaluation of an extant MMPG for training is an invaluable exercise. The Gorman's Gambit project was therefore undertaken to examine the technical, logistical, and pedagogical design issues involved in using an MMPG as a basis for a military training exercise in which users interact virtually in teams and potentially learn teamwork skills as a result.

TEAMWORK SKILLS

The academic literature on teamwork (e.g., Salas & Cannon-Bowers, 2001) makes a clear distinction between "teamwork" and "taskwork." Taskwork refers to the individual skills necessary to perform a particular job. For instance, taskwork might include how to operate the controls associated with a particular weapon. In contrast, teamwork skills are viewed as existing over and above the "taskwork" skills needed to perform in any individual position on a team. According to Orasanu and Salas (1993), accepted characteristics of a team include multiple individuals, multiple information sources, interdependence among team members, defined roles, and common goals. Hence, teamwork skills are the behavioral processes that support effective team functioning, and these skills are critical for most military operations.

The research literature provides ample evidence that teamwork skills do exist, that these skills can be defined, trained, and assessed, and that teamwork skills training can improve performance (e.g., Salas & Cannon-Bowers, 2001). More specifically, several key skills have been identified that support team effectiveness (e.g., Cannon-Bowers, Tannenbaum, Salas, & Volpe, 1995; Freeman, Diedrich, Haimson, Diller, & Roberts, 2003; Serfaty, Entin, & Johnston, 1998; Sims, Salas, & Burke, 2004; Smith-Jentsch, Johnston, & Payne, 1998; Smith-Jentsch, Zeisig, Acton, & McPherson, 1998). These skills include, but are not limited to, such items as Monitoring & Back-up, Information Exchange, and Leadership (Table 1). For more detailed descriptions of some of the skills found in Table 1, see Sims, Salas, & Burke (2004).

These teamwork skills are the focus of our training development. We ask whether these teamwork skills can be observed in MMPG environments and how best to support the training of such skills in these environments in the future.

THE EXERCISE

To address these questions, we conducted the Gorman's Gambit Exercise at Ft. Benning, GA. Below, we describe the development of the exercise, present the procedures used, and then explain the pertinent results. Note that our intent was not to evaluate training effectiveness per se, for we did not seek to determine the extent of actual learning and transfer through use of the game. Rather, our intent was to present a series of lessons learned surrounding the critical technological, logistical, and pedagogical issues in order to understand the extent to which MMPG environments have the capabilities typically necessary for effective training. Via these lessons learned, we shed light on the requirements gaps and capabilities necessary for moving from gaming to training

Game Choice

Existing MMPGs differ in terms of the setting, character types and abilities, interface characteristics and capabilities, and other factors. In selecting the multi-player computer game to use for Gorman's Gambit, several candidates were considered for possible use. The game Neverwinter Nights (NWN; Trademark of Wizards of the Coast, Inc. http://nwn.bioware.com/) was chosen as the prospective training environment. Similar to many MMPG games, it afforded the study of a large number of users (up to 64) working in collaboration to conduct an exercise in a fantasy setting. However, unlike many MMPGs, NWN also supported relatively fast and simple scenario structuring and extension. In addition, it provided a mechanism for the facilitators to observe using invisible characters, included the realistic ability to harm teammates, and enabled each player to have different capabilities and inventory.

Table 1. Teamwork Skills Supporting Team Effectiveness

Leadership: The ability to direct and coordinate the activities of other team members, assess team performance, assign tasks, develop team KSAs, motivate team members, plan and organize and establish a positive atmosphere.
Monitoring: The ability to develop common understandings of the team environment and apply appropriate task strategies and processes in order to accurately monitor teammate performance.
Back-Up Behavior: The ability to anticipate other team member's needs through accurate knowledge about their responsibilities. Includes the ability to shift workload among members to achieve balance during high periods of workload pressure.
Adaptability: The ability to adjust strategies based on information gathered from the environment through the use of compensatory behavior and reallocation of intra-team resources; altering a course of action or team repertoire in response to changing conditions (internal or external).
Team Orientation: Propensity to take other's behavior into account during group interaction and the belief in the importance of team goal's over individual member's goals.
Closed Loop Communication: The practice of confirming receipt and understanding of others' communications. This practice builds trust in the communication skills, knowledge, and intent of others and ensures that information is accurately conveyed.
Team Mental Models: The ability to accurately represent the capabilities of others, their responsibilities, and their perception of the state of the world.
Coordination: The practice of planning, preparing, organizing people and/or tasking to accomplish a goal.
Communication Push: The practice of sharing or sending information with/to others.
Communication Pull: The practice of seeking information from others or other data sources; asking questions; attempts to gather intelligence.

Method

The Gorman's Gambit exercise was conducted over two days. The first day consisted of six hours of training. The second day consisted of the main Gorman's Gambit exercise. Participants were separated into two competing platoons of equal size (20 participants). Each platoon was composed of 3 squads, each with a similar mix of player types. Each participant was assigned a specific avatar (scout, medic, archer, artillery, or tank) and a role (platoon leader, squad leader, or squad member). The avatars varied in their individual capabilities in order to promote teamwork and collaboration between players as they had to cooperate to apply different combinations of capabilities in order to meet mission demands.

Participants

Forty members of a U.S. Army Infantry Platoon participated in the exercise. The soldiers were between 19 and 33 years of age (M= 23.6 years) with between 1.5 and 174 months of military experience (M= 51.2 months). Participants ranged from E-2 (Private) to O-1 (Second Lieutenant). The soldiers averaged 51.2 months of service, and 25 of the 40 soldiers had been deployed within the last year. The soldiers averaged 3.7 hours per week of computer use in the last year, with an additional 4 hours of game-playing (PC based or video game console systems [e.g., Sony's Playstation or Nintendo's Game Cube]) experience per week in the last year.

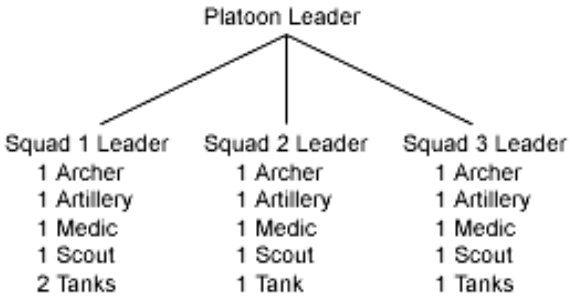

Figure 1. The Exercise Command Hierarchy.

Platoon and Communication Organization

The avatar organization (Figure 1) was designed to support the objective of teamwork demonstration. We encouraged inter-squad teamwork by allocating different resources and abilities to different avatar types. Because of the heterogeneous composition of the squads, squadmates were dependent on one another to accomplish certain tasks. We encouraged intra-squad teamwork further by controlling communications, creating a hierarchical communication system in which we determined who could talk to whom. In order to coordinate multi-squad tactics communication needed to be sent up the proper chain of command, involving the Platoon and Squad Leaders. The Platoon and Squad Leader positions

were determined by the participant's real-world rank and experience.

Training

Training for this exercise consisted of three phases. During the first phase of training, the existing in-game training was used to introduce players to the game functionality. For Training Phase II, we created a training arena in which players could practice using their avatars' skills (weapons) in an unstructured environment. For Training Phase III, we created a structured training mission that required the coordinated efforts of all squad members to succeed. In particular, this final training exercise was designed to encourage collaboration and coordination as being a key aspect of game play.

Scenario

Using the built-in scenario editor, the Aurora Toolset (Trademark of Bioware Corp, copyright 1997-2005), we created a scenario loosely based on "capture the flag." This design was chosen because it (1) could accommodate a relatively large number of participants, (2) is an engaging and competitive task, and (3) requires relatively modest development resources because it does not require extensive non-player character (NPC) development or the use of human confederates. In each of two camps, we placed a flag that indicated possession or ownership of that territory. To change possession of that territory, participants had to pull a lever placed adjacent to the flag. Once a lever was pulled, the territory would remain in the possession of the puller's platoon until a member of the opposing platoon gained control of the lever, thereby claiming it as their own. In addition to the levers in the two primary camps, a third flag and lever were located in a "Hidden Camp." Players were told that the hidden lever could be found somewhere in the environment, but were not given its specific location. The hidden camp was protected by NPCs who could inflict damage to the avatars.

The stated goals of the game were to:

- Goal 1: Defend your flag
- Goal 2: Capture the enemy's flag
- Goal 3: Capture and hold a third flag hidden in an unknown location

The Gorman's Gambit exercise consisted of three successive sessions. Each session involved running the scenario and initiating the mission from the same starting condition (each platoon in its own camp). To encourage different strategies, and resource trade-offs among the teams, we defined two different "winning conditions" for a mission. In the first condition, the winning platoon was the platoon that held the most flags at the end of 30 minutes. In the second condition, the winner was the platoon that held flags for the longest total amount of time by the end of 30 minutes. Table 2 indicates which condition was used in which game session. Players were instructed to maintain contact with their leaders, to assist their teammates, and to engage the opposing team in combat when necessary. In each session, players would communicate either (1) through Voice over Internet Protocol (VoIP) or (2) through text chat. This communication manipulation was conducted to gauge the effects of different communication mediums on teamwork behaviors and to emulate two use case possibilities: high and low bandwidth network conditions.

Table 2. Goal, Communication Mode by Session

Session	Goal	Communication Mode
1	Possession at end of 30 minutes	Voice-over IP
2	Possession for longest duration	Text chat
3	Possession at end of 30 minutes	Voice-over IP

Each session lasted 30 minutes and was preceded by a 15 minute planning period and followed by a 15 minute debriefing period. During planning, the platoons were placed in separate rooms for privacy. During this time, Platoon Leaders relayed their strategies for the subsequent session.

During each session, participants sat at computer stations which contained a monitor, keyboard, mouse, and headset. Team A was located in one large room, where they were seated as pairs at computer cubicles. Due to facility constraints, Team B was distributed among four rooms, with squads largely seated together.

During post-exercise debriefing, the two platoons were again divided into separate rooms. The debriefing periods were opportunities for each team to reflect on specific events during the session: successes, failures, and surprises. Lessons learned during the debriefing were noted and applied to future sessions. These debriefings were conducted by the platoon and squad leaders.

At the end of the third and final session and debriefing, an After Action Review (AAR) was conducted jointly with both teams. While debriefings

were opportunities to reflect on specific occurrences during the sessions, the AAR provided an opportunity to reflect on the potential for using MMPGs for training. Participants were asked questions by the facilitators, who also facilitated discussion. The AAR lasted approximately 30 minutes. A camera was used to videotape selected activities during each planning period, game session and debriefing, as well as to record the entire AAR.

Measures

The measurement emphasis was on the careful observation of teamwork skills. Several approaches were used in concert to elicit instances of teamwork, and are described below. Our aim was not to capture every instance of teamwork, but instead to obtain a sample of behaviors to use as evidence of the benefits or disadvantages MMPGs bring as training tools. To this end, the data collection approaches used were:

- *An In-Session Observation Tool*: Using a paper and pencil based form, observers documented several event details. These included: Time, Participants Involved, a detailed description of the event, the presence or absence of several key teamwork skills, ratings of those skills, and comments. Key teamwork skills assessed in this exercise include monitoring, back-up, team orientation, communication push and pull, and coordination. Observers used the operational definitions of each teamwork skill as described in Table 1. Some observation was done using a video camera, to allow for later coding.

- *Team Debriefs and Post-Session AAR:* Debriefing sessions provided many opportunities to capture instances of *adaptability, leadership, team orientation,* as well as overall gaming experiences. The AARs was semi-structured with a set of core questions to field to the participants. Facilitators conducted the final AAR and captured the event on videotape, with participants' permission. The questions addressed participant likes and dislikes of the game, team challenges, teamwork examples, strategies and adaptations, relevance to Army tactics and training, and comparison to other MMPGs.

- *Post-Exercise Questionnaire:* The Post-Exercise Questionnaire contained 21 questions, nineteen of which were responded to on a Likert scale of low (unfavorable) to high (favorable) ratings. The remaining five questions allowed for open-ended answers to further detail their experiences and opinions in addition to a rating. Questionnaires were completed anonymously and were labeled only by their team and avatar type (e.g., team A, medic), and participant number. Questions probed several areas: game experience, character knowledge, team interactions, self and team assessment, situational awareness of self and team, and practical applications of the game as a training tool.

RESULTS

Scenario Results

Final statistics were collected at the end of each mission, describing which team occupied each lever, and the total lever control times for each team. The overall results for each of the three scenarios were as follows:

Mission One

At the end of mission one, Team B possessed the majority of levers.

Mission Two

At the end of mission two, Team A had the longest total lever control time.

Mission Three

At the end of mission three, Team B possessed the majority of levers.

Results to Inform DARWARS

Based on the methods and measures described, we present a series of nine results regarding critical technological, logistical, and pedagogical issues discovered in the Gorman's Gambit exercise. These results reflect our goal of informing the development of a game-based training platform, and shed light on the requirements gaps and capabilities necessary for moving from gaming to training.

1. Teamwork skills can be observed in MMPGs.

Using multiple data sources including gameplay video, notes, and observer in-game evaluation forms, more than 115 examples of specific teamwork skills were extracted and reviewed. Most events involved multiple teamwork skills (5-6 skills), as teamwork skills often work in conjunction with each other, such as *leadership* and *monitoring* (Sims, Salas, & Burke 2004). The two skills have overlapping definitions that would make it probable, although not without exception, that where you have *leadership* you also have *monitoring* and visa versa. The teamwork skills demonstrated in this exercise suggest that MMPGs can support large-scale exercises in which many individuals with differing but complementary skills work together towards a single effort.

2. Any game-based training system must be robust.

The realization of distributed network-based training carries technical challenges. Training systems must be flexible and compatible while remaining hardened to prevent unintended usage. Necessary aspects of flexibility and compatibility include allowing for variations in: number of participants, computer and/or network configurations, communication and team hierarchy structuring, and complementary technology.

After Action Review responses indicated high frustration levels when opponent team members were able to take advantage of software vulnerabilities. For example, several soldiers found underhanded ways to bypass intentional game manipulations; by exiting and restarting the NWN application upon death, players were able to immediately respawn on location. In addition, by inviting opponent team members into chat groups, several players were able to view enemy communications during the text chat gaming session. These examples of soldier resourcefulness led to frustration and reduced effectiveness of the opposing team, and undermined the facilitator-imposed scenario structure. For these reasons, while the training product must be robust enough to allow for flexibility, it must also guard against user or environmental factors that could mitigate training value.

3. Targeted avatar design and rapid modification are critical for training effectiveness.

Training effectiveness is contingent upon modification and development of avatar characteristics in a manner that is quick and effective enough to correspond with the changing demands of players and trainers. For example, the Platoon Leaders were not satisfied with their characters' slow speed and low combat abilities, and believed these deficiencies detracted from their ability to lead their platoons effectively and gain their soldiers' respect. Targeted character attribute changes were made quickly and easily (i.e., in a matter of minutes), allowing content developers to increase the speed and combat effectiveness of these characters. Platoon Leaders reported increased levels of satisfaction and effectiveness as a result of this rapid manipulation. The incorporation of authoring tools tailored for NWN allowed for easy initial authoring as well as rapid character modifications. These tools required moderate amounts of technical expertise, but do have a GUI interface which allows rapid familiarization with functionality. The DARWARS training platform therefore requires built-in and easy to use authoring tools that allow distributed local trainers to adapt to changing training and user demands.

4. Targeted scenario design is critical for training effectiveness and operational acceptance.

The ability to quickly alter existing scenarios or create new targeted scenarios is fundamental to the development of DARWARS training. Existing gaming technology may provide a venue for occasionally practicing specific skills within the virtual gaming environment. However, highly effective training demands tailored scenarios that are *designed* to exercise specific skills, in a repeatable and consistent manner. Our development of infantry-specific gaming scenarios considered several aspects of basic infantry training in an effort to correspond with the participant pool. For instance, the NWN software is largely limited to ground-based interaction, congruent with the operational requirements of the infantry. There were several powerful analogies. NWN allows the artillery avatar to summon a small flying goblin. The soldier's point of view could be changed to take on the goblin's perspective and fly quickly through dangerous areas, avoiding traps and enemy engagement, and allowing for reconnaissance. This was quickly recognized as being analogous to the real-world function of a UAV. In addition, several soldiers commented that the resource and communication manipulations corresponded to actual military conditions. Gorman's Gambit required the manipulation of gaming aspects so that they would correspond with infantry operations. However, a variety of military users (e.g., Air Force, Marines, Navy, etc) will require the ability to cater game aspects to specific trainee populations.

5. Ease of conducting and maintaining a training session are critical for successful participation.

When managing the interaction of 40+ players, simple connectivity that is mostly transparent to the user is a necessity. Within NWN, setting up the client and getting started playing the game occurred in a matter of seconds. The simple networking capability of NWN allowed easy deployment on a large number of machines. If a restart of the server was needed (e.g., to start a new mission), the users could easily join the new game (within seconds). Without this capability, the exercise would have been constantly delayed. If the process of starting a session or correcting technical problems involves a significant amount of time or complications, the level of user participation and "immersion" will be highly affected.

6. Using gaming technology for training requires additional assessment tools.

The specific goals and objectives of a DARWARS training program require the corresponding assessment tools to monitor training progress and objective fulfillment. One limitation of the present research was the inability to incorporate built-in assessment measures for use during training. COTS gaming systems do not generally have the assessment components that are critical for effective training. Training systems require the ability to observe from a global perspective, collect data from measures of performance fully integrated into the simulator (e.g., text logs to allow for later communications analysis), and incorporate tools for AAR. Thus, the use of the NWN COTS software did not provide the opportunity to pursue such assessment methods.

7. Training superiority can be improved by carefully controlling level of fidelity.

Laptop- and desktop-based simulators do not have the same physical or visual fidelity as large simulators, but can reflect real-world characteristics to a high degree. Varying the degree of fidelity for certain dimensions based on training goals will provide training value to a low cost system. For instance, an important component of teamwork skills is communication and coordination. Thus, in the work reported here we attempted to provide an adequate and realistic communication capability. Our efforts were rewarded, for the soldiers commented that the communication system was a good analogue to their typical hierarchical system. The questionnaire results show (Figure 2) that soldiers thought they were able to push information at a high level to others, receive a high level of communications, and coordinate at a high level.

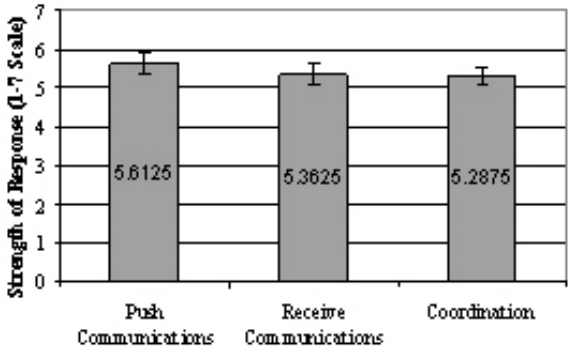

Figure 2. Average Ratings for Three Teamwork Behaviors

These aspects are all core elements of effective teamwork. Hence, the MMPG explored here – augmented with manipulation of communications flow to reflect operational conditions – produced situations capable of being the basis for effective training in that the skills of interest were elicited.

8. Training on the interface and avatar roles and skills is essential.

In this exercise, training took several iterations, with more than one phase – first individual skills and then teamwork skills – to facilitate effective interaction and coordination. In the first training phase, participants learned characteristics and capabilities of their characters. This aspect of the training paid off well. In a post-exercise questionnaire, the mean response to the item, "how well did you understand what your character was supposed to do?" was 6.2 out of 7. Clearly, the soldiers felt competent in exercising the capabilities of the character they controlled in the game. In the free-for-all format of the next training phase, participants practiced exercising the capabilities of their character and learned more about the dynamics of the game. During the final training phase, all the members of a team engaged a specially designed practice scenario to help them develop teamwork and foster coordination. Not only did this phased approach to training succeed, but the post-exercise questionnaire results indicated that the better soldiers understood their characters (i.e., the better trained they were to play the game), the greater the capacity for training and user acceptance. Moreover, soldiers rated the training program as moderately to highly effective, with an average rating of 4.9 (out of 7).

9. Low operational realism has both benefits and drawbacks.

The fantasy setting afforded the exhibition of the teamwork behaviors predicted by Gen. Gorman. Observers noted that participants were easily able to identify parallels between the components of the fantasy realm (small flying goblins) and equivalent military objects (UAVs). However, the departure form their operational environment also makes it more difficult for buy-in from military participants, as evidenced by their feedback. Some soldiers reported having difficulty taking on a military mind set while playing the game. It is plausible that this bias could inhibit skill transfer. The most frequent negative comment voiced during the AAR by soldiers was poor realism (43%). This indicates that a sizable minority of soldiers is conflicted by the game environment and

believes that more operational realism is required for adequate transfer of training to occur. However, the non-operational setting could easily be used to train critical thinking skills and challenge participants to engage appropriately in unfamiliar environments.

CONCLUSIONS

The military is interested in supporting effective large-scale distributed simulation-based training that will enhance and expedite soldier instruction. Within DARWARS, soldiers will have the opportunity to learn and practice a variety of skills on advanced PC-based training systems that cater to the demands of the individual operational environments. However, such large-scale development necessitates investigation into the training system's potential feasibility, capabilities, and implementation. Our analyses provided us with the opportunity to begin to answer several important questions regarding the use and augmentation of COTS MMPG software, the necessary MMPG technology characteristics for promoting and assessing teamwork training, and the key considerations to evaluate prior to development of MMPG-based training. Based on observation and participant interviews and surveys, we identified the following answers to our initial questions, to inform DARWARS with regard to the application of MMPG technology to warfighter training.

1. MMPG Role-Playing Games may be well-suited for supporting training of teamwork behaviors.

A variety of evidence demonstrated that teamwork does occur during MMPG game-play, in the form of coordination, leadership, monitoring, team orientation, back-up, adaptability, communications pushing and pulling, and closed-loop communication. The MMPG environment, therefore, is sufficient to produce instances of teamwork, and may provide an appropriate medium for instruction of military teamwork skills.

2. The augmentation of existing MMPG technology may be suitable for DARWARS training.

The modification of MMPG technology may be able to support potentially large variations in such factors as local technologies used, number of participants involved, and resourceful soldiers. The system must be compatible with a variety of PC platforms and network connections, stable through large and rapid fluctuations in numbers of participants, and resistant to resourceful and cunning participants. It may be possible to modify and/or augment MMPG software to arrive at gaming characteristics that satisfy these criteria. For example, existing MMPG gaming technologies do not have the components critical for teamwork training assessment. Specifically, monitoring of training progress and objectives fulfillment requires embedded tools for observation, in-game performance metrics, and tools for supporting AAR. An effective training platform should have the ability to measure and record operationalized performance variables of interest. This will enable local trainers to assess participant, team and global statistics in a short period of time, as well as facilitate fast and reliable AAR and objective progress monitoring. These assessment components are critical for the move from gaming to training (Weil et al., 2005).

In this study, we were concerned with evaluating the potential of Massive Multi-Player Games for training, rather than evaluating the training effectiveness of MMPGs. Collectively, the lessons learned from this exercise demonstrate MMPGs may be good models to emulate for military training. However, they also highlight several inherent challenges with using COTS gaming systems in assessment-intensive applications such as military teamwork training. Our results therefore support the potential use of MMPGs for training. If the assessment and lessons learned challenges are met effectively, then the vision of using existing technology to supplement military training has the potential to be fully realized.

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