

## FROM GAMING TO TRAINING

Jared Freeman, Ph.D., Jean MacMillan, Ph.D., Craig Haimson, Ph.D.,  
Shawn A. Weil, Ph.D., Webb Stacy, Ph.D., & Fred Diedrich, Ph.D.  
Aptima, Inc.  
Boston, MA & Washington, DC

Online games deliver engaging opportunities for practice. Training, however, is more than this; it is structured practice with feedback. To structure practice entails organizing a game's goals, tasks, roles, and assets so that they support training objectives. To provide feedback requires measurement and assessment of human behavior regarding those training objectives. To do both of these in turn requires that the game support scenario authoring, real-time monitoring and control of gameplay (training), During- and After-Action Review of performance, and periodic evaluation of the all of these functions and their effects on learning. Current games offer little or no support for many of these core training functions. We describe the place of online games as practice environments within the larger training system, several specific gaming environments we are applying to training, and pilot studies that illustrate the strengths and weaknesses of online games as training vehicles. (Keywords: Game, scenario design, performance measurement, feedback)

### INTRODUCTION

Online games deliver what much training lacks: experience so compelling it attracts and deeply engages users. Commercial sales figures make the case well. Sales of online games in the U.S. rose 167% in 2003 to \$1 billion (Mercury News, 2004). Sales in China's emerging market rose 64% to \$157 million the same year (IT Facts, 2004).

Many of these games – notably first person shooters, strategy games, and flight simulators – simulate military operations. Thus, it is not surprising that the defense community has shown an increasing interest in leveraging these technologies for military training.

What, precisely, is the enticing experience that online games offer to players? It is the opportunity to immerse oneself within a visually captivating environment and to exercise one's skills at a rapid pace, often in teamwork with others. In short, games offer *practice* in cue recognition, response, decision making, and team coordination<sup>1</sup>.

---

<sup>1</sup> Note that many games do not entirely satisfy the requirement of visual fidelity. These games do not faithfully replicate the appearance or behavior of objects warfighters must learn to recognize, and they do not provide a natural visual perspective on them. Physical fidelity of controls is also typically quite low (a gamepad may substitute for a steering wheel), and physical feedback (the impact of a bullet) is, of course, entirely lacking in games. Nevertheless, fidelity is usually sufficient to

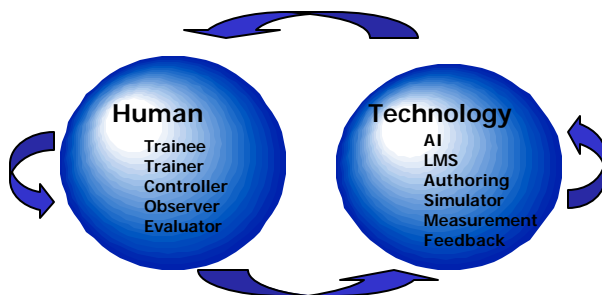
However, training is more than practice. It is *deliberate practice with feedback*. By "deliberate", we mean that practice exercises the knowledge and skills required for success in real-world missions, and that it does so with the depth and frequency needed to acquire or retain expertise. By "feedback", we mean that measures and assessments of performance are taken and delivered during or after gameplay. These are the conditions that have been empirically shown to foster expertise (Ericsson, 2004) in domains as diverse as computer programming, music, sports, and medicine.

With our colleagues at Aptima, we are exploring the role of gaming simulations for training in several recent projects sponsored by the Defense Advanced Research Projects Agency (DARPA), the U.S. Army, and the U.S. Navy. In this work, we have approached training as a dynamic system in which humans and technology interact. Humans serve several roles in this system: trainees, trainers, training controllers, observers, and researchers (interested in training effects), and evaluators (typically managers interested in the cost effectiveness of training systems). Training technologies include simulation environments (e.g., a game space), behavioral models (Artificial Intelligence (AI) or NonPlayer Characters (NPCs)), Learning

---

recreate the key situations required for exercising more cognitive competencies, such as decision making, as well as team coordination.

Management Systems (LMSs), scenario authoring tools, measurement systems, feedback systems, and other components. We represent these entities in Figure 1. Throughout this brief article, we indicate some of the key relationships within and between humans and technologies using the notation  $H_{\text{entity}} \leftrightarrow T_{\text{component}}$  to denote the flow of control or information ( $\leftarrow \rightarrow$ ) between a person (H) such as a trainer, and a technology (T) such as an authoring system. For example, a measurement system may assess trainee (in) actions ( $H_{\text{trainee}} \rightarrow T_{\text{measurement}}$ ), and a feedback system may present those assessments to trainees ( $T_{\text{feedback}} \rightarrow H_{\text{trainee}}$ ).



**Figure 1:** Training is a system of interactions within and between human users and technologies.

In the remainder of this article, we describe this research and our findings concerning the functions of training systems that games fulfill, and those that must be addressed through training procedures or implemented in software to make games in to training systems, in the full sense of the term.

### GORMAN'S GAMBIT

Gen. Paul Gorman (U.S. Army, Ret'd.) has asserted that commercial games can be used to train teamwork skills, regardless of whether the games depict modern or historic warfare (Gorman, July 2003). In a recent study conducted for DARPA and the Office of Naval Research, Aptima and prime contractor BBN Technologies tested this thesis (Weil et al, 2004; 2005). The findings from this study illustrate the potential of massively multiplayer games (MMPGs) for training, as well as their limitations.

**Design:** The research team evaluated several MMPGs to identify one that (1) simulated ancient or fantasy warfare, (2) supported as many as 40 players who were (3) differentiated by capabilities, (4) constrained

their communications to a modern military hierarchy, (5) allowed players to affect each others' missions, and (6) enabled trainer/controllers to observe game play. *Neverwinter Nights™* by BioWare Corp. was selected as the MMPG that best satisfied these requirements<sup>2</sup>. The game was augmented with a Voice Over IP (VOIP) network.

Forty U.S. Army Infantry soldiers participated in the study of teamwork within *Neverwinter Nights*. The soldiers were between 19 and 33 years of age ( $M= 23.6$  years) with 1.5 to 174 months of military experience ( $M= 51.2$  months). Participants ranged from E-2 (Private) to O-1 (Second Lieutenant) ( $M= E-5$ , Sergeant). The participants averaged 51.2 months of military service, and 25 of the 40 had been deployed within the last year. They averaged 3.7 hours per week of computer use in the preceding year, and 4 hours of game-playing weekly on PCs or console systems (e.g., Playstation, Nintendo).



**Figure 2:** Opponents battle in *Neverwinter Nights™* (BioWare Corp.)

<sup>2</sup>Other games evaluated in this study were *Ultima Online*, trademarked by Electronic Arts, Inc.; *Everquest*, trademarked by Sony Computer Entertainment America Inc.; *Dark Age of Camelot*, trademarked by Mythic Entertainment, Inc.; *World War II Online*, trademarked by Playnet Incorporated; *Battlefield*, trademarked by Electronic Arts, Inc.; *Final Fantasy*, trademarked by Square Enix Co., Ltd; *Star Wars Galaxies*, trademarked by Lucasfilm Entertainment Company Ltd.; *PlanetSide*, trademarked by Sony Online Entertainment, Inc.; and *Unreal Tournament*, trademarked by Epic Games, Inc. *Neverwinter Nights* is a trademark of Wizards of the Coast, Inc.

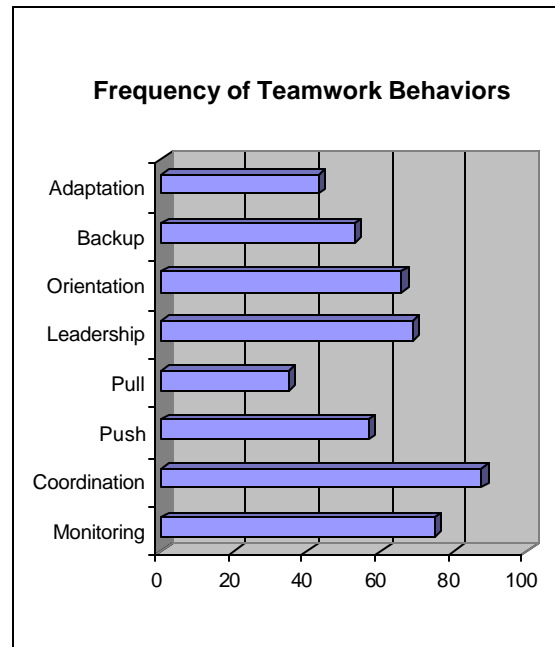
In this study, the soldiers played on two competing teams of 20 members each, organized hierarchically as one platoon leader, and three squads each consisting of a squad leader and five or six specialized soldiers.

The research team configured the game to require and afford a set of teamwork behaviors that are well established in the research literature: coordination through planning, leadership, monitoring, backup, communications push and pull, team orientation, and adaptation (Cannon-Bowers, et al., 1995; Freeman, et al., 2003; Sims, Salas, & Burke, 2004; Smith-Jentsch, et al., 1998). In particular, the authors systematically varied the capabilities of avatars. Each squad consisted of an archer, medic, artillery specialist, scout, and one or two strongmen, in addition to the squad leader. Tasks in the simulation space were designed to require coordinated use of their specialized skills. The VOIP communications network was configured to constrain communication realistically, allowing talk only between leaders at the two echelons, and within squads.

On the first day of the study, participants engaged in six hours of training to learn *Neverwinter Nights* and practice coordinating as a team. On the second day, participants executed three games of capture the flag. Measures of teamwork process and outcomes were taken by observers. Participants' observations and comments were also gathered in debriefings and in a post-study survey. This measurement strategy captured a convenient sample of teamwork behaviors (but did not systematically measure all instances of teamwork behavior).

**Findings:** The findings from this study illustrate the potential role of online games in training systems.

This carefully designed instance of a medieval military MMPG elicited teamwork behaviors in all of the targeted categories. The game provided soldiers with practice in teamwork skills ( $T_{\text{simulator}} \rightarrow H_{\text{trainee}}$ ) (see Figure 3). Most trainees (80%) stated this in their assertions that the game bore a functional relationship to modern military practice, and in particular that the communications system replicated current, hierarchical networks.



**Figure 3:** Gameplay in *Neverwinter Nights*<sup>TM</sup> elicited all of the targeted teamwork behaviors.

Games are often recommended for training because they are challenging and engaging. Ironically, participants in this study found this game only moderately exciting and interesting (rating it 4 on average on a scale of 0 to 7), and not at all stressful (rating: 1.7). There are several possible explanations for this finding. Trainees may not have reached the level of expertise with the interface or team strategies to fully enjoy and engage in the game. Alternatively, a more intensive scenario may have been needed, or a more rapidly paced study. Finally, it may be that some trainees were simply disinclined to engage with the online game. In the commercial environment, users are self-selected: less interested users never begin playing games, or quit them. In training, all trainees *must* play. Those disinclined to play may learn less. This attitude x treatment interaction requires further research.

Some functions of *Neverwinter Nights* proved particularly useful for training.

The ability to define avatars and the environment was critical to this study. Both were defined to support and require teamwork between participants, and in particular, teamwork related to several specific and empirically validated skills. Avatar and environment authoring is supported by some

gaming systems. However, no authoring system to our knowledge constrains design so that it is relevant to training objectives. ( $H_{\text{trainer}} \rightarrow T_{\text{authoring}}$ ). This is an open area for research and development.

AI entities in the game provided useful introductory training concerning NWN's capabilities and user interface ( $T_{\text{simulator}} \rightarrow H_{\text{trainee}}$ ). However, it was necessary to supplement this with training ( $H_{\text{trainer}} \rightarrow H_{\text{trainee}}$ ) and practice runs ( $T_{\text{simulator}} \rightarrow H_{\text{trainee}}$ ) designed to familiarize trainees with avatar capabilities and teamwork techniques prior to the start of the game.

The researchers were able to monitor trainee teamwork by using an observer function (a Dungeon Master) within the virtual environment. This allowed them to survey the field of play unseen by the trainees ( $H_{\text{observer}} \rightarrow H_{\text{trainee}}$ ). In addition, researcher / controllers were able to manipulate the gamespace and avatars during play, as was the case when they "lifted" some avatars out of a space that trapped them artificially and unrealistically ( $H_{\text{controller}} \rightarrow T_{\text{simulation}}$ ). Between games, the researchers used the rapid authoring tools of Neverwinter Nights to refine the capabilities of avatars (e.g., making platoon leaders more powerful and speedy) and the characteristics of some objects in the environment ( $H_{\text{controller}} \rightarrow T_{\text{simulation}}$ ).

This game, like most, provided no trainer-controllable functions for measuring human behaviors, such as teamwork ( $H_{\text{trainee}} \rightarrow T_{\text{measurement}}$ ). Thus, observers manually rated performance, and we collected participants' subjective ratings. This strategy is often necessary; always costly; and produces data that are incomplete, poorly sampled, and sometimes inaccurate due to the perceptual limitations of observers and trainees, and a host of nearly inescapable cognitive biases – such as primacy, recency, anchoring (Kahneman, Slovic, and Tversky, 1982) – that slant recall, interpretation, and assessment

In addition, all debriefing was conducted by participants with no support from the gaming technology in the form of scenario replays or performance assessments. Many military trainers prefer this debriefing strategy because it engages trainees in critiques, diagnosis, and argument – all useful skills for learning and mission execution. However,

some research is underway concerning the potential for automatically retrieving critical scenario events as an aid to debriefers (see T-CAST, below;  $T_{\text{feedback}} \rightarrow H_{\text{trainer}}$ ), and automatically presenting assessments of performance for solo trainees (see STRATA, below;  $T_{\text{feedback}} \rightarrow H_{\text{trainee}}$ ).

In sum, Neverwinter Nights provided a productive team practice environment and certain authoring and observer/controller tools. However, it was necessary to manually constrain authoring to focus on teamwork training objectives, and to supplement this game with human measurement and feedback processes.

### T-CAST: TEAM COACHING ASSISTANT FOR SIMULATION-BASED TRAINING

In an ongoing effort for the U.S. Army Research, Development and Engineering Command – Simulation and Training Technology Center (RDECOM-STTC), Aptima and BBN Technologies are developing T-CAST (Team Coaching Assistant for Simulation-Based Training). T-CAST is an intelligent subsystem that augments the teamwork training capabilities of a MMPG: the Asymmetric Warfare - Virtual Training Technology (AW-VTT, see Figure 4) under development by Forterra Systems and RDECOM-STTC.



**Figure 4:** Forterra Systems' Asymmetric Warfare – Team Training Technology (AW-VTT) is a MMPG being developed for asymmetric warfare training.

AW-VTT is a prime example of a commercial MMPG technology that is being modified for use as a military training tool. Like Neverwinter Nights™, AW-VTT presents an environment in which human trainees can control avatars that execute military missions in a visually rich game space; however, AW-VTT simulates real-world operational

environments (e.g., a modern urban landscape in the Middle East) and characteristic US forces and capabilities. AW-VTT is specifically designed to recreate conditions associated with asymmetric urban warfare. Asymmetry is a discrepancy between the strengths of friendly and hostile forces, one that drives the enemy to use snipers, improvised explosive devices, and other techniques. In urban settings, friendly forces respond by using specialized procedures for controlling crowds, patrolling streets, and searching buildings.

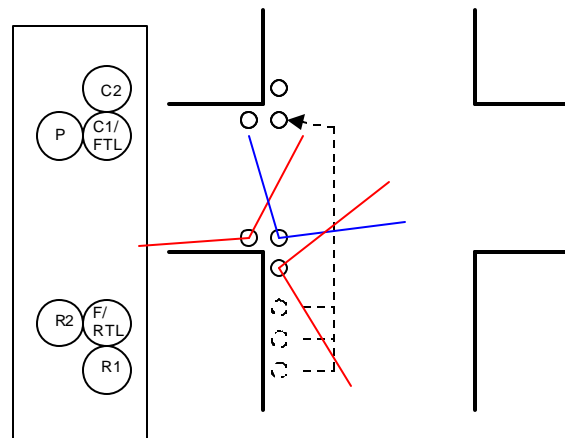
The function of T-CAST is to recognize emergent teamwork events within AW-VTT and to index them so that trainers can rapidly retrieve and review them during debriefing. A pilot study explored a method for developing basic training and assessment for a MOUT scenario simulated within AW-VTT.

**Design:** The pilot study consisted of three phases: scenario design, scenario execution, and development and evaluation of behavior models.

In the design phase, the team mapped extent teamwork theory (Sims, Salas, & Burke, 2004) to basic MOUT tactics, techniques, and procedures (TTPs) for conducting a street patrol with a squad of dismounted infantrymen. The researchers then developed a simple scenario that exercised these TTPs ( $H_{\text{trainer}} \rightarrow T_{\text{authoring}}$ ) by (1) crafting a basic story with support from an SME, (2) fleshing out details in accordance with Army doctrine, and (3) modifying these details to align with the capabilities of the AW-VTT simulator. (For example, certain standard hand signals were modified to accommodate the gestures currently available to avatars). The team additionally identified potential errors that could occur during the scenario, either as omissions of described behaviors or as incorrect deviations from the prescribed activities. Several of these errors were incorporated within the scenario script.

During scenario execution, six participants played out the scenario in AW-VTT, maneuvering their avatars along streets, across intersections, and around doorways and other potential threat locations in accordance with Army doctrine ( $H_{\text{trainee}} \rightarrow T_{\text{simulator}}$ ) (see Figure 5). Participants replicated

both correct and incorrect behaviors defined within the scenario script.



**Figure 5:** Crossing an intersection, two fire teams cover and bound around one another. T-CAST will recognize the execution of maneuvers such as this.

In the modelling phase, we prototyped human behavioral models that captured the activities described in the scenario script. We first developed a set of instructions for each player that explicitly defined the doctrinal behaviors that players were expected to demonstrate through control of their avatars within the scenario, as well as the conditions under which these behaviors were required. We encoded these instructions within finite state network models and validated these models by providing them with artificial simulator data and evaluating their responses to ensure completeness (all behaviors were accounted for) and consistency (there were no contradictions or mismatched dependencies within or across player models).

#### **Findings:**

This exercise demonstrated a principled method for developing scenarios for use in MMPG-based military teamwork training. AW-VTT proved to be an effective platform on which to deliver this training, simulating many of the behaviors from which critical teamwork competencies and specific knowledge and skill deficits implicated in infantry TTPs could be assessed. In subsequent review of the simulation video, we verified that all correct and incorrect behaviors described in the scenario scripts were observable and classifiable.

The effort also resulted in the development of human behavioral models that illustrate a capability (now being refined and implemented) to encode typical tactical problems and solutions. This capability will ultimately allow the T-CAST pattern-matching subsystem to recognize and record instances of key operational situations occurring within the simulation environment ( $T_{\text{simulation}} \rightarrow T_{\text{measurement}}$ ), as well as trainee responses to these situations ( $H_{\text{trainee}} \rightarrow T_{\text{measurement}}$ ).

We concluded from this brief feasibility study that the AW-VTT MMPG supports presentation of scenarios that tap teamwork competencies. However, a principled process for authoring scenarios will be required to ensure that practice addresses teamwork skills. In addition, we concluded that it is possible to model and automatically recognize both the emergent situations in which teamwork skills should be exercised and the exercise of those skills. These functions can facilitate performance assessment and evaluation, critical components required for transforming games into training.

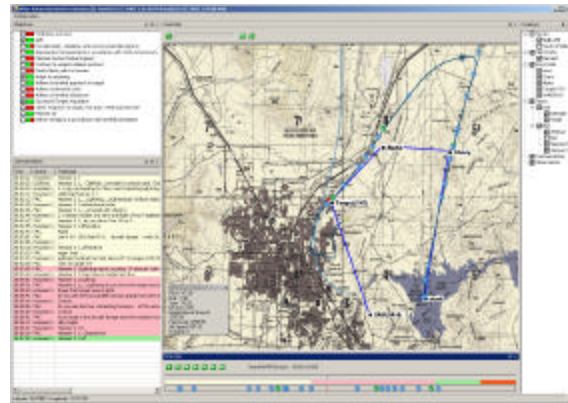
### STRATA

U.S. Navy aviators practice coordinating with other air wing elements during exercises at the Naval Strike and Air Warfare Center (NSAWC) air wing training detachment. However, this coordination training is expensive, logistically complex and, thus, rare. Between the infrequent exercises, trained skills degrade quickly (Arthur, Bennett, Stanush, & McNelly, 1998).

As part of the DARWARS program (see above), several organizations are collaborating to augment a high fidelity, laptop flight simulator (Airbook) with a variety of training functions. The product, STRATA, will provide Synthetic Teammates for Realtime Anywhere Training and Assessment (Bell, Johnston, Freeman, and Rody, 2004). The project team is led by CHI Systems and includes Aptima, Visual Training Solutions Group, and NAVAIR / Orlando.

Airbook (by VTSG) is a high-fidelity simulation of the displays, flight controls, weapons, sensors, and flight characteristics of an F/A-18 fighter jet. It runs on a laptop augmented with two, high-quality flight controls. An HLA interface (by MÄK Technologie s) provides

interoperability between the simulation and other components of the STRATA training system. The most critical of these are the following.



**Figure 6:** The STRATA AAR system presents a tactical replay with popups / rollovers describing entities and assessments of actions (center), map overlay controls (right), assessment on training objective (top left), and auto-transcribed communications (bottom left).

Behavioral models (created by CHI Systems) serve as intelligent, interactive teammates in STRATA's close air support scenarios (CAS). The models can fly an Airbook F/A-18 as wingman or flight lead ( $T_{\text{ai}} \rightarrow T_{\text{simulator}}$ ), serve as Forward Air Controller, and communicate verbally with the human user in either role ( $T_{\text{ai}} \leftrightarrow H_{\text{trainee}}$ ).

The STRATA training configuration system takes data concerning training mission (e.g., CAS), user role (e.g., flight lead), training objectives (e.g., situational awareness, adherence to planned route, response to threats, communications), and other data to automatically populate a brief, select and configure performance measures ( $T_{\text{LMS}} \rightarrow T_{\text{measurement}}$ ), and select a debriefing format.

Aptima's performance measurement system in STRATA leverages verbal communications data from the behavioral models, and event data from the simulation to measure (score) and assess (convert scores to evaluations such as pass/fail) performance on each active training objective. In recent work (Stacy, et al., 2005), we have developed a Human Performance Measurement Language for expressing the attributes of human performance in games and simulations. In addition, Aptima has implemented software for graphically designing measures, automatically

implementing code, computing measurements and assessments, and displaying them.

STRATA measures and assessments are presented by an After Action Review (AAR) system that supports review by replay (the traditional AAR strategy). The AAR also introduces tools that support review by training objective, in which the user selects training objectives of interest, the AAR display marks the location of relevant assessments on a tactical map, and the user replays the action and communications at those points in a focused effort to diagnose failures and successes (see Figure 6;  $H_{\text{trainee}} \rightarrow T_{\text{feedback}}$ ). An automated debriefing presentation has also been implemented to supplement the manual modes just described. ( $T_{\text{feedback}} \rightarrow H_{\text{trainee}}$ ).

In sum, STRATA augments a laptop simulation with AI plus and briefing, measurement, and feedback that are focused on training objectives. All of these are important components of a training system; the last few are rarely found in games.

**CONCLUSION**

In the studies and development efforts described above, Aptima and its partners are attempting to define the role of online games in training, augment the capability of games, and test the effects of training-enabled games on learning.

There are several ways to enable games for training. We and our partners have added technology external to games (such as voice communication systems), integrated technology into games (such as measurement systems), developed strategies for leveraging the native capabilities of games (e.g., strategies for designing avatars, environments, and events so that they are relevant to training objectives), and developed training procedures (e.g., familiarization practice that prepares trainees to use and learn from games). Table 1 summarizes some of the strategies that address common challenges in the use of games for training.

Future research and development should leverage these strategies, and explore new ways to transform games into training systems.

**ACKNOWLEDGEMENTS**

This work was supported by DARPA, the Office of Naval Research, and U.S. Army RDECOM-STTC. The opinions expressed here are those of the authors, and not necessarily those of the U.S. Department of Defense.

**Table 1:** Functions required to create training systems using online games. ( $\rightarrow$  denotes control flow or information flow).

Relation	Required training function
$H_{\text{trainer}} \rightarrow T_{\text{authoring}}$	Guide the design of environments, avatars, and events so that they are relevant to the training audience & training objectives
$T_{\text{LMS}} \rightarrow T_{\text{measurement}}$	Support rapid game configuration / customization for the trainees and training objectives at hand
$T_{\text{simulator}} / H_{\text{trainer}} \rightarrow H_{\text{trainee}}$	Train the use of game controls, team roles, and teamwork behaviours
$H_{\text{observer}} / T_{\text{simulation}} \rightarrow H_{\text{trainee}}$	Enable observers to monitor gameplay
$T_{\text{simulator}} \leftrightarrow H_{\text{trainee}}$	Provide trainees with the perceptual cues and action controls required to train targeted skills
$T_{\text{ai}} \rightarrow T_{\text{simulator}}$	Provide intelligent teammates and opponents required to create a realistic mission environment
$T_{\text{ai}} \leftrightarrow H_{\text{trainee}}$	Enable intelligent entities to communicate and interact with trainees
$H_{\text{controller}} \rightarrow T_{\text{simulation}}$	Enable controllers to change the environment & events during game play
$T_{\text{simulation}} \rightarrow T_{\text{measurement}}$	Recognize emergent opportunities to test & measure targeted skills
$H_{\text{trainee}} \rightarrow T_{\text{measurement}}$	Measure the behaviors and effects of individuals and teams
$H_{\text{trainer}} / H_{\text{trainee}} \leftrightarrow T_{\text{feedback}}$	Enable trainers & trainees to retrieve specific assessments and replays in debriefs
$T_{\text{feedback}} \rightarrow H_{\text{trainee}}$	Automatically, intelligently display assessments and replays to trainees

## REFERENCES

- Arthur Jr., W., Bennett Jr., W., Stanush, P. L., and McNelly, T. L. (1998). Factors that influence skill decay and retention: A quantitative review and analysis. *Human Performance*, 11, 57 – 101.
- Bell, B., Johnston, J., Freeman, J., & Rody F. (2004). STRATA: DARWARS for Deployable, On-Demand Aircrew Training. In *Proceedings of the Interservice/Industry Training, Simulation, and Education Conference (I/ITSEC)*, December, 2004.
- Cannon-Bowers, J.A., Tannenbaum, S.I., Salas, E., & Volpe, C.E. (1995). Defining team competencies and establishing team training requirements. In R. Guzzo & E. Salas (Eds.), *Team effectiveness and decision making in organizations* (pp. 330-380). San Francisco: Jossey-Bass.
- Chatham, R.E., and Braddock, J. (2001). Report of the Defense Science Board Task Force on Training Superiority and Training Surprise (Washington, DC: Office of the Undersecretary of Defense for Acquisition, Technology, and Logistics, 2001), 5, <http://www.acq.osd.mil/dsb/trainingsuperiority.pdf>
- Chinese online game sales nearly doubled. (16 January 2004). ITFacts. On line at: <http://www.itfacts.biz/index.php?id=P562>
- Ericsson, K. Anders. (2004). Deliberate practice and the acquisition and maintenance of expert performance in medicine and related domains. *Academic Medicine*, 79, 10, S70-81.
- Freeman, J., Diedrich, F. J., Haimson, C., Diller, D. E., & Roberts, B. (2003). Behavioral representations for training tactical communication skills. *Proceedings of the 12th Conference on Behavior Representation in Modeling and Simulation*, Scottsdale, AZ.
- Gorman, Paul. (July 2003). Comments at DARWARS program meeting. Washington, D.C.
- Kahneman, D., Slovic, P. & Tversky, A. (Eds.). (1982). *Judgment under Uncertainty: Heuristics and Biases* Cambridge, UK: Cambridge University Press
- Online game sales surpass \$1 billion in U.S. (24 March 2004). Mercury News. On line at: <http://www.siliconvalley.com/mld/siliconvalley/8263163.htm>
- Sims, D.E., Salas, E., & Burke, C.S. (2004). Is there a "Big Five" in teamwork? 19th Annual Conference of the Society for Industrial and Organizational Psychology, Chicago, IL.
- Sims, D.E., Salas, E., & Burke, C.S. (2004). Is there a "Big Five" in teamwork? 19th Annual Conference of the Society for Industrial and Organizational Psychology, Chicago, IL.
- Smith-Jentsch, K.A., Zeisig, R.L., Acton, B., & McPherson, J.A. (1998). Team dimensional training: A strategy for guided team self-correction. In J.A. Cannon-Bowers & E. Salas (Eds.), *Making decisions under stress: Implications for individual and team training* (pp. 271-295). Washington, DC: American Psychological Association.
- Stacy, W., Merket, D., Freeman, J., Wiese, E., Jackson, C. (2005). A Language for Rapidly Creating Performance Measures in Simulators. *Proceedings of the Interservice/Industry Training, Simulation and Education Conference*, Orlando, FL.
- Weil, S.A., Hussain, T.S., Brunye, T., Sidman, J., & Spahr, L. (2005). The Use of Massive Multi-Player Gaming Technology for Military Training: A Preliminary Evaluation. Submitted to Human Factors and Ergonomics Society 49th Annual Meeting, Orlando, FL.
- Weil, S.A., Hussain, T.S., Diedrich, F.J., Ferguson, W., & MacMillan, J. (2004). Assessing Distributed Team Performance in DARWARS Training: Challenges and Methods. *Proceedings of the Interservice/Industry Training, Simulation, and Education Conference*, Orlando, FL.

## ABOUT THE AUTHORS

Jared Freeman, Ph.D., is Vice President for Research at Aptima. Dr. Freeman holds a Ph.D. in Cognitive Psychology from Columbia University and a M.A. in Educational Technology from Teachers College, Columbia University.

Jean MacMillan, Ph.D., is Chief Scientist at Aptima. Dr. MacMillan holds a Ph.D. in Cognitive Psychology from Harvard University, an M.C.P from Harvard University, and a B.A. from Antioch College.

Craig Haimson, Ph.D., is Team Lead for Cognitive Training and Educational Systems at Aptima. Dr. Haimson received a Ph.D. in Cognitive Psychology from Carnegie Mellon University and a B.A. in Psychology from Harvard University.

Shawn Weil, Ph.D., is an Experimental Psychologist in the Cognitive Systems Group at Aptima. Dr. Weil received his M.A. and Ph.D. in Experimental Psychology from The Ohio State University, and a B.A. in Psychology/Music from Binghamton University.

Webb Stacy, Ph.D., is Vice President for Technology at Aptima. Dr. Stacy received a Ph.D. in Cognitive Science from SUNY/Buffalo, and a B.A. in Psychology from the University of Michigan.

Frederick Diedrich, Ph.D., is Director of the Human Performance Division at Aptima. Dr. Diedrich holds a Ph.D. in Cognitive Science and a M.S. in Experimental Psychology from Brown University, and a B.A. in Psychology from Hamilton College.

Details concerning the professional experience of these authors, as well as contact information, can be found at: [www.aptime.com](http://www.aptime.com).