APPLICATION OF COMMERCIAL PERSONAL COMPUTER GAMES TO SUPPORT NAVAL TRAINING REQUIREMENTS: INITIAL GUIDELINES AND RECOMMENDATIONS

David S. Coleman
Sonalysts, Inc.
Waterford, CT
Dr. Joan H. Johnston
Naval Air Warfare Center Training Systems Division
Orlando, FL

The Department of Defense has been implementing a number of commercial PC simulation games to support surface, subsurface, and battle group individual and team tactical training. Many of these low cost games offer realistic and accurate graphical and dynamic depictions of U.S. and foreign surface ship, air, and submarine platforms. In addition, the sophisticated 3-D visualization, challenging tactical scenarios, and the high level of interactivity presented in the current generation of PC games is appealing to today's computer-literate young officers and enlisted personnel, creating a potentially effective learning environment. Conversely, features added to some products to increase entertainment and gamesmanship for the broader commercial audience may misrepresent actual combat situations, conditions, or available information that could adversely impact potential training value. This paper examines the advantages and disadvantages of using commercial PC games for naval training applications and offers recommendations and guidelines for integration of these products into Navy training curricula.

Mr. David S. Coleman is the Vice President for Training Systems and Operations at Sonalysts, Inc., Waterford, CT. He has a B.S. degree in International Security Affairs from the U.S. Naval Academy, 25 years of Navy and Naval Reserve operational experience, and approximately 20 years of experience in the management and development of advanced Navy training systems and programs. Recently, he provided scenario and database development support for the new commercial computer game ***Jane's Fleet Command***™ developed as part of the **Electronic Arts' *Jane's Combat Simulations*** series.

Dr. Joan H. Johnston received her Ph.D. in Industrial/Organizational Psychology from the University of South Florida. Dr. Johnston is a Senior Research Psychologist in the Science and Technology Division of the Naval Air Warfare Center Training Systems Division (NAWCTSD). She is responsible for conducting behavioral research to develop training and simulation principles for the Tactical Decision Making Under Stress (TADMUS) applied research program. Her research focus is applied and advanced research and development in the areas of embedded training, team training, and training for decision making.

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INTRODUCTION

The use of "games" in Naval training is not a product of the computer age. Gaming has been used at the Naval War College since the 19th century in the teaching of strategy and tactics. However, the introduction of the microcomputer in the 1970's facilitated the development and implementation of the first broad use of a computer-based tactical game for training - the Navy Tactical Game or NAVTAG. NAVTAG was a menu-driven software program hosted on an early microcomputer that enabled multiple opposing players to conduct tactical employment of forces and combat systems against each other in a turn-based fashion. Classified at the time, the database was composed primarily of U.S. (Blue) and Soviet (Red) naval surface, submarine, and aviation forces and their associated weapon systems. NAVTAG provided a viable tool to teach tactical strategies and familiarization of threat platforms and weapons systems. However, the lack of any significant graphics capability and the serial play requirements (versus real-time/parallel play) resulted in limited realism and sustained student interest.

Military computer games appeared in the commercial marketplace in the 1980's with the introduction of personal computers. These games provided novel interest and entertainment to the military gaming enthusiast, but still lacked sufficient visual and performance realism to be considered as serious tools for tactical training. More recently, the introduction of affordable high-speed Pentium™ processors has vastly expanded random access memory (RAM), hard disk capacity, and high-performance videocards. These revolutionary improvements enabled a number of commercial gaming companies to design and develop a number of PC military simulation games with 3-D graphical animations and performance previously available only on high-end workstations. In addition, to dramatically improve visualization, gaming companies have teamed up with reputable military data sources (e.g., Jane's Defense) to ensure game performance and databases reflect real-world platforms, combat and sensor systems, and operating environments.

Moreover, Navy research conducted in the past decade has empirically demonstrated that low cost "table top" PC-based simulations can support instructors in training students to learn complex individual and team knowledge and skills. For example, a number of researchers have found PC-based simulations can support development of assertiveness, teamwork, crew coordination, interpositional knowledge, stress management, and tactical decision making (Baker et al., 1993; Bowers et al., 1992; Brannick et al., 1995; Inzana et al., 1996; Johnston et al., 1998; Smith-Jentsch et al., 1996; Volpe et al., 1996).

Most of the military services are evaluating the use of commercial PC games as possible training support tools. The Air Force is evaluating several such games as **DID's *F-22 Total Air War***, ***Jane's F-15***, and **Microprose *Falcon 4.0*** as potential, low-cost flight simulators. The Air Force is also considering working with game developers for the possible development of command strategy games. **MaK Technologies** is modifying their ***Spearhead*** tank simulation for the Army and building ***MEU 2000*** for the Marine Corps under SBIR efforts.

Current commercial PC games being evaluated for use in tactical training by a number of Navy training commands include: ***Jane's Fleet Command™***, ***688(I) Hunter/Killer™***, and ***Harpoon 97™.*** In addition, **Graphic Simulation's *F/A-18 Korea™*** and **Microsoft's *Flight Simulator™*** are being evaluated for potential naval aviation training support applications.

To assist in the evaluation and implementation process, this paper provides a listing of capabilities and

limitations in using commercial PC games for naval training, followed by suggested guidelines and recommendations for optimal use as inexpensive, yet potentially effective tactical training tools. These guidelines and recommendations are based on interactions with, and feedback from, Navy training commands currently using, or planning to use, PC games in their curriculum; a review of past and present game integration efforts; and Sonalysts' lessons learned as a commercial, military-simulation game developer with 15 years of experience as a developer of computer-based tactical trainers.

TRAINING SUPPORT CAPABILITIES OFFERED IN COMMERCIAL PC MILITARY SIMULATION GAMES

Commercial PC games can provide the Navy training and simulation community with accurate and realistic virtual operating environments in which students can learn and practice tactical skills and decision making. The success of a commercial game is primarily dependent on sales. Sales to the mainstream gaming audience is driven to a significant degree by the level of realism and detail in the supporting graphics and animation presented in the game. More importantly, it is the ability to orchestrate these visualization components in the creation of a convincing virtual environment that ensures sustained player interest. To meet the commercial demand for this realism, gaming companies are investing a significant portion of their development costs into detailed terrain mapping and topographical replication corresponding to specific geographic locations and areas of potential military conflict. A more precise environmental replication is complemented by increasingly more detailed and accurate graphical depiction (including movement and interactivity) of game entities or objects.

Appearance and performance of military platforms, weapon systems, and sensors are modelled accurately in today's commercial PC games. Most of the physical and performance specifications of military surface, subsurface, and air platforms, and their associated weapons and sensor systems are available in such unclassified, off-the-shelf references as *Jane's Fighting Ships* or U.S. Naval Institute's *Combat Fleets of the World*. Commercial game developers have incorporated this data into their simulation software ensuring a high degree of accuracy in the performance of each entity in their games. In addition, many game developers work closely with experienced military subject matter experts (SMEs) during game design and development to provide first-hand descriptions of how specific platforms are employed and perform in actual military operations. For example, using the maneuvering controls shown in Figure 1, ***688(I) Hunter/Killer*** offers the look and feel of conning a nuclear attack submarine. Gameplay is also enhanced in most military simulations by the use of "intelligent" platforms or agents that employ the use of artificial intelligence (AI) to allow objects not under player control to react realistically given variations in a tactical situation (e.g., fire a self-defense weapon system in response to an in-coming missile).

Most commercial military simulations allow operators to conduct gameplay at a selectable level of difficulty. This flexibility in level of play is very important in allowing operators (or students) to set challenging, yet attainable goals in performance, thus reducing frustration while maintaining interest. A significant attribute of computer-based gaming is the implementation of specific, challenging goals, such as the accumulation of points, leading to a final game-winning criterion. Goal-setting has consistently been found to be a powerful moderator of performance when compared to the performance of individuals given vague goals (Latham & Locke, 1987). Goal setting and attainment can be more accurately measured in newer PC games due to improved performance assessment and replay capabilities.

Many commercial military games can be played in a multiplayer configuration over a local area network (LAN) or the Internet. The multiplayer capability offers the possibility to support training in Navy command, control, and communications associated with multiplatform operations in a team or single operator environment. In fact, the commercial PC gaming community is taking multiplayer capability and connectivity to a new level with the creation by ***Jane's Combat Simulations*** of a multiplayer, persistent-state, online combat simulation "world" called ***Jane's World War*** (McDonald, April 1999). Players around the world would be able to plug into an ongoing world war scenario. This remote multiplayer capability also makes these games potentially useful in supporting Navy, Naval Reserve, and NROTC distance learning requirements. The portability and broad availability of these games offer the potential for their use in supporting individual study or independent practice in tactical concepts at home, at sea, or at a shorebased training facility.

Figure 1. 688(I) Hunter/Killer Maneuvering Controls

Another advantage of the multiplayer configuration is the ability to set up opposing forces run by different players. This capability gives Navy instructors the option of controlling opposing forces against a group of students in an exercise to develop skills in a particular tactical area or against a specific operational situation. Conversely, if the number of instructors is limited, the AI capabilities offered in the game could be sufficiently robust to allow multiple students to participate in challenging scenarios without a game controller "in the loop."

The ability to develop and customize tactical scenarios makes PC games a powerful instructor support tool for use in teaching naval tactics and decision-making specific to a particular threat, geographic area, or operating environment. Until recently, most commercial PC military games offered a set number of pre-defined scenarios with little or no option for modification. While the scenarios offered might be engaging, they were developed specifically to be entertaining with no intent to support Navy training objectives. More recent games offer a highly flexible and user friendly scenario modification capability or "mission editor." Using a mission editor, Navy instructors can create scenarios tailored to support practice in one or more tactical training objectives or mission areas. Examples of some of these editing selections are: country, number and type of ship, submarine or aircraft, geographic location and operating area, composition of friendly, threat, and neutral participants, atmospheric and acoustic environment, formation and transit tactics, and mission goals and objectives. Equally important is that an entire mission scenario can be developed in a matter of minutes allowing instructors to quickly replicate ongoing, anticipated, or historical real-world tactical situations. Figure 2 shows an example of a ***Jane's Fleet Command*** battlegroup.

The implementation of off-the-shelf or modified commercial PC games for tactical training support can offer a distinct cost advantage over traditional trainer development approaches. The submarine

force has been using ***688(I) Hunter/Killer*** "out-of-the-box" as an informal tactical training tool for over a year. The U.S. Naval Academy is integrating ***Jane's Fleet Command*** as the centerpiece for the midshipman Strategy and Tactics course. Costs associated with the implementation of this tactical training approach are the retail cost of $40.00, or less, per game. Taking this approach a step farther, the Navy has contracted with the game developer to add various model enhancements and functionality to ***688(I) Hunter/Killer*** to better support specific submarine training requirements. Costs for the modifications are minimal.

Commercial PC games offer the instructional advantage of making the "work" of training become "play." Play is generally defined as being intrinsically motivating (pleasurable for its own sake and not dependent on external rewards). Moreover, to be considered intrinsically motivating, the learning environment should have the common characteristics of challenge, curiosity, fantasy, and control. Games represent the instructional artifact most closely matching these characteristics (Reiber, 1996). The intense competition in the commercial PC gaming market has provided the incentive to ensure that each new game must be more engaging than its predecessor and/or competitor - offering even greater challenge, curiosity, fantasy, and control. Concurrent with this development trend, in an effort to appeal to a wider audience with broader variations in computer experience, game companies must ensure that user interfaces are appealing, yet intuitive.

LIMITATIONS OF COMMERCIAL PC GAMES AS A NAVAL TRAINING SUPPORT TOOL

Commercial PC games cannot replace "live" exercise or operations. Commercial PC military simulation games have progressed dramatically toward providing a viable virtual combat operating environment to practice tactical concepts. However, they cannot replace underway multi-unit exercises using real platforms and services as an optimum training environment. One possible approach for maximizing predeployment training would be to review and input the elements of an operation order for an upcoming Fleet exercise into a game using the mission editor. Participants (Navy staffs or units), individually or in groups, could then practice operations in the anticipated operating area using the game to achieve the prescribed objectives against the defined threat prior to going to sea for the actual exercise.

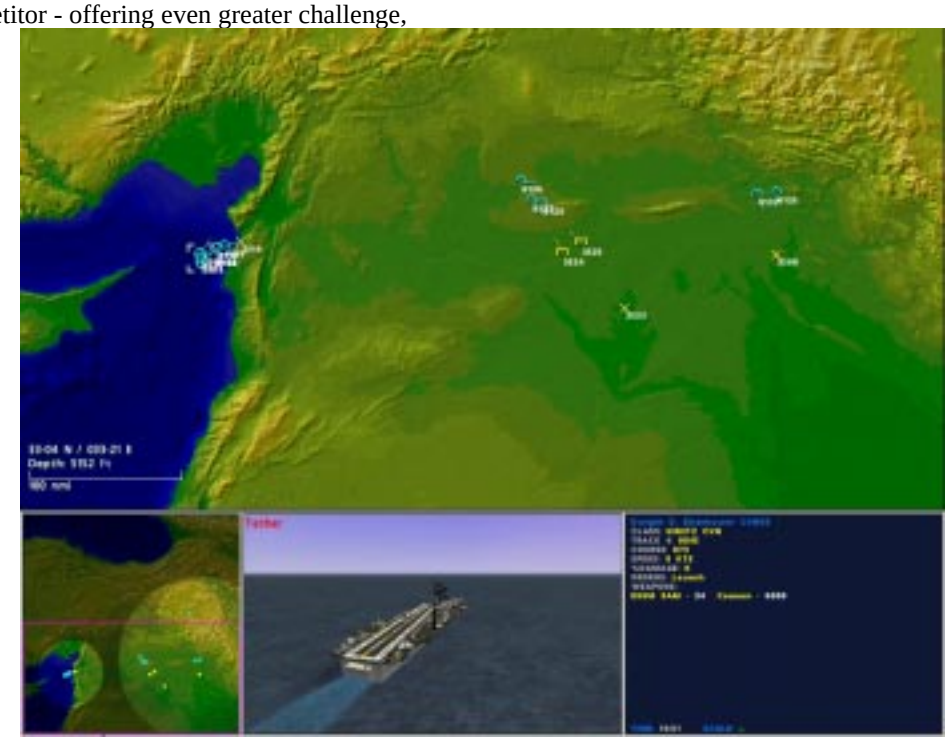

Figure 2. Jane's Fleet Command Battlegroup Scenario

Classified training cannot be conducted using off-the-shelf commercial games. Although off-the-shelf PC games cannot be used to train classified tactical procedures, they can be modified to add classified platforms or system parameters.

Most PC games do not have sufficient platform performance modelling fidelity to be used as a substitute for a flight or maneuvering simulator. A number of platform simulator games can replicate the instrumentation and operational sequencing of onboard systems of a particular aircraft or naval vessel. Although these simulation games present some realism, they cannot provide the necessary fidelity to train operators (pilots or conning officers) in actual maneuvering of the replicated platform. But, they can be used to provide basic operational familiarization of the target platform, instrumentation, and procedural training.

Most PC games offer some unrealistic or exaggerated platform or system capabilities. "Cheats" are available in many PC games providing players with such unrealistic capabilities as unlimited ammunition or fuel supplies, or continuous sonar contact in poor ocean acoustic environments. These "cheats" could potentially result in negative training if employed in PC games used in a formal curriculum. However, they can easily be turned on or off in most games.

More advanced games require more capable PCs. Most of the new military simulations require top-of-the-line PCs with advanced graphics cards and at least 64Mb of RAM. However, even the most capable PCs are still significantly less expensive than high performance workstations, and PC costs continue to decline.

Games may require some modifications to effectively support existing course training objectives or specific platform training requirements. Some PC games can provide valuable training support as basic training or orientation tools for some existing curricula. However, to support more advanced training applications, some degree of modification may be required to ensure that the capabilities simulated correlate more precisely to a particular platform or that actual threats (or other necessary objects) are represented. Several parameters in ***688(I) Hunter/Killer*** are currently being modified by the game developer under tasking from Naval Submarine School to better support course training objectives. Modifications may involve some nominal licensing fee.

Few empirical demonstrations of training effectiveness have been established for PC games. A major limiting aspect of implementing PC games "out-of-the box," or as modified systems, is the lack of empirical evidence to demonstrate training effectiveness. Without such information to guide making good training decisions, even low cost systems distributed in large numbers to young recruits could have a negative effect on budgets, without having a significant impact on development of knowledge, skills, and abilities. Therefore, it is imperative that formative and summative evaluations of such systems during the early phases of implementation be conducted to document lessons learned.

The next section is initial guidance for the implementation of PC games into courses of instruction as viable tactical training tools. These guidelines are designed for course managers and/or curriculum developers.

GUIDELINES FOR USING COMMERCIAL GAMES

Figure 3 outlines a suggested approach for integration of PC games into tactical training curricula.

Conduct a needs analysis. Just as in the case of a formal training system development effort, the first step is to conduct a needs analysis to identify and prioritize the functions the game must provide to support course training objectives (Goldstein, 1993). Once this required functionality has been identified, the commercial gaming and simulation market should be evaluated to determine which titles might match those requirements. There are probably some gamers on the instructor staff that will be glad to provide this information and look for more. In addition, a number of commercial PC gaming magazines and websites offer detailed reviews of a wide range of PC games.

Evaluate. Once one or more games applicable to the target course or instructional requirements are identified, develop evaluation criteria based on the needs analysis to assess level of technical accuracy, flexibility of scenario modification, breadth of database, intuitiveness, and overall quality of game play engageability (Goldstein, 1993; Phillips, 1983). Have SMEs and students participate as test subjects in the games to validate evaluation criteria, and to establish empirical relationships with traditional training requirements.

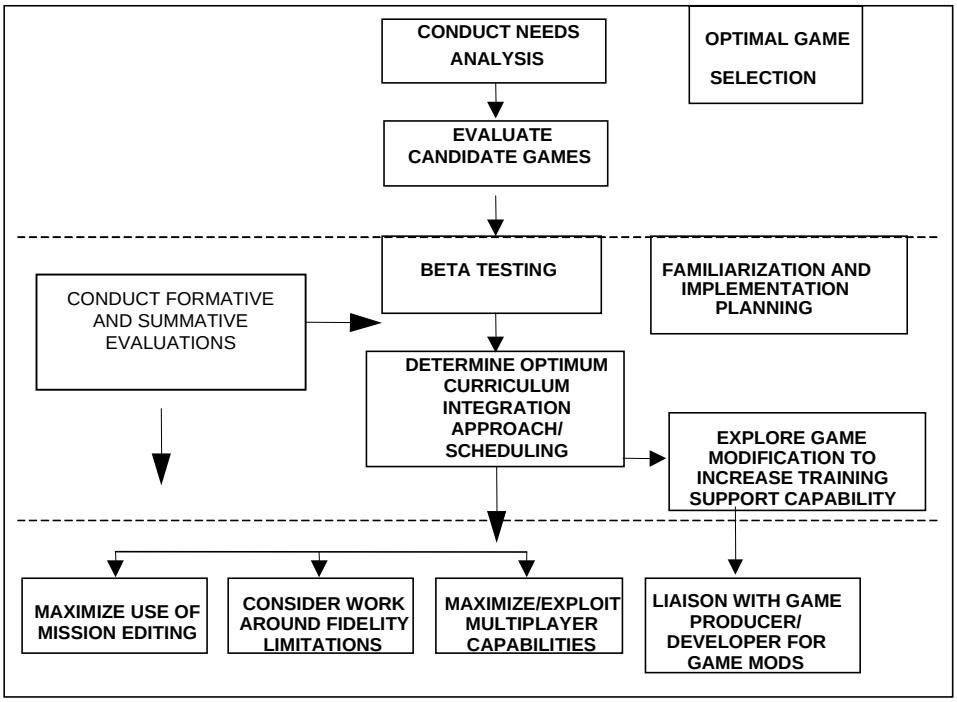

Figure 3. Approach for integration of PC games into tactical training curricula.

Be a Beta Tester. In the case of a candidate game under development, contact the producer or developer and ask to be a Beta tester. The Naval Academy was a Beta tester of ***Jane's Fleet Command*** several months before game release, which provided an early opportunity to determine if this game could be used to support their Strategy and Tactics course. Beta testing generally costs nothing and offers the opportunity to provide feedback or recommendations that might be incorporated into the release - possibly making the game better-tailored to requirements. It should be noted that the gaming company will probably want game testers to sign a nondisclosure agreement.

Determine the optimal integration approach. The next step is to review the target course content and desired presentation schedule to determine where and how game scenarios/exercises should be integrated. The Naval Academy is planning to use ***Jane's Fleet Command*** to support interactive practical exercises to be presented in conjunction with each warfare area lesson (*i.e.*, Surface Warfare, Air Warfare, Undersea Warfare). Play will be implemented in a multiplayer configuration with a variety of options including instructors playing "red" forces, or individual or multiple students playing against the computer-generated adversary. The game will also be used to familiarize midshipmen with the assets and capabilities of the U.S. Navy and other navys around the world.

Maximize game scenario modification or mission editing capabilities to match real-world operating areas, anticipated own-force composition and tactical posture, and expected threats. Many of the new PC simulations have extensive scenario building or modification capabilities. It is important to become familiar with all of the features of the scenario or mission editor in order to quickly and effectively tailor scenarios to exercise students in the desired mission area or training objective. An example of optimum leveraging of game editors is the case of Ensign Herb Lacy, who obtained exceptionally high scores during his primary and intermediate phases of flight training as a result of many hours of practice using ***Microsoft Flight Simulator.*** Ensign Lacy made extensive use of the scenario editing functions of the game, adding instruments to replicate his trainer configuration and scenery that emulated the specific geography in and around the Corpus Christi training area (Heines, March 29, 1999). Another value of a well-designed scenario editor in a tactical training application is the ability to rapidly change scenario parameters to illustrate to students the tactical impact of changes such as friendly or threat numbers, capabilities, or positioning.

Note aspects of the game that are not detailed enough or over simplified. When integrating a PC game into a curriculum, it is important to ensure that instructors and students are made aware of any artificialities (introduced to enhance gameplay), or short-cuts that tend to oversimplify, or significantly reduce steps involved in an important procedure. Precluding ineffective training and maintaining a realistic perspective is crucial to learning appropriate knowledge and skills. For example, a number of specific steps and communications are involved in the shipboard air defense detect-to-engage sequence. A battle group-level game will not model many of the details of this process and could give the impression that air defense is merely a "point and shoot" evolution unless amplification is provided by the instructor.

Multiplayer capabilities can be effectively leveraged to train decision-making associated with command and control of naval forces. Some new games have extensive multiplayer options that enable Navy instructors to partition players into teams representing U.S. task group and/or individual unit commanders, or allied forces working in consort. Given a prescribed operation order, students can use a game such as ***Jane's Fleet Command*** to practice tactical employment of assigned forces to obtain a primary objective against an opposing force in a particular area of operations.

MODIFICATION OF COMMERCIAL PC GAMES TO SUPPORT NAVY TRAINING APPLICATIONS

Modified PC games offer a cost effective option to the development of a new training system. While off-the-shelf commercial PC games can support an increasing number of Navy training requirements, many advanced training applications must have greater levels of fidelity, specific functionality and/or replication, or simulation warranting classification. In some of these cases a commercial PC game could adequately provide the necessary training support with the addition of some modifications. The cost of these modifications is dependent on prices set by the particular game producer, the number of modifications, and the level of difficulty of the revision. A case in point is ***688(I) Hunter/Killer***. This submarine simulation game is currently being modified by the game developer for COMSUBGRU TWO to add higher fidelity modeling of weapon systems, the addition of other platform types, and automation of some tasks. Once these modifications are implemented, intentions are to distribute the modified game to all of the submarines in the Fleet as an onboard training support tool.

Modification of off-the-shelf commercial games requires the establishment of a relationship with the game producer. Upon establishing that a modified PC simulation game may be a good candidate to address a specific training support requirement, the next step is to contact the game producer or developer. Game producers work in a high volume, intensely competitive environment where a "hot" commercial military simulation game may sell hundreds-of-thousands of copies. Consequently, they may not be interested in modifying their product (even at a good price) for a relatively low level of distribution. However, many game producers outsource their game development to a software company or group. This developer may be more receptive to revising the game software, is familiar with the game code, is less concerned with volume sales, and can implement modifications relatively quickly and reasonably. Given positive interest from the game developer, the game producer must still agree to the modification. This agreement may entail a nominal license fee, a limitation on the number and distribution of the modified game (e.g., no distribution or resale outside of the U.S. Navy), or an advertised reference to U.S. Navy use of the game.

Conduct formative and summative evaluations to establish system training effectiveness. Documentation of empirical evaluations that demonstrate training effectiveness are crucial to ensuring students will benefit from PC game applications. Formative and summative evaluations should be conducted to establish training effectiveness prior to final approval for implementing such games. A formative evaluation involves identifying and using process measures to guide initial development and introduction of the prototype training to test participants (Goldstein, 1993). Specific performance criteria should be established that are indicators of training transfer (Goldstein, 1993). Data from the formative evaluation is used to establish a summative evaluation, which indicates the training has achieved the level of effect that was expected. For example, a formative evaluation would involve tracking a number of student performance metrics during training and showing a relationship to performance on a final exam. Comparing test performance of students in traditional training to test performance of students following the PC-based game would establish a formative evaluation (Phillips, 1983). Finally, relating training

performance to performance on actual tasks would further development of a formative evaluation. Using training performance to predict on-the-job performance is imperative for validating the cost effectiveness of PC based games.

CONCLUSIONS

PC-based simulation games offer increasingly sophisticated mission editing capabilities, potentially enabling Navy instructors to rapidly develop tactical scenarios tailored to support their specific course training objectives. Commercial game producers and developers are also increasingly receptive to Department of Defense use of their products "out-of-the-box" or in a modified form for training as a marketable testimony to their authenticity. However, as games become formally integrated into Navy training programs, the next major step should be to conduct assessments of such systems to a) establish effectiveness as tactical training support tools, b) identify cost/benefits, and c) identify and document guidelines for the strategies used to develop specific knowledge, skills, and abilities.

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