INCREASING LEARNING PERFORMANCE WITH AFFORDABLE GAMING AND SIMULATION

WHITE PAPER

Authors: Mark Heimburger, Dennis Wikoff, and Amanda Palla
TABLE OF CONTENTS

Executive Summary ...................................................................................................................... 1
Introduction ................................................................................................................................... 2
Instructional Benefits of Gaming and Simulation .......................................................................... 3
Historical Perspective on Gaming and Simulation ........................................................................ 7
Why Is It More Expensive? ........................................................................................................... 9
Making Gaming and Simulation More Affordable ....................................................................... 10
Case Studies................................................................................................................................ 12

LIST OF FIGURES

Figure 1: Cycle of experiential learning and transfer from gaming and simulation ............... 4
Figure 2: Jiffy Lube Management Training ................................................................................... 5
Figure 3: A digital learner.............................................................................................................. 6
Figure 4: Boeing KC-10 flight simulator (left) and the Link Trainer (right) ......................... 7
Figure 5: Soldiers using virtual reality in training ........................................................................ 8
Figure 6: GC-MS Mobile Performance Support Application ............................................... 12
Figure 7: Foreign/Non-Standard Weapons Interactive 3D App ............................................. 13
Figure 8: Jiffy Lube Manager Training Simulation ................................................................ 14
Figure 9: USDA/DHS Biosecurity Course ............................................................................... 14
Figure 10: US Army Stryker Vehicle VTT .............................................................................. Error! Bookmark not defined.
EXECUTIVE SUMMARY

From its inception in the late 1920s, modern gaming and simulation has advanced from a training method used primarily by the military and aviation industries to include a broad section of government, business, and service organizations that desire proven, cost-effective training tools.

The benefits of gaming and simulation include:

- Providing learners with practice opportunities for tasks that are too dangerous or too expensive, or that occur too infrequently
- Enabling training anytime and just about anywhere
- Reducing training time
- Improving knowledge and skill transfer and retention over more traditional forms of training (Bell, Kanar, & Kozlowski, 2008; Hahn, 2010)

Technological developments of the past 25 years, such as the personal computer and smartphone, have brought about an evolution in the use of gaming and simulation in training, moving from predominantly the U.S. military to business, health care, law enforcement, government, and the service industry.

Unfortunately, the fixed costs of designing and developing gaming and simulation are generally significantly higher than some of the less-effective computer- and Web-based training.

This white paper discusses some solutions for reducing the overall cost of integrating gaming and simulation into organizational training programs for greater overall performance.
INTRODUCTION

Since its inception in the late 1920s, modern gaming and simulation has advanced from a training method used primarily by the military and aviation industries to include health care, business, customer service, and other industries. Although the terms gaming and simulation are frequently used interchangeably, they typically have noticeably different applications in the context of training and education. There are a number of definitions for gaming and simulation, but for the purposes of this discussion, the following definitions are applicable:

- **Simulation**—Artificial environments that are created to manage individuals’ experiences of reality.
- **Games**—Specific types of simulation that feature competitive engagement, rules, and a scoring system (Bell, Kanar & Kozlowski, 2008).

Gaming and simulation are proven training techniques that enable a “learn by doing” approach in a safe environment, allowing learners to experience situations that may be too risky or costly to duplicate in reality. Another similarity is that the costs of designing and developing gaming and simulation can be much higher than traditional training.

Incorporating gaming and simulation into a training program, however, can be affordable over the life cycle of the training. Before we present potential solutions to the high cost of gaming and simulation, it is important to discuss some background about these training methods:

- Why they work particularly well for certain types of training
- How development and implementation costs limited their early use to some very specific training programs
- How technology has expanded their distribution into a broad cross-section of industry and education
INSTRUCTIONAL BENEFITS OF GAMING AND SIMULATION

Gaming and simulation offer significant benefits over traditional training. First, they provide practice opportunities for tasks that are too dangerous or too expensive, or that occur too infrequently. The training of pilots using flight simulators and of soldiers through large-scale military wargaming are two examples of tasks that cannot be effectively trained on the job.

Similar tasks in other areas of government, business, and industry include:

- Customer service
- System and equipment maintenance
- Cross-cultural negotiations
- Inter-agency disaster response
- Medical training

Second, gaming and simulation enable training anytime and just about anywhere using distance learning technology (e.g., Internet, personal computer, mobile device). Implementing a distance learning approach for the delivery of training has benefits for both the organization and the learner. The organization is able to reduce or eliminate some of the costs associated with providing traditional training, such as instructor and classroom costs, travel and lodging expenses for trainees, and trainees’ downtime from their regular jobs. Learners have the benefit of being able to take the training they want, when they want, in a comfortable environment, and at their own pace.

Third, research has shown that using gaming and simulation has the potential to decrease the number of hours it takes for learners to reach proficiency in task performance over other forms of training (Hahn, 2010). Finally, gaming and simulation have also proven to be as effective as, or even more effective than, traditional training in the transfer and retention of knowledge and skills, and most importantly, improvements in on-the-job performance. The body of literature on the subject suggests that the success of gaming and simulation is the result of experiential learning that occurs when a task is practiced and experienced. Figure 1 illustrates the cognitive process that occurs when learners practice tasks using gaming and simulation.
Figure 1: Cycle of experiential learning and transfer from gaming and simulation (adapted from Priest & Gass, 1997)
In today’s global environment, business, government, and military organizations want to develop critical thinkers who can quickly react and adapt what they know to dynamic changes in situations. According to recent research, developing this adaptive capability requires (1) that learners be active participants in the learning process and (2) that the learning take place in a meaningful, relevant context (Bell, Kanar & Kozlowski, 2008). Gaming and simulation are powerful tools for creating more realistic, experiential learning environments that enable the application and practice of knowledge and skills. The simulated environment is a “safe” environment in which to make mistakes, receive immediate feedback, and correct errors. Learners can enter this safe environment and practice as often as necessary to meet their expectations and achieve performance requirements. Gaming and simulation are also very effective tools for learner self-assessment, enabling learners to recognize when they “get it” and when they don’t.

Gaming and simulation work well for the delivery of instruction because they can satisfy many of the learning preferences expressed by adults, including:

- Providing meaningful feedback that improves performance. Feedback can be immediate and can also be connected to an established curriculum to reinforce learning.
- Actively engaging the learner. Engagement is supported through the use of realistic environments and situations, problem-solving challenges, and competition and collaboration with other learners.
- Creating a safe environment in which mistakes can be made and corrected without risk.
- Providing “hands-on” practice that leads to mastery.
- Supporting self-directed learning; allowing learners to explore information, processes, and procedures at their own pace.
- Encouraging exploration, action, and reflection; and providing the ability to explore, solve problems, experience consequences, and reflect on results.

- Using multimedia elements in meaningful ways.

- Enabling effective assessments that test what has been taught at the application level (Driscoll, 2002).

Another factor behind the growth of gaming and simulation is the coming of age of a “digital generation” of learners who have grown up using computers for recreational and learning experiences (Prensky, 2001). The first digital learners entered the workforce in the mid-1990s. As a result of their early and frequent exposure to computers and video games, their brains function differently than their parents' brains. Some of these differences include:

- Faster decision making
- Parallel processing of information rather than linear
- More visual
- Prefer random access to information rather than step-by-step
- Prefer active involvement in the learning process to passive learning (i.e., reading, lectures)
- Prefer learning and working environments that are similar to gaming environments (Prensky, 2001)

Apart from the benefits listed above, gaming and simulation can be used to enhance learners' specific skills, such as:

- Technical and functional expertise
- Problem solving and decision making
- Interpersonal and communications skills, and/or team-based competencies (Lateef, 2010)
HISTORICAL PERSPECTIVE ON GAMING AND SIMULATION

The first flight simulator, the Link Trainer, was developed in the late 1920s and became widely used in pilot training a few years later. At the beginning of World War II, these simulators were used to train large numbers of military pilots in the United States and Britain. During its evolution, the fidelity—the degree to which a simulation matches reality (Prensky, 2001)—of the Link Trainer was enhanced from a “stick and rudder” device to include capabilities for flight instrument training, course plotting, celestial navigation, and bomber crew training.

Over time, flight simulators have evolved into multi-million dollar pieces of equipment with advanced, computer-aided visual and motion systems (Page, 2000), as illustrated by the Boeing KC-10 simulator shown here (Figure 5). These high-fidelity, full-motion flight simulators were so expensive to build that only national government and large commercial airlines could afford them.

Simulations are now used at all levels of military training and planning. And as technology has advanced, so has the development of simulators to train soldiers in the use of that technology. With advanced global positioning systems (GPS) and terrain mapping, using a simulator to learn to fly an unmanned aircraft is nearly identical to actually flying the aircraft. The modern U.S. military uses simulations in the training of nearly 100% of its weapons systems, including the most basic system—the soldier with a rifle.

Figure 4: Boeing KC-10 flight simulator (left) and the Link Trainer (right)
Technological developments of the past 25 years, such as the personal computer and smartphone, have brought an exponential increase in the use of gaming and simulation in other sectors including business, health care, law enforcement, government, and the service industry. By the late 1980s, nearly all business schools in the U.S. had incorporated gaming and simulation into their curricula, and three-quarters of large corporations in the U.S. (defined as having more than 1,000 employees) used business simulation for staff training. More recent developments in the use of gaming and simulation for instruction include the integration of virtual reality (see Figure 5) and the use of computer-based high-fidelity simulations to improve the results of learner assessments (Curtin et al., 2011).

Figure 5: Soldiers using virtual reality in training
WHY IS IT MORE EXPENSIVE?

Although gaming and simulation can result in better transfer of learning and performance objectives while reducing overall training time, they can also be significantly more expensive to design, develop, and integrate into the overall training program compared to traditional forms of training.

Research shows that the fixed cost of gaming and simulation can be in excess of four times greater per hour of training than that of traditional, page-turner e-learning (Bell, Kanar & Kozlowski, 2008). For smaller organizations with limited training budgets, this makes gaming and simulation cost prohibitive.

The greatest asset of gaming and simulation—fidelity—is also the primary cost driver. The more realism that is required to meet performance objectives, the greater the increase in the level of effort, complexity, and staff competencies required for every phase of development of highly interactive, media-rich gaming and simulation.

The industry-standard process for training development is the ADDIE model. The acronym is derived from each phase in the process (Analysis, Design, Development, Implementation, and Evaluation). For gaming and simulation development, each phase of the ADDIE process is more costly than for traditional training, as explained below:

- **ANALYSIS**—Instructional designers must conduct more extensive research and analysis into the requirements for performance outcomes and the contextual elements necessary to create realistic, meaningful scenarios and environments.
- **DESIGN**—Designers spend a good deal of time producing design plans and storyboards that provide the details of the specifications, tell the story, and present the options and results of various correct and incorrect decisions.
- **DEVELOPMENT**—Gaming and simulation typically involve richer media elements and complex programming in order to present learners with realistic decision-making scenarios and more engaging interactivity.
- **IMPLEMENTATION**—Integrating gaming and simulation with Learning Management Systems is more complex and time consuming.
- **EVALUATION**—Additional time and resources are required for formative evaluation, testing, and bug fixes.

How, then, can organizations realize the benefits of gaming and simulation at lower costs than have traditionally been required for these types of training?
MAKING GAMING AND SIMULATION MORE AFFORDABLE

Several potential solutions are available that can reduce, or eliminate, some of the expenses associated with the development of gaming and simulation over the life cycle of the training.

ADVANCES IN DEVELOPMENT AND DELIVERY TECHNOLOGY

Technological advances in training delivery and development tools have made gaming and simulation far more cost effective over the life cycle of a training program. Laptop computers, tablets, and smartphones are capable of running high-fidelity gaming and simulation and enable learners to connect to training from just about anywhere in the world. Innovations in development tools, such as game engines and 3D media software, are improving the realism of virtual environments and reducing the amount of time it takes to produce high-quality gaming and simulation. Using some of these tools, a subject matter expert can create scenarios and lessons that used to be limited to high-budget simulation projects with teams of software engineers. In these cases, the development teams have done the heavy lifting up front, allowing the utilization of a fully functional tool to create high-quality content in less than half the time.

REUSE OF PROVEN INSTRUCTIONAL STRATEGIES, CONTENT, MEDIA, AND CODE WHENEVER POSSIBLE

In many cases, existing components of a training program can be reused to support a gaming/simulation approach. These components may include electronic files containing text-based instruction and previously produced training videos or other media that can be made available to learners as they are engaging in a simulation. Including such resources reinforces the learning process.

Programming tools such as Vertex Solutions Group’s “Adventure Engine” gaming engine save significant time in development by providing a programming framework that handles decision point code and complex branching. Development in the HTML5 mark-up language makes it possible for programs to be written once and published for multiple delivery platforms.

While modularity in development, or “chunking” of the learning material, provides for reuse of content, time and money can also be saved by using a modular system architecture. For example, when programming simulation components, if a scenario uses both a Hummer vehicle and a Stryker vehicle, the software developer should first look at the similarities between the two. If both vehicles use the same radio, that component’s code can be reused throughout. All components are programmed so that they can be reused and plugged into other vehicles, scenarios, or instructional flows as necessary. A library of these items then provides the developer with ready-to-use code that saves time after the initial creation.
EMPLOY EXPERIENCED STAFF TO SAVE DOLLARS
Using staff who have considerable knowledge and experience with the design and development of gaming and simulation can reduce the overall cost of the training. Experienced staff understand the process and can identify solutions that have worked for previous efforts. They stay current on time-saving improvements in technology and they know how to effectively engage the client in the process in order to produce high-quality, effective instruction.

TARGET GAMING AND SIMULATION TO SPECIFIC LEARNING OBJECTIVES IN THE TRAINING CURRICULUM THAT REQUIRE APPLICATION/PERFORMANCE
Integrating gaming and simulation as a supplement to an existing training program, as opposed to a stand-alone tool, may be the most effective method for knowledge and skill transfer and retention (Hahn, 2010). Instructional designers analyze the training program to identify performance objectives best suited for gaming and simulation methods. By focusing on the specific objectives that can be better trained through gaming and simulation, unnecessary costs are avoided.

This concept can also be applied to the selection of training delivery methods to ensure training is delivered through the appropriate device. For example, a highly effective training simulation on a personal computer may not be as effective if presented on the smaller screen of a smartphone.

TARGET FIDELITY TO WHAT IS ESSENTIAL TO THE TRAINING OBJECTIVES
Targeted fidelity is providing enhanced fidelity of the game or simulation strictly in the areas required by the learning objectives while maintaining an overall quality that remains engaging. Research suggests targeted fidelity simulations can be just as effective as those with high fidelity (Hahn, 2010). With the current crop of development tools, reducing the fidelity of a simulation does not necessarily mean reducing the realism of the environment. Furthermore, limiting the ability of learners to perform specific actions within a training scenario can save significant development time and effort, and it reduces learner time in the training.

Vertex estimates that the application of the solutions noted here may result in a savings of up to 30% in development and maintenance costs associated with gaming and simulation.
CASE STUDIES
Vertex Solutions Group (VSG) (formerly Adayana) is a performance and learning technologies company that partners with federal and commercial organizations to solve their most pressing learning challenges with custom end-to-end solutions. The following case studies provide specific examples of how VSG employed the cost-saving measures recommended above to enhance our clients' training systems through the incorporation of affordable gaming and simulation.

GC-MS MOBILE PERFORMANCE SUPPORT APPLICATION

Figure 6: GC-MS Mobile Performance Support Application

☑ Advanced Development Software
☑ Experienced Staff

The Gas Chromatography–Mass Spectrometry (GC-MS) device is a portable mass spectrometer that identifies and quantifies chemical warfare agents and toxic industrial chemicals. Our customer needed a cost-effective, standardized, portable, and easily accessible way for users to obtain operation and maintenance information at the time of need.

The team developed the GC-MS Mobile Performance Support Application, an easy-to-use 3D app that enables users to rapidly practice operation and basic maintenance activities:

- The GC-MS application was developed with the Unity 3D Game Engine by developers with many hours of experience with that tool.
The application uses a “write once, publish many” approach, resulting in consistent user experiences across multiple platforms (e.g., iOS and Android).

The detailed, touch-sensitive 3D interface is powered by a highly efficient mobile game engine, creating a realistic immersive experience on mobile platforms.

The resulting GC-MS application enables touch manipulation of the GC-MS system, including assembly, calibration, operation, and maintenance, in a 3D environment.

This application earned the 2013 Federal Government Distance Learning Association’s Innovation Award.

FOREIGN/NON-STANDARD WEAPONS INTERACTIVE 3D APPLICATION

- Reuse of GC-MS code and approach
- Experienced Staff

The Foreign and Non-Standard Weapons 3D Models and Performance Support Application is an innovative performance support tool that combines accurate, highly interactive 3D models with instructional scaffolding and guided practice to enable learners to understand and practice complex tasks. This app is expected to increase users’ levels of proficiency, decrease the amount of time necessary for training on each weapon, and provide performance support in austere environments.

The team designed, developed, and integrated highly detailed 3D animated models of foreign/non-standard weapons that enabled on-demand, coached practice of armorer-level disassembly, reassembly, and function check tasks, as well as visualization of the internal operation of 16 foreign and non-standard weapons. Development costs were reduced by reusing the approach and programming code that previously produced the GC-MS mobile application.
JIFFY LUBE MANAGER TRAINING SIMULATION

- Reuse of VSG’s “Adventure Engine” and media components

The Jiffy Lube Manager Training Simulation was developed to provide roughly 6,000 potential managers the opportunity to reinforce the concepts and teachings found in the current instructor-led training courses taught at Jiffy Lube University. The simulation allows managers to respond to daily activities and scenarios that are relevant to their day-to-day work responsibilities.

This simulation virtualizes a typical Jiffy Lube store into a 3D environment. It was built as a lightweight, Web-deployable simulation that is integrated into a learning management system and that is flexible and modular in order to accommodate the development of additional scenarios for future efforts.

Cost-saving measures on this project included the reuse of VSG’s Adventure Engine gaming engine, a programming framework that handles decision point code and branching, and accommodates varying degrees of complexity of the branching. Additional cost savings were recognized through the reuse of character avatars purchased for previous projects.

USDA/DHS BIOSECURITY—TRAIN TO CONTAIN

- Reuse of VSG’s “Adventure Engine” and Unity 3D
- Experienced staff

To enhance training on biosecurity within the agricultural industry, the United States Department of Agriculture (USDA) and Department of Homeland Security (DHS) requested immersive courseware using a realistic, 3D game-like environment to familiarize learners with the biosecurity principles and best practices used to contain the spread of pathogens during an outbreak of disease in animal production operations.

By utilizing VSG’s Adventure Engine gaming engine, programming costs on this project were significantly reduced as compared to the cost of programming the entire product from scratch. Further cost reductions were recognized as a result of the VSG team members’ experience with the gaming engine, the Unity 3D software, and the design of scenario-based immersive learning.
U.S. ARMY STRYKER

☑ Targeted fidelity for specific systems

VSG is creating a series of virtual tactical trainers (VTTs) for the U.S. Army 316th Cavalry Regiment in support of training on the major components of the M1126 family of vehicles. The VTTs will enable service members to interact with the specific vehicle components by taking them apart, rotating individual components, studying cut-away and x-ray views, and learning where components are located.

Through the use of this state-of-the-art training tool, the U.S. Army will be able to reduce student failure rates, enhance training on the M1126 Stryker, and provide refresher training outside of the school in order to prevent skills from atrophying. Stryker is an excellent example of targeting the fidelity of the training tool to meet specific training objectives.
CONCLUSION

Gaming and simulation are proven training methods with significant benefits over traditional training, such as:

- Providing learners with practice opportunities for tasks that are too dangerous or too expensive, or that occur too infrequently
- Enabling training anytime and just about anywhere
- Reducing training time
- Improving knowledge and skill transfer and retention over more traditional forms of training (Bell, Kanar & Kozlowski, 2008; Hahn, 2010).

Owing to the high cost of developing complex, full-motion, ultra-high-fidelity devices, gaming and simulation were once used by only the U.S. military and a few commercial aviation companies. Recent technological developments, however, such as the personal computer and smartphone, have expanded the use of gaming and simulation to business, health care, law enforcement, government, customer service, and other industries.

Unfortunately, the fixed costs of designing and developing gaming and simulation remain significantly higher than some less-effective computer- and Web-based training methods.

The Vertex Solutions Group excels at applying a range of innovative cost savings and cost avoidance solutions in order to enable our clients to effectively integrate gaming and simulation into organizational training programs for greater overall performance.

Contact us today at 1-888-225-9398 for a FREE consultation or visit our website www.VertexSolutionsGrp.com.
WORKS CITED


AUTHORS
Mark Heimburger, Senior Immersive Instructional Systems Designer

Mark Heimburger is our award-winning Senior Immersive Learning Designer. Mark has over 15 years of experience developing web-based training. He has designed serious games and virtual world–based training for Civilian and Defense government agencies. Mark holds a Master of Science degree from Eastern Illinois University.

Dennis Wikoff, Vice President of Government Programs

Dennis Wikoff has more than 30 years of senior management experience including training technology systems integration, Advanced Distributed Learning, gaming, and modeling/simulation. During his tenure with VSG, Dennis has overseen business development, enterprise learning system assessments, and technology integration. Prior to joining Vertex Solutions Group, Dennis was an officer in the Air Force, where he was Operations Manager of the Aero Ballistics Research Facility and Program Manager in the B2 Systems Program Office.

Amanda Palla, Director of Technical Operations

Amanda Palla has more than 13 years of experience in Web development and e-Learning. She manages the diverse staff who design and develop Web-based training (WBT), instructor-led training (ILT), immersive learning, and mobile solutions. Amanda holds an Ed.M. and her areas of expertise include project management, tool and process development, programming, and instructional design.
ABOUT VERTEX SOLUTIONS GROUP

As a human capital performance and learning technologies company, we have partnered with more than 65 federal agencies and hundreds of commercial organizations to ensure sustainable success through end-to-end, technology-enabled learning and development solutions. Our customized, scalable services have been deployed across a range of functions, levels, and geographies for more than 20 years. Our custom immersive learning services include serious games, simulations, and 3D modeling. If you are looking for engaging learning solutions that support the application of knowledge and skills, allow users to practice and improve their decision making, and improve human capital performance, contact us today.

For more information, visit [www.vertexsolutionsgrp.com](http://www.vertexsolutionsgrp.com) or call 1-888-225-9398.