Serious Games 101

Dr. Peter Smith
13501 Ingenuity Dr.
Orlando FL, 32826
USA

Peter.Smith.CTR@adlnet.gov
PeterAlfredSmith@gmail.com

ABSTRACT

The founding of the Serious Games Initiative in 2002 has ignited a renewed interest in using games for training and education that has only grown over the last decade. To fully appreciate the advances that have been made in the industry in this time it is important to understand the pivotal events that have occurred in that time frame and prior. This work seeks to lay a foundation of what serious games are and further explore the key moments that have helped shape this industry into what it is today. This will include both major milestones in serious games developments, and missteps and issues that are still plaguing the industry today.

1.0 SERIOUS GAMES EVOLVING DEFINITION

The term Serious Games, an umbrella term that has come to mean any games that have any goals other than pure entertainment, was popularized in 2002 when Ben Sawyer of Digitalmill, and David Rajeski of the Foresight and Governance Project at the Woodrow Wilson International Center for Scholars founded the Serious Games Initiative (SGI). The SGI was founded to pursue the goal of helping to organize and accelerate the adoption of computer games for non-entertainment purposes. This included exploring new techniques in Raph Koster's book, A Theory of Fun for Game Design [1] he described the motivating factor of fun in all games, entertainment, education, or otherwise, as the act of learning. James Paul Gee a respected games researcher best known for his book, What Video Games Have to Teach us About Learning and Literacy, focuses on the idea that all good video games exhibit thirty-six learning principles supported by literature in learning and cognition research [2]. Serious Games are not based solely on the idea that games can teach, but that the principles behind good game design actually support learning. That is, the idea that fun in games is not a passive act of absorbing learning material from a media platform, but that it is a part of the fundamental act of experiencing games.

Clark C. Apt defined Serious Games as games that "have an explicit and carefully thought-out educational purpose and are not intended to be played primarily for amusement" [3]. Apt wrote these words over thirty years before the founding of the SGI but his words are still relevant and extremely close to the current definition that most game scholars adhere to for serious games. His definition's one inconsistency is that serious games have evolved to include more applications than just education. Serious games are commonly defined as some derivation of: A game designed for a primary purpose other than pure entertainment. This definition is purposefully open ended in order to allow for the diverse backgrounds of various serious game practitioners.

Mike Zyda, the Director of GamePipe at USC, defined serious games as: "a mental contest, played with a computer in accordance with specific rules that uses entertainment to further government or corporate training, education, health, public policy, and strategic communication objectives"[4]. Ben Sawyer defined Serious Games in 2008 as "Resources from the field of videogames reapplied for the purposes beyond entertainment including education, healthcare, productivity, defense, workforce development and more." While these particular definitions met the vision of what a serious game could be, others whose application

of serious games do not fit into the categories defined were still searching for a definition. Further still, many industries utilize gaming technology but do not explicitly create games with the technology, yet have aligned themselves with the serious games movement. So, Serious Games are now commonly considered: The application of games or gaming technologies primarily for non-entertainment purposes. This definition does away with categories and welcomes all types of Serious Games into the fold.

1.1   Names Used for Serious Games

While the definition of Serious Games was being debated, the actual name applied to the category of games was still being hotly contested in the industry. Many organizations felt that the word game demined or undermined the quality of the educational products that were being built. Others wanted to separate themselves from some of the more questionable developments and define their own category where they could more purposefully decide what they considered to be part of it. Others were just plain unaware of the emerging industry and through necessity developed their own terminology. This is a small list of some of the more popular terms used to describe Serous Games:

- Educational Games

- Simulation

- Virtual Reality

- Alternative Purpose Games

- Edutainment

- Digital Game-Based Learning

- Tactical Decision-making Simulation

- Immersive Learning Simulations

- Impact Games

- Persuasive Games

- Games for Change

- Games for Good

- Synthetic Learning Environments

- Game-Based "X"

Debates over this issue are seldom fruitful. It is usually best to defer to the terminology used by the segment of the industry a person is involved with, while maintaining an understanding that all these terms are referring to the same subset of games.

1.2   Taxonomy of Serious Games

The Taxonomy of Serious Games was presented at the Serious Games Summit (SGS) held at the 2008 Game Developers Conference (GDC). The focal slide of the taxonomy is provided here. It defines the current categories of games that have been developed by the Serious Games industry including, Games for Health, Advergames, Games for Training, Games for Education, Games for Science and Research, Games for Production, and Games as Work. It further cross references them with the industries that currently use Serious Games. Further slides show the amount of development in each category, illustrating that most of the work in the Serious Games Space was being done for education and training in both schools and the military. [5]

Table 1: Taxonomy of Serious Games.

	Games for Health	Adver-games	Games for Training	Games for Education	Games for Science Research	Production	Games as Work
Government & NGO	Public Health Education & Mass Casualty Response	Political Games	Employee Training	Inform Public	Data Collection / Planning	Strategic & Policy Planning	Public Diplomacy, Opinion Research
Defence	Rehabilitation & Wellness	Recruitment & Propaganda	Soldier/Support Training	School House Education	Wargames / planning	War planning & weapons research	Command & Control
Healthcare	Cybertherapy / Exergaming	Public Health Policy & Social Awareness Campaigns	Training Games for Health Professionals	Games for Patient Education and Disease Management	Visualization & Epidemiology	Biotech manufacturing & design	Public Health Response Planning & Logistics
Marketing & Communication	Advertising Treatment	Advertising, marketing with games, product placement	Product Use	Product Information	Opinion Research	Machinima	Opinion Research
Education	Inform about diseases/risks	Social Issue Games	Train teachers / Train workforce skills	Learning	Computer Science & Recruitment	P2P Learning Constructivism Documentary?	Teaching Distance Learning
Corporate	Employee Health Information & Wellness	Customer Education & Awareness	Employee Training	Continuing Education & Certification	Advertising / visualization	Strategic Planning	Command & Control
Industry	Occupational Safety	Sales & Recruitment	Employee Training	Workforce Education	Process Optimization Simulation	Nano/Bio-tech Design	Command & Control

The taxonomy did not put an end to the debates over what a Serious Game is. New types of Serious Games are constantly emerging and test the boundaries of what these games can be. The real success of the taxonomy is that developers and researchers of Serious Games were able to visualize that they are part of the overall whole of a much larger industry.

2.0 HISTORY OF SERIOUS GAMES

"The Earliest games were developed not for idle amusement but for serious purposes… By playing with teammates, they would also learn how to coordinate maneuvers and how to strategize. Over time, these athletic games evolved into formal competition. Undoubtedly, the best known of the ancient sporting events are the Greek Olympic Games." [6] While modern society often trivializes the importance of games, relegating them to the level of common children's toys, the idea of using games for educational purposes is as old as the idea of games themselves. As mentioned above by Carolyn Handler Miller, not only did games originate to teach youth how to participate in society they also taught strategy, how to compete, and also how to cooperate in teams. [6]

2.1 Ancient Serious Games

The earliest board game ever created, Senet, appeared in Egypt in 3000 BC. Archaeologists have found at least 40 of these board games in various tombs throughout Egypt including those of Pharaohs and commoners alike. The game was thought to be both a form of entertainment and a window to mystical knowledge. Scholars suggested that players thought certain results would forecast their fortunes, good players were favoured by the gods, and only through mastery of the game could one ascend to death.

Figure 1: A Timeline of Ancient Serious Games.

By 1400BC a new game, Mancala, was formed from a commonly used accounting tool. While it evolved to be a gambling tool, do its roots imply that it also helped the player become a better trader? Unfortunately, the answer to that question has been lost to the ages. What is clear is that these games laid the ground work for future games like Go, Chaturanga, and chess that were commonly used to teach military strategy. These games would later evolve to lay the foundations of modern war gaming in the US military. [7]

2.2 Board Games

Board games quickly took the mantel as the premier platform for serious games. With games like Go appearing as early as 2300BC. Go, the oriental equivalent of Chess was played using white and black stones to trap the opponents pieces and gain control of the largest portion of the board. The strategic thinking required to master Go has help it maintain its popularity today.

Chaturanga originated in India in 500BC and can be played by 2 or 4 players. This game predates Chess and contains similar pieces, representing infantry, rajah, elephant, cavalry, and chariot. Original version of the game included dice, but they were removed. More rules were modified and modern day Chess was born. Checkmate is an English form of the Persian words "Shah Mat" meaning "dead king."

Figure 2: A Timeline of Serious Board Games.

Modern day family board games have emerged from the foundations laid by these early games. Including the use of dice, race to the finish mechanics, moving and negotiating pieces on a boards, are just a few of the techniques that have been carried over. Games like Statego and Risk teach military strategy. Monopoly teaches about financial planning, and negotiating. Scrabble teaches spelling and lateral thinking.

3.0   EMERGENCE OF SERIOUS GAMES

Clark C Apt's book Serious Games was published in 1970 and represents the first recorded use of the term Serious Games [3]. The term Serious Games was not, however, an instant success. In the 30 years that followed, serious games had a few false starts on the road to becoming a main stream part of the non-entertainment world, the most dramatic of these being in both the education and training arenas

4.0   ELECTRONIC GAMES

The first interactive computer game was created in a small lab at MIT in 1961. The game was called Spacewar! The game ran on a DEC PDP-1 Computer that had enough computational power to display a small ship on a circular CRT screen. The students who developed it were looking to build something fun. They created a revolution.

Figure 3: A Timeline of Electronic Games.

Computer Space, was the first coin operated arcade game system. Nutting Associates developed the game in 1971, which was for the most part a consumer version of Spacewar! Soon after the release of Computer Space, Atari entered the field. Pong was Atari's first foray into the videogame industry. Pong was a virtual version of tennis played by two players. It was the first videogame to achieve large scale popularity and is credited with creating the videogame boom that followed.

The first home console was the Magnavox Odyssey. It was specifically designed to only work on Magnavox TVs and came with 8 game "cartridges" that would allow you to change games. They however did not contain actual games, but signalled the machine what game to play.

Soon after Atari would bring a home version of Pong to market, and followed that with the popular 2600 hardware. After the initial boom, the market fell flat and did not recover until Nintendo released the Nintendo Entertainment System in the 1980's. From there the market has grown to a multi-billion dollar industry. In this time period a number of Serious Games (though called by other names) were developed primarily in 3 forms, original development, edutainment, and mods.

4.1   Original Development

Before the more modern notion of Serious Games took hold the US military made many attempts at using video games for training. The earliest being in 1980 when the US Army commissioned Atari to build the Atari Bradley Trainer [8]. This game was a modified version of the popular vector graphics based game Battlezone, also published in 1980. Only 2 Atari Bradley Trainers were ever built and shown at a trade show. It is unknown why the US Army never deployed the game, but it was never actually used by soldiers. Another military project was started by 1984, this time by the US Navy, to use a video game to teach Morse Code [9]. This project also only made it through the prototyping phase. The US military's view of games at the time was that they were not serious enough for military training, though the problem seemed to be one of vocabulary only.

4.2   Edutainment

Paralleling the emergence of games in the military is the development of the ill-fated Edutainment market. In the early 1980s Edutainment games became an incredibly popular trend. These games, such as "Where in the World is Carmen Sandiego," "The Oregon Trail," "Reader Rabbit," "Math blaster," among many others flooded the market with games that contained some level of educational content. Mizuko Ito described it as a time where the developers where empowered with a "sense that they were creating possibilities for learning that freed it from the institutional constraints of schooling." [10].

Edutainment games succeeded in capturing an audience, and establishing itself as an accepted part of the games industry, however, they never quite got established as a credible form of education. Ito, suggests that the reason behind this is that, "edutainment embodies the challenges which reformers face in creating new genres of representation and practice…" [10]. However the answer is much simpler. In general the games did not achieve the dual goals of being good educational platforms while also being good games. Some, like "Oregon Trail" are remembered for their fun sequences, while others like "Math Blaster" hammered home the learning content. Few if any provided a sound model that future success could follow. Edutainment, along with many of the other past attempts to develop learning games have largely been deemed failures. A sentiment best stated by Michael Zyda, the Director of the Game Pipe Lab at USC. "The game industry has already witnessed the failure of edutainment, an awkward combination of educational software lightly sprinkled with game-like interfaces and cute dialog. This failure shows that story must come first and that research must focus on combining instruction with story creation and the game development process." [4] When Serious Games began many people pointed at Edutainment as an important part of our past that should not be forgotten or repeated. Though, without new development models it is difficult to avoid the traps.

4.3   Mods

The original Doom game was an early first person shooter developed by id Software in 1995. While it was not the first 3D shooter developed by the company, that honour, goes to Wolfenstein 3D, Doom was the first game that included the ability to officially modify a game. There were tools available to everyday players to change the game to play however they wanted.
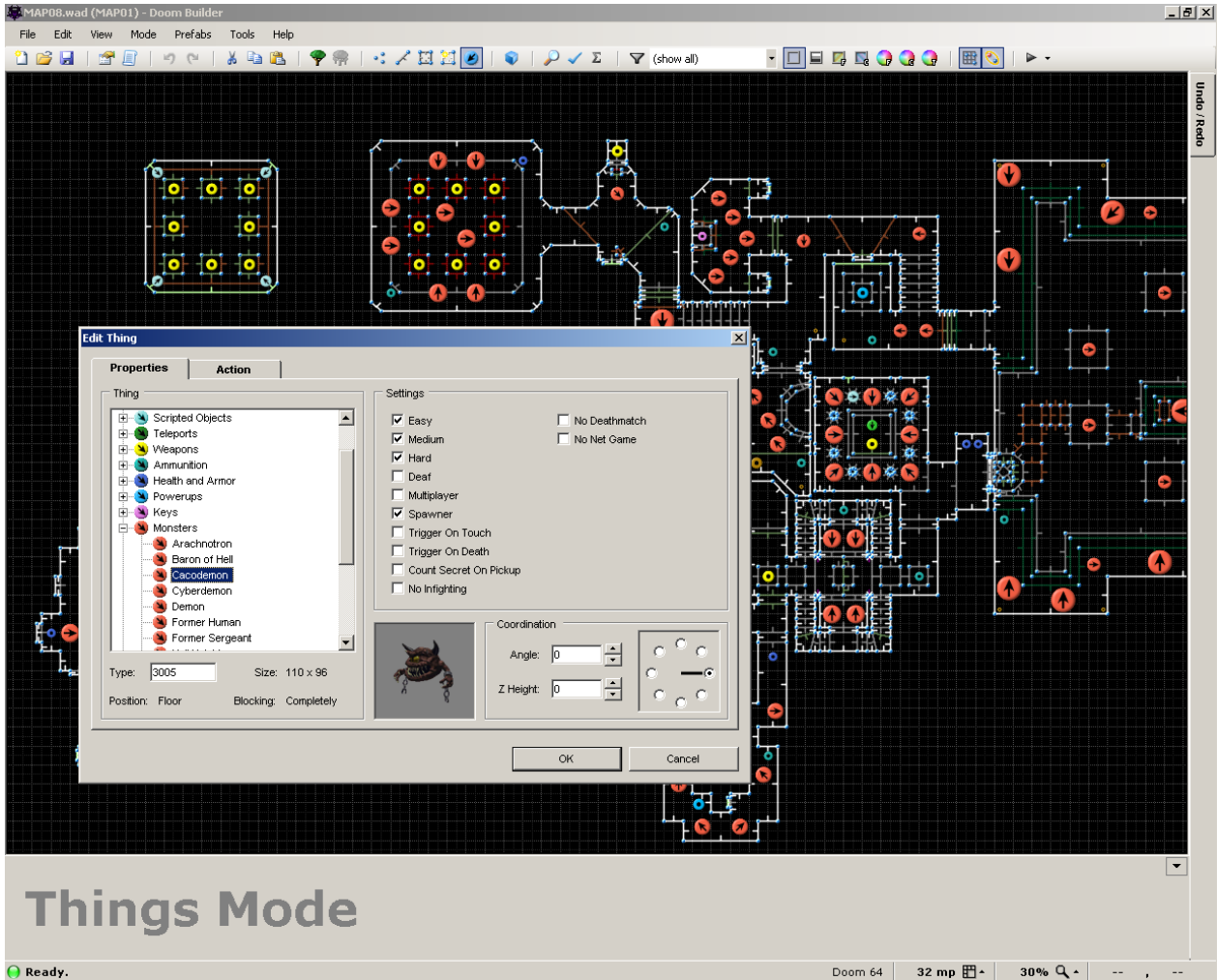

Figure 4: Doom Builder.

Using the capability, as a grass roots effort Marine Doom was made. Marine Doom is a modification (mod) of the popular first person shooter game Doom created by the US Marine Corps Modelling and Simulation Management Office (MCMSMO) developed for the training of US Marine fireteams. The game drops the available health of the player down to a believable amount and put the player on 4 man fire team. The games multiplayer features allow the team to practice together in the 3D environment. While this was a very innovative application of a $50.00 videogame, the licensing issues around using games in this way is not always clear and if this type of development is pursued in the future a detailed examination of the End User License Agreement (EULA) associated with the game should be performed.

5.0   SERIOUS GAMES BREAK OUT

The excitement that surrounded the establishment of the Serious Games Initiative sparked a new call to arms among researchers and game developers alike. Established game developers like Raph Koster the designer of Star Wars Galaxies began championing the serious games space. In Raph Koster's book, A Theory of Fun for Game Design [1] he described the motivating factor of fun in all games, entertainment, education, or otherwise, as the act of learning. This new call to arms was not based solely on the idea that games can teach, but that the principles behind good game design actually support learning. That is, the idea that fun in games is not a passive act of absorbing learning material from a media platform, but that it is a part of the fundamental act of experiencing games.

5.1   Games for Recruitment

In 2002, around the same time the Serious Games Initiative is organizing, the US Army released America's Army. America's Army is a game developed for recruiting soldiers to the US Army. The original version was developed at the Naval Postgraduate School's MOVES Institute for Colonel Casey Wardynski. The game was wildly successful as a free commercial release based on the Unreal Game Engine.

The popularity of America's Army is unquestionable and for a long time it was the poster child of Serious Games in the military. In 2008 it received a Guinness Book Record for the most downloaded war game. The newest version, America's Army: Proving Ground, was developed in house at the Army Game Studio, and was released in August of 2013. The popularity of this game was a double edged sword for budding Serious Games Industry. While the game brought lots of attention to the field, it was at its core an entertainment game that served as a platform for starting recruitment conversations. It did not need instructional objectives, or have other goals that more traditional Serious Games would need, yet it became the model of what a Serious Game should be. Moving from entertainment to educational design models has proved to be a much more complicated issue.

5.2   Games for Training

The DARWARS research program was formed to accelerate the development of US military training systems. The goal of a lightweight simulation based training application led to the development of DARWARS Ambush! The initial application involved road-convoy-operations training, while subsequent applications include training for platoon level mounted infantry tactics, dismounted infantry operations, Rules-of-Engagement training, cross-cultural communications training, and other areas. It's based on the technology of Operation Flashpoint a technological predecessor of VBS2.

While DARWARS Ambush! was the most successful game based training program at the time, many other developers were entering this space. It was a very interesting time of experimentation and many exciting new games were developed.

5.3   Games for Health

Games for Health are another fast growing sector in the Serious Games industry. Games in this sector include games that actually provide engagement to otherwise strenuous physical activity, as well as games that help change attitudes and behaviours towards health risks, medication adherence, and pain management. One of the most popular games in this area is Re-Mission. Re-Mission is a 3rd person shooter designed to teach children with cancer the importance of adhering to their medications. In the game the player is tasked with shooting cancer cells and if they do not destroy each cell they will grow back and cause additional problems for the player. This was combined with an online community to discuss the experiences of the players both in the game and with their own cancer treatments. Studies indicated that players were more likely to adhere to the full treatment despite the fact that by the end of the treatment cycle the medication makes them feel worse than the actual cancer does.

5.4   Games for Research

A relatively new field in Serious Games is Games for Research. In 2010 the Game Fold.It was released in an effort to enlist players into the processing of processing large datasets and find new discoveries in science through crowd sourcing. Players of Fold.It are earning points for folding real protein structures in the game.
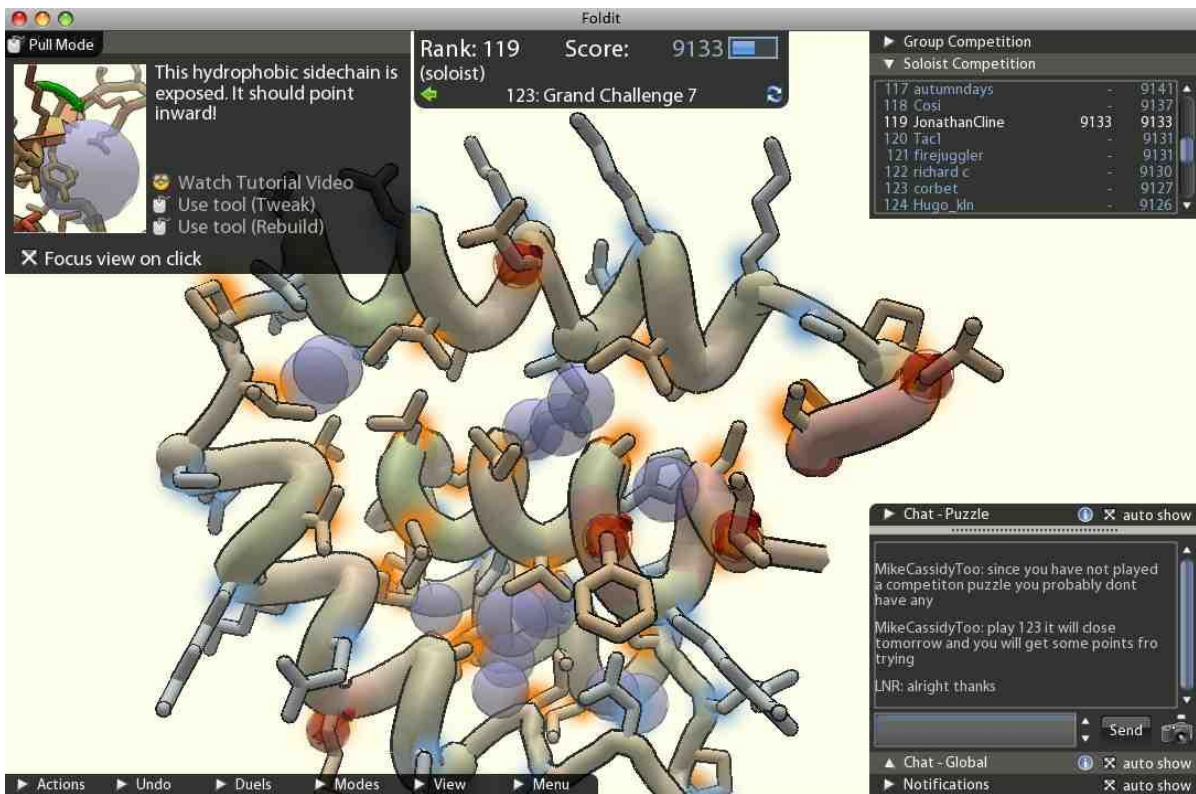
With thousands of players interacting with protein structures and attempting to maximize their score in the game they are finding the best and most efficient folding structures. The game became very popular after releasing an enzyme related to a potential cure for HIV, which had been unsolved by scientists for over 10 year, to its players and had them solve it in less than a week. The power of crowd sourcing for science in games is now a growing field that is being used in games for mapping neurons, diagnosing malaria, and fighting cancer. There is huge potential in this model for analysing any large datasets. What is commonly considered a boring job becomes exciting when the right game mechanics are employed.

6.0   EMERGING BUSINESS MODELS

As various types of Serious Games have emerged there is still ambiguity around the best business model for selling them. The standard model seems to be grant or contract based, however, this is limiting the potential of iterating through sequels and building expertise. While it would be nice to find a consumer level model for success the contract model seems to be working and how to best structure these deals has been a point of experimentation for a number of years.

6.1   Co-Development

The US Marines through developer Destineer developed Close Combat: First to Fight. This game used a co-development model. This model had the entertainment company build an entertainment game while the government got a modified version for military training. This required the US Marines to evaluate the

entertainment game and suggest changes that would be rolled into a more military focused game. Close Combat was released to little fanfare in the entertainment market and was also considered less than perfect in the military domain as well. Attempting to meet the needs of two markets appears to be too hard to work feasibly.

6.2   Console Gaming

The US Army experimented with console gaming in the form of the game Full Spectrum Warrior. The game was developed by Pandemic Studios and was released on the Microsoft Xbox. The name Full Spectrum Warrior comes from the Army's program for training soldiers to be flexible and adaptable to a broad range of operational scenarios. The game was deployed as training primarily at West Point, but everyone that bought the Xbox game had the military content. It was hidden through a cheat code, but that was posted on the internet virtually immediately. Because the content was not well hidden, it could not be sensitive. For the most part entering the code made the game harder to win. The costs associated with building a console game were not worth the benefit. Also, similarly to the Close Combat: First to Fight experiment the end result was not a perfect entertainment or training game.

6.2   Engine Licensing

Many Serious Games programs today rely on licensed game engine technologies. These game engines come fully packaged and ready to deploy games based on their particular set of capabilities. Each game engine has its strengths and weaknesses, and should be evaluated before being used. While there are literally thousands of game engines available there are a few that are more popular, and are often used in this space. These include but are not limited to:

- VBS2

- Unreal

- CryEngine

- Unity3D

- Flash

The engine used for a particular Serious Game does not necessarily have any direct implications on the quality of the application, but it does provide developers a leg up on having to build their own technology. Prior to the commoditization of game engines, home grown engines would be difficult to install, non-uniform to use, and would often crash. As game engines have become more popular the general level of stability of game based training programs has greatly improved. With technology out of the way designers can now concentrate more on actually designing the best possible product and less time concerned with making it work.

6.2   Enterprise Solutions

An enterprise solution to games is characterized by having a single platform for which games can be deployed. This is not necessarily a single game, but a single suite of games on common hardware. There is, however, usually a flagship game that is used to meet the majority of the game-related requirements. The suite is used to augment the flagship game to allow game based training on alternative hardware, or to meet a different type of requirement.

This strategy has proven to generate an overall cost savings and ROI by reducing the cost of licensing multiple engines, developing multiple assets, and training users on multiple systems. This cost savings has allowed the Services to implement new technologies and refine existing ones to build the best possible ecosystem of development and innovation in the game for training space.

The U.S. Army has defined a requirement to support on-demand training, mission planning and rehearsals, stimulation of battle command systems, and Joint interoperability by leveraging COTS and government off-the-shelf (GOTS) applications and advanced simulation technology. The U.S Army was the first Service to adopt an enterprise solution to games. They stood up TRADOC Capability Manager (TCM) Gaming in April 2008. They selected Virtual Battlespace 2 (VBS2) as an Army gaming program of record and acquired an enterprise license for use throughout the Army. The games are delivered on a common hardware platform and included in the Army Games for Training Toolkit. Using VBS2, Operational Language and Culture, Elect BiLAT, Moral Combat, VBS2 Fires and other games are in the works. Beyond VBS2, games included in the suite all meet Army requirements that are not fully met within VBS2 but run on the same platform. These technologies come from the commercial gaming industry, federal research agencies, laboratories, and academia. Each application has unique characteristics that augment and improve an existing training capability or fill training capability gaps.

The final product for this effort is a gaming tool kit consisting of selected COTS/GOTS applications that fulfill training requirements. The Army will leverage and influence gaming technologies in order to rapidly deliver relevant training capabilities to support current and future soldier, leader, collective, and mission rehearsal training. The use of COTS/GOTS product portfolio of Gaming Technology is readily available and facilitates our ability to fill operational capability gaps required for training current/future forces.

Enterprise gaming solutions have provided the DoD with a new set of standards for games. Games are now built with target hardware platforms in mind. Assets within the game are built with an existing art style and common tools. Control mechanics can be reused across games, so users do not need to be retrained to control every game on the platform. [11]

8.0   RESEARCH

While all of the development previously discussed was occurring there were also a large number of studies conducted into the effects of Serious Games. While not a complete list the following meta-analysis and survey studies of gaming all showed positive results from studies conducted on Serious Games:

- Hays, 2005
- Alexander, 2005
- Oneil, 2005
- Fletcher, 2006
- Vogel, et al., 2006
- Fengfeng, 2009
- Sitzmann, 2011

There is still always a need to conduct more empirical studies and to constantly test the approach. That said, the number of these studies has grown at an incredible rate, and the mounting body of evidence support the use of games for training. The real question is no long do games teach, but how do we build the best games for training and education.

8.0   CONCLUSIONS

Serious Games have a rich history in the US military and beyond of bringing game experiences and technology to people beyond the entertainment space. While this trend may appear new, the use of games for learning has a rich history and the idea of using a game as a learning platform is an established concept that

has withstood the test of time. Research in this area must move from if games can teach, to how do we improve games that do. Proponents of serious games suggest that they should improve motivation, time on task, motivation to learn, and a litany of other benefits based primarily on the thought that what works in an entertainment game will work in a learning game. While this might not always be the case further research into the nature of this question in imperative for serious games to continue.

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