Streamlining Simulation Development using a Commercial Game Engine

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ABSTRACT

Recent sensor upgrades on the US Army's AH-64D Apache helicopter have transformed the way modern combat is conducted. The technological advances in this sensor allow Pilots and Co-Pilot Gunners to perform extremely accurate target identification and engagement activities to defeat terrorists and insurgents while truly minimizing collateral damage.

The Commercial Game Industry has pushed the envelope in advancing computer graphics hardware & software, and is constantly raising the standards of what is possible in immersive games. This technology allows for complex simulations to run within the context of a game, provided the underlying game engine foundation supports the full exploitation of the Graphics Processing Unit (GPU).

This paper will highlight how familiarization training can be dramatically enhanced by the application of COTS game engine and middleware features toward a training niche created by very modern tactical sensor technology. The conclusion can then be drawn that creative, game based solutions can and should be applied to unique, newly emerging combat training requirements.

1.0 INTRODUCTION AND BACKGROUND

Camber Corporation has a long history of Modelling & Simulation support to the US Army Aviation Program Offices (PMO) in high fidelity flight simulation and engineering analysis. As part of this support, Camber has been in a unique situation to be able to integrate technology from the game industry into training

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
OCT 2009	**N/A**	**-**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Streamlining Simulation Development using a Commercial Game Engine	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Game Technology Research Camber Corporation 977 Explorer Blvd. Huntsville, AL 35806**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT

Approved for public release, distribution unlimited

13. SUPPLEMENTARY NOTES

See also ADA562563. RTO-MP-MSG-069 Current Uses of M&S Covering Support to Operations, Human Behaviour Representation, Irregular Warfare, Defence against Terrorism and Coalition Tactical Force Integration (Utilisation actuelle M&S couvrant le soutien aux operations, la representation du comportement humain, la guerre asymetrique, la defense contre le terrorisme et l'integration d'une force tactique de coalition). Proceedings of the NATO RTO Modelling and Simulation Group Symposium held in Brussels, Belgium on 15 and 16 October 2009., The original document contains color images.

14. ABSTRACT

Recent sensor upgrades on the US Armys AH-64D Apache helicopter have transformed the way modern combat is conducted. The technological advances in this sensor allow Pilots and Co-Pilot Gunners to perform extremely accurate target identification and engagement activities to defeat terrorists and insurgents while truly minimizing collateral damage. The Commercial Game Industry has pushed the envelope in advancing computer graphics hardware & software, and is constantly raising the standards of what is possible in immersive games. This technology allows for complex simulations to run within the context of a game, provided the underlying game engine foundation supports the full exploitation of the Graphics Processing Unit (GPU). This paper will highlight how familiarization training can be dramatically enhanced by the application of COTS game engine and middleware features toward a training niche created by very modern tactical sensor technology. The conclusion can then be drawn that creative, game based solutions can and should be applied to unique, newly emerging combat training requirements.

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**SAR**	**12**	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

systems for military applications. Camber operates a full scale AH64 simulator to support pre-flight mission rehearsals and subsystem integrations. This simulator has been cited by Apache PMO as a major cost saver [1] by reducing actual flight time. This legacy contract work highlights both the Army's long standing desire for Modelling & Simulation, and Camber's expertise and ability to perform to the customer's requirements.

2.0 SENSORS OVERVIEW

As new technology is integrated into military and civilian equipment, training devices must be built that enable users to rapidly learn how to safely and effectively operate the equipment. In this case a powerful Forward Looking Infra Red (FLIR) sensor has dramatically increased the vision of the co-pilot/gunner allowing engagements from much greater distances with much higher resolution imagery displayed in the cockpit.

2.1 Technology

This Sensor technology is largely made possible by advanced, proprietary real time image processing techniques that Camber played a role in evaluating and documenting. This FLIR simulation includes a real time, distributed PC implementation of edge enhancement, range compression, histogram and other computationally intensive image processing functions. The result is a high contrast, high detail, near television quality display image.

2.2 Usage in Combat

High resolution FLIR technology has been fielded for several years now and has been used extensively in current conflicts. It has transformed the way tactical engagements take place due to the ability of the Apache to clearly view targets at greater distances and observe subtle activities with greater clarity. These recent conflicts have involved a very cunning and crafty enemy whose actions and intentions must be observed at the human behaviour level. This requires an additional burden on the pilots and gunners to clearly interpret what they see before they fire. Apaches are also in service now with modifications to allow a UAV to display its sensor video inside the cockpit, providing an additional set of eyes for situational awareness. With this increased power comes increased responsibility along with a new set of communication and interoperability issues as pilots, UAV operators and foot soldiers all observe the same target from different perspectives.

3.0 GAME TECHNOLOGY OVERVIEW

The power of the advances in Game Technology is easily observed by anyone who has played video games or watched movies within the last few years. The realism is stunning and the Commercial Game Industry fuels the fire of cutting edge advances in hardware and immersive experiences. It is also obvious to those in the Military Simulation and Training industry that a great effort has been made in recent years to embrace game technology at all levels. The US Army has an official Program Office for Gaming now, and there are many Serious Games organizations and development studios. The Interservice/Industry Training, Simulation & Education Conference (IITSEC) even sponsors a Serious Games Contest, which Camber participated in as a selected Finalist two years ago.

3.1 Advances

The Commercial Game Industry has pushed the envelope in advancing computer graphics hardware (HW) & software (SW), and is constantly raising the standards of what is possible in immersive games. This technology allows for complex simulations to run within the context of a game, provided the underlying game engine foundation supports the full exploitation of the Graphics Processing Unit (GPU). The GPU is largely responsible for the superior look and lighting effects common to next gen games.

Other advances in game engine technology that directly relate to better training simulations include support for larger, outdoor terrains and more natural human animation. Large, realistic game worlds featuring outdoor landscapes and crowds of characters can now be more easily created using modern game engines. Very realistic characters and motion captured animations can be integrated to represent the real detail that is now visible in a modern Apache's FLIR sensor, and necessary for effective training of the latest tactical scenarios.

The Commercial Game Industry has also produced advances in Graphical User Interfaces (GUI) as games by nature must be very easy and fun to use. The input devices, GUI development tools and middleware available today have set new standards for how efficiently functional and artistically engaging a human/machine interface can be.

3.2 Trinigy Vision

Based in Austin, TX, and Southern Germany Trinigy is a privately owned company committed to licensing game engine technology and first-class support to video game and serious game development studios across the globe. Trinigy's Vision Game Engine has proven its versatility and reliability in more than 100 commercial game productions, applications and simulations all over the world.

Rather than being a monolithic technology, Vision has been designed with a focus on flexibility and modularity. Both the runtime and tools have clean, well-structured Plugin APIs, so new features and modules can easily be added without modifying the engine's source code. This modularity also makes it easy to integrate Vision into existing production pipelines.

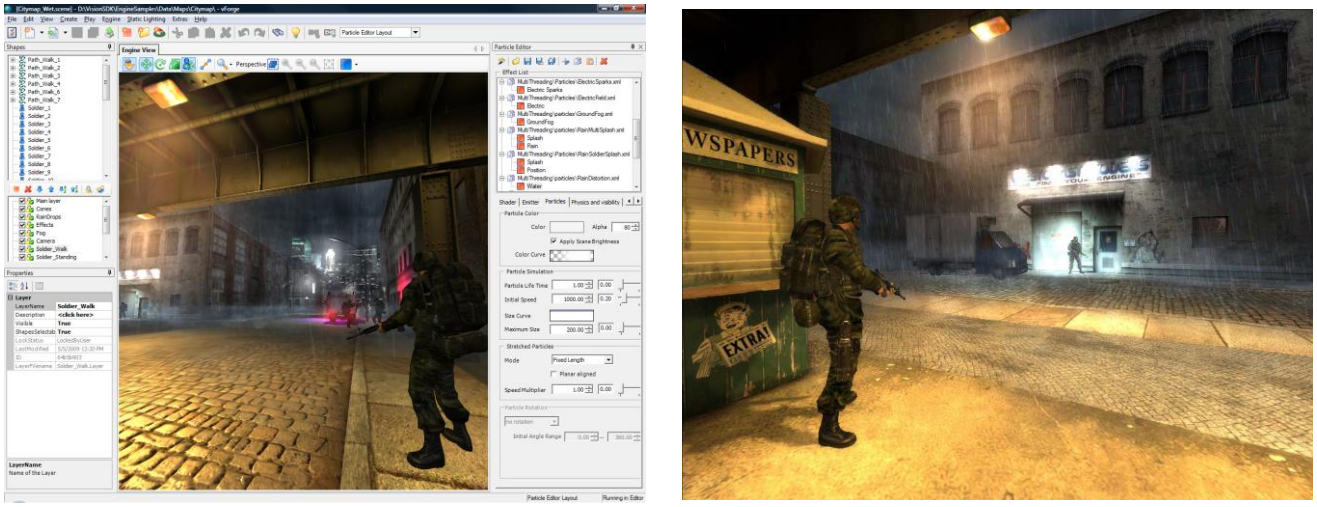

Figure 3-1: Representative Trinigy Vision Screen Shots

3.2.1 Streamlining Development, vendor perspective

Commercial game engines have been designed to streamline the development of games and serious game projects. The following chapters will highlight some features of Trinigy's Vision Engine, specifically how it helps to streamline serious game development.

3.2.1.1 Using core technology out of the box

The Vision Engine includes a very efficient rendering core with state of the art lighting and shadowing techniques, various visibility culling techniques, an extensive and scalable animation system, an efficient particle rendering system and more features out of the box. Instead of first developing all this base technology, developers using Trinigy can directly start with game logic and application development instead - not losing any time at the early stage of the project.

3.2.1.2 Having tools from the very beginning

Tools are definitely one major benefit of commercial game engines, such as Trinigy. Having powerful and tested tools at the very beginning of a project allows the team to immediately work on the game content and getting playable content up and running more quickly.

The Vision Engine 7's SDK provides an intuitive WYSIWYG (= what-you-see-is-what-you-get) workflow designed to maximize efficiency and to decouple level design from the programming side. Artists can export art assets like geometry, textures, animations, materials or lights from their preferred modelling software into the scene editor, vForge. The scene can be interactively populated, visual effects can be created and tweaked in runtime and all aspects of interaction can be tested with no turnaround times.

3.2.1.3 Middleware Integrations, ready to be used

The Vision Engine's combination of runtime and tools provides a reliable infrastructure for any type of real-time application. It is thus the ideal platform for connecting additional middleware solutions, such as

streamlined user interface components and vegetation rendering.

The Vision Engine provides an extensive set of middleware integrations out of the box, allowing the game developer to immediately use additional middleware without spending time on integrating them into the runtime and the tool chain. These integrations include common solutions for physics, network and AI as well as technology for procedural animations and geometry destruction.

3.2.1.4 Support & Customizing

As a technology partner Trinigy does not just deliver a product, but accompanies the developer during the complete development cycle of the project. This includes competent technical support provided by the founders of the company, as well as additional customization and development tasks. Having such an expert knowledge available is a significant benefit.

3.3 Application to Training

Game Technology applies to Military training in more than just the obvious upgrades in game engines and hardware. The increased visual realism and performance promote better immersion and help match the expectations of the generation of young pilots who have grown up playing video games. Training effectiveness can be degraded with the old outdated visuals of many existing simulations. Large, operationally cumbersome training applications can be counter-intuitive and boring when contrasted to the graceful, stylistic interfaces many young aviators have been exposed to with their video games. For familiarization training, the traditional "push this button", "flip this switch", PowerPoint intensive style can be replaced by an entirely new design methodology, games as a medium for embedded training.

This is not a new concept since Serious Games have been promoted and in use now for years. What is relatively new are actual, meaningful studies producing metrics validating training improvements from using games (not just game technology upgrades).

Recent studies have been performed [2] that produced real, scientifically derived metrics offering validation to games as a medium for training. The referenced study involved a Flooding Control Trainer (FCT) game developed for the US Navy Recruit Training Command (RTC). A set of trainees who had been given the standard RTC training but had not yet taken the required evaluation test were divided into two groups. A Treatment group that played the FCT game for one hour each, then took the test two days later, and a Control group that had no exposure to the game but took the same test. The results are summarized with striking differences. Decision making errors were reduced by 50%, Communication errors reduced by up to 80%, and Situational Awareness skills were improved by 50% in those trainees comprising the Treatment group.

The previously mentioned game technology advances also allow for more complex and creative games to be used for training. Games that resemble the more popular entertainment games involving elaborate storytelling and cinematic effects provide a more immersive and compelling experience to the player. The underlying game engine technology today has much better support for high end, embedded multimedia content. Camber's SPeAR process [3] promotes a story based game design as a better approach to training games. This game design methodology utilizes a larger authentic mission context, and relevant engaging story, among other components, to progress the learner and unify the game experience.

4.0 RATIONALE FOR GAME BASED SOLUTION

So the real world military technology has been developed and deployed, the tactical benefits realized and

new niche training requirements discovered.

General advancements in commercial game engine technology continue to push the envelope of what is possible in realistic and engaging entertainment.

A generation of aviators have grown up playing high end video games, and expect a certain level of stimulation and engagement from their expensive training.

Recent studies provide real metrics that games can provide a more effective medium for familiarization training.

We now build a rationale for matching a game based solution using commercial technology to a specific training objective derived from modern Army Aviation combat.

4.1 Rules of Engagement

Rules of Engagement (ROE) describe how a pilot and co-pilot are to engage the enemy in order to maximize effective elimination of threats, minimize collateral damage and justify decisions to shoot as well as to not shoot. The burden of proof ultimately rests with the pilot and gunner to justify their decisions. This can create apprehension toward the ROE as it can be quite involved, seemingly restrictive, and legally enforced. Improper adherence to ROE can cost the lives of friendly troops and innocent civilians. Sometimes the decision to not shoot, brought about by ROE apprehension, endangers the lives of troops on the ground. ROE varies according to theatre and specific ROE elements can be tightened or relaxed dependent on recent local activities. ROE training involving the new sensor technology in recent combat situations can be made more effective by presenting the trainee with as wide a range of realistic, classroom level scenarios and lessons learned as possible. This visually intensive, decision centric training objective sets up well for a game implementation.

5.0 GAME CONCEPT

Camber's Game Technology Research was funded to discover ways to engage the commercial game industry for new business as well as performance improvements to existing simulations. We have imposed it upon ourselves to feature our legacy Modelling & Simulation expertise with the Army in a game concept that required a high end, commercial game engine. A game concept that highlights our relevant experience in sensor technology, interoperability issues, and deployed desktop training solutions must be integrated with the ROE training objectives.

5.1 Checkpoint Recon

Checkpoint Recon is a single player, classroom level familiarization training game. Currently, its development status is a fully playable vertical slice of the proposed concept. The game is a 100% custom Camber development and features a fictitious game world that allows for the player to free roam in an Apache helicopter. There are scripted vignettes of activity scattered throughout the city that draw the player's attention. These scenarios are created to represent the spectrum of encounters that an Apache crew might have to make. Some characters behaviour is obviously hostile while other times the behaviour, location and objects possessed by a non-player character (NPC) require the player to exercise "tactical patience" and mark their observations. When the player determines a hostile action or hostile intent being represented by an NPC he must follow representative ROE guidelines to register his decision to shoot or not-shoot. The game rewards the correct decision, which, contrary to entertainment games, is sometimes a no-

shoot decision. Screen shots from Checkpoint Recon can be seen in Figures 5.1 through 5.5

Figure 5.1: Checkpoint Recon Game World

Figure 5.2: Checkpoint Recon Player View, Pilot

Figure 5.3: Checkpoint Recon Hostile Action Vignette

Figure 5.4: Checkpoint Recon Player View, Co-Pilot

Figure 5.5: Checkpoint Recon AAR Avatar

5.1.1 Streamlining Development, developer perspective

So how does a commercial game engine, specifically Trinigy Vision, help us streamline the development of our training game concept? By providing every feature that helps us bring the full power of what's available in 3D graphics technology into our game without burdening our dev team with having to write custom encapsulations and integrations. Being a research project, the dev team is very small compared to most entertainment game teams. Allowing the developers to focus on game specific logic and asset creation, and not on engine development, is the most efficient use of our time and budget.

5.1.1.1 Next gen rendering power, lighting effects

A large portion of what streamlines development is the core of the engine itself. A powerful rendering engine allows for detailed, normal mapped art assets to be immediately incorporated with realistic shadows, lighting effects, depth of field and a full integration of SpeedTree. These are some of the key features that lay the foundation for the outdoor scene realism required by the genre of our game. Having these features available "out of the box" means that the games look and visual quality will match expectations generated by recent generation video games.

Another part of the game engine that is exploited in Checkpoint Recon is the support of advanced game quality character models and animations. The Game Artist's preferred, industry standard tools are supported throughout a full content creation pipeline seamlessly integrating assets into the engine. Models created in Maya, textured and normal mapped using zBrush are then animated using animations from our own motion capture system as well as Motion Builder. Animation blending is supported in the engine and then integrated

with powerful Lua scripting to create more realistic character scenarios. In order for the sensor simulation to look correct all art assets, especially characters, must be textured with an additional texture layer for an IR depiction. Our artists have access to real source imagery from years of Camber contract support to the Army.

5.1.1.2 GPU Sensor Effects

The sensor simulation portion of the game is crucial. Being able to replicate a generalized subset of the real time FLIR processing algorithms in the GPU means that the look presented in the game will be non-distracting from the training objective. The entire game concept centers on how the sensors have created a niche training objective in the way Apache combat engagements are prosecuted. This "simulation within the simulation" must look right to the user/trainee. Custom pixel shaders allow the image processing effects to be applied as a full scene multi-pass rendering process. The Trinigy Vision engine provides a robust and reliable programmers interface to support implementing these GPU programs. The real time, image processing effects currently implemented include optical blurring, detector non-uniformity error, residual non-uniformity correction, edge enhancement and Rayleigh histogram.

5.1.1.3 Scaleform GUI integration

Scaleform Gfx is a commercial game industry toolkit for embedding Flash based user interfaces and cinematic videos into 3D games and sims. The integration with Scaleform Gfx middleware allows for easier implementation of game style GUI's. This streamlines development of the game by allowing creative Flash and multimedia artists to work in their familiar toolsets separate from game programmers, and have their content replicated exactly in the game.

5.1.1.4 Vendor as team member

Using a commercial game engine streamlines development of a simulation game in ways other than through exact technical features. If the commercial engine vendor can be viewed as a team member then you greatly increase the effective size of the dev team. The vendors business is to track technical advances in gaming HW and middleware integrations. This technology changes very rapidly and can easily disrupt development schedules if the dev team tries to keep up on their own. When game developers need additional features in the engine they could modify the engine code themselves (provided they purchased a source code license option), or the vendor can implement the new features at the developers request.

5.1.1.5 Personnel

Another way using a commercial game engine can streamline development is in the kind of people we are able to attract and retain. Having creative, young game developers working for you will speed the process. Having commercial game technology as part of your project will give incentive to experienced game programmers and artists come to work for a defence contractor when they probably wouldn't otherwise.

6.0 CONCLUSIONS

This IRAD game project can now support several conclusions related to using commercial game engine technology for simulation based training games. The reaction of real Apache pilots, those in training, active duty and retired has been very positive. The game has been presented to many Army Aviators at trade shows and by their invitation to military bases. This overwhelming positive reaction proves that the concept and supporting technology are valid for the training objective, Rules of Engagement familiarization. Using a

commercial game engine has allowed our small Research and Development team to focus on our niche expertise, and the game concept implementation. Having a training game built on commercial technology also provides us with a stark contrast in image quality, performance and maintainability to that of existing, legacy technology training apps.

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