1.15 A First Person Shooter/Real Time Strategy Hybrid: Lessons Learned

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INTRODUCTION

Today's military training bears little resemblance to the methods of previous generations. The Cold War is over and the enemy has changed. Doctrine that was once useful is now woefully out of date. No longer are we confronting a predictable nation but instead a diverse collection of independent fighters spread out over several countries. The enemy has changed, his tactics have changed and circumstance dictates that we must change as well.

The wars in Iraq and Afghanistan have tested virtually all aspects of the military's support infrastructure. After fighting continuously for over a decade, many weaknesses have been revealed by the steady grind of war. Chief among them is the inability of the military to rapidly and adequately train its soldiers in the latest doctrines.

In response to the enemy developing new strategies on a near monthly basis, the Joint Training Counter-IED Operations Integration Center (JTCOIC) was first created. Designed to supplement the current training system, it would attempt to address the current training shortfalls. As a result, new methods were devised to streamline training.

THE TRAINING CHALLENGE

Currently the military's training program is in flux. It is in the process of transitioning away from older table-top methods and towards a completely new digital paradigm, a move made possible only recently by the widespread adoption of new simulations technology. However, to fully appreciate the significance of this change it is helpful to look at how the military trains today and how it hopes to train tomorrow.

Current U.S. Military Training Doctrine

Currently the most prevalent form of training is classroom lecture supplemented with PowerPoint presentations. This method is popular because it is cheap, simple and easily customizable. Additionally it can be designed to accommodate almost any size class and requires virtually no additional materials other than a computer and projector. Unfortunately, this method can also be fairly inefficient (Worley & Dyrud 2004). Instructors are limited by their experience, the curriculum is often out of date and, most importantly, students are easily fatigued by long sessions. Often the results are students, overwhelmed by data, who ultimately retain very little from the experience (Tufte 2003). So while this method is cheap and easy, it is also does a poor job effectively training soldiers.

In support of stateside training, and to supplement lecture based instruction, Mobile Training Teams (MTT) are sent into the field to train soldiers in theater. These teams do an excellent job; however they are tasked with training an incredibly large number of soldiers, in different countries, in wildly differing environments. While this is preferable to the alternative of no training, providing a consistent training experience for all troops has proven to be quite difficult. Despite an increase in manning, there simply isn't enough MTT's to fulfill the demand.

Recognizing that the increasing frequency and diversity of U.S. military conflicts will continue to require highly trained soldiers, steps have been taken to modernize the current training environment. In keeping with this realization, a new directive was announced in 2010 aimed at formally expressing this long awaited change in direction.

The U.S. Army Learning Concept for 2015

In a letter explaining this new training concept for 2015, Training and Doctrine Command (TRADOC) commander General Dempsey described it as follows:

> *We live in a much more competitive security environment. This means that we shall have to learn faster and better than our future adversaries. Stated a bit differently, we must prevail in the competitive learning environment.*

> ...
> *The Army Learning Concept 2015 does not focus on any particular technology, but rather focuses on the opportunities presented by dynamic virtual environments, by on-line gaming, and by mobile learning. It speaks of access to applications, the blending of physical and virtual collaborative environments, and learning outcomes.*
>
> *Martin E. Dempsey*
> *General, United States Army*
> *Commanding*

This letter was written to clarify the purpose of this new doctrine. Specifically, it mentions how the military plans on improving every aspect of their soldier's training. New tools will be used that places a premium on mobility, virtualization and universal data access.

Since this new paradigm of military training focuses on the key aspects of adaptability, mobility and up to date material, the Maneuver Center of Excellence (MCOE) team decided to base part of their training curriculum on the tactical simulation, Virtual BattleSpace 2 (VBS2 2011).

THE MCOE EXPERIMENT

Computer based training simulations offer a rapid and efficient way to train a large number of soldiers. Moreover the current soldier is quite familiar with this type of training as they have played commercial video games for many years, making them particularly well suited for this medium. As such, this type of training is gaining attention in schoolhouses looking to modernize their curriculum (Sellers 2001).

In an effort at revamping their curriculum, the Maneuver Center of Excellence (MCOE) decided to rework the Leadership Decision Exercise portion of their training program. Specifically, they began laying plans to incorporate Virtual Battle Space 2 (VBS2) into their classes. To assist with that effort, MCOE instructors met with the Systems Integration Modeling & Simulation (SIMS) division of the JTCOIC.

MCOE instructors would meet many times with JTCOIC SIMS programmers as they crafted a series of requirements that they would need VBS2 to fulfill if the training was to be a success. Presented below are the key elements they agreed upon:

- Capability to train multiple soldiers at once
- Capability to train multiple command positions simultaneously
- Ability to play from enemy perspective
- Realistic map based interface
- Use of geo-specific terrain
- Large scale training with minimal staffing
- AAR capability

These objectives align with the Army Learning Concept 2015 parameters and taken together, these objectives outline a method of training soldiers that will be far superior to the decades old sandbox method currently in place.

The solution that was ultimately delivered to the MCOE consisted of a highly customized training scenario run in VBS2. The scenario allowed for over 11 students controlling over 200 entities to participate in a coordinated offensive against an enemy building in an urban environment.

To achieve this coordination, the standard First Person Shooter (FPS) interface of VBS2 was enhanced by adding in the map based control structure of an Real Time Strategy (RTS) game. Before we can explain the details of this solution though, an explanation of the similarities and differences between a First Person Shooter and a Real Time Strategy game is required.

First Person Shooters

Because of the popularity of such commercial FPS titles like *Half Life*, *Halo*, *Counter Strike* or *Medal of Honor*, this genre of game is quite familiar to this current generation of soldiers. Though this particular style of shooter has been around for over 20 years, it wasn't adopted by the Military for training simulation until fairly recently. The current best selling FPS (see Figure 1) is shown below.

Figure 1. Most Popular Current Commercial FPS, *Call of Duty 4*

The current standard FPS training simulator in the military is *Virtual Battle Space 2* (VBS2), a military version of the commercial game, *Armed Assault*. This simulator (see Figure 2) has proven to be so useful that it is currently used by all four branches of the military in addition to numerous other coalition partners such as the U.K., Canada, New Zealand and Australia.

Figure 2. U.S. Army FPS of Choice, *VBS2*

VBS2 is primarily used for squad level training. Designed to support roughly 200 in game units at once on a map 10 km square, the scope of the game is limited to a city sized game area.

Because the perspective of the player is confined to one unit, to complete a mission multiple human players are required to play simultaneously via a network game. AI units are used to supplement the experience; nonetheless there is a direct correlation between complexity of a scenario and the number of human players required.

Real Time Strategy

Unlike First Person Shooters which focus solely on the individual, Real Time Strategy games (see Figure 3) focus on controlling large armies simultaneously. There is a diverse mix of units, a large terrain to traverse and effective play requires coordinating multiple combined arms attack groups.

Figure 3. *Company of Heroes*

RTS games are the commercial equivalent of the military's virtual constructive simulations such as JSAF or JCATS. With a focus on coordination of forces and choice of tactics, these simulations are better suited to training commanding officers.

Figure 4. *Command & Conquer 3*

The two examples shown above depict two very popular RTS style games, *Company of Heroes* and *Command & Conquer 3*. In each game there is a map (see Figure 4) used to direct a player's forces along with various other methods for controlling units. This map based interface would prove to be the critical component of the MCOE solution.

CHALLENGES FACED

Now that the framework has been laid for understanding the MCOE training scenario it is time to move on to analyzing the problems this team encountered, along with the key lessons they learned as this development proceeded.

There were four main areas of expertise that came together to create this project. Each area tapped the resources of different teams within the JTCOIC SIMS. As a result, even two members of SIMS completed the bulk of the work, this project would eventually involve contributions from almost a dozen SIMS personal. This project would come to include scenario developers, programmers, 3D artist, terrain specialists and system administrators as everyone worked feverishly to meet an April 14th deadline.

The remaining portion of this document describes the lessons learned by each team as they struggled to complete a high quality product in the face of changing requirements, increasing project scope and unforeseeable difficulties.

LESSONS LEARNED - OPERATIONS

Before any code was written, before any graphics were designed or any network setup, the entire training exercise had to first be designed. Fort Benning's MCOE leadership would work closely for over nine months with JTCOIC SIMS personnel as the MCOE training scenario was developed.

Have a Process to Determine Requirements

The first lesson learned also turned out to be the most important, namely determining project requirements. In what would become a long and detail oriented process the MCOE instructors slowly worked out what they wanted this training to entail.

What they ultimately decided on was a VBS2 Urban Ops scenario set in downtown Columbus, Georgia. Enemy combatants had taken over a walled public safety building complex and four platoons of infantry and coalition forces had been tasked with securing the area. The students would play various command roles within the BLUE forces such as company commander, aviation controller, platoon leaders, squad leaders or OPFOR. The ultimate goal was to retake the prison, kill or capture all enemy units and do so with minimal loss of life and restore control to the local government authorities.

This mission template was initially developed over a period of several days. However, senior leaders within MCOE and other CoE's such as Fort Rucker and Fort Sill expressed a desire to participate in the training which resulted in new requirements being added. Additional changes were made as they discovered what the simulation could fully do. As a result, instead of being given a single document containing the mission specifications, what was produced was a constantly evolving set of requirements. This more than anything contributed to the length of time needed to produce a working version.

Understand the Depth of the Problem

Further delay was caused by the training staff underestimating the amount of operational data the programmers would need. Because the development team had no prior military experience to use as a reference point, instructions that were self explanatory to military personal required elaboration for the programmers.

For instance, it was insufficient to merely state that a unit had to move to a new location. Additional details were needed such as convoy movement patterns, alternate destinations if initial one was blocked, call signs of the units, correct terminology for movement orders and verbal responses.

Often times seemingly simple mission features could require much more supplemental information than initially provided. Data such as armaments for the air support, accurate map icons or proper breaching procedures were some of many subtle details that had to be right for the training to be accurate.

Solutions

For future training scenarios, explicit objectives must be defined before any other work can begin. Moreover, it is required that someone with advanced VBS2 experience be involved with the initial planning to provide a reasonable guide for what the simulation is and is not capable of producing.

Then, once the initial framework of the scenario has been complete, as many mission details as possible should be recorded. Attack plans need to be diagramed, convoy routes planned, medevac and air support defined along with any custom details that would be required. By providing as much information as possible up front, mission designers can minimize the need to rework the scenario later in development.

LESSONS LEARNED - TERRAIN

Building a geo-specific terrain (a terrain modeled on an actual location) of Columbus, Georgia was a long and challenging process made harder by the lack of American building models in VBS2. Because VBS2 is used extensively to train soldiers going to Iraq and Afghanistan most of the terrain features and buildings are specific to Iraq and Afghanistan. The landscape leans towards deserts, mountains and minimal greenery while the buildings are squat, drab and brown. Though this has worked quite well for its intended purpose, it doesn't blend very well in urban America.

As a result, custom terrain had to be designed pulling in as many geo-typical American looking buildings, foliage and unit models as could be found, some of which had to be created from scratch.

Use Location Specific Models

Due to a lack of American looking houses and buildings, many Eastern European models had to be substituted. Some buildings such as the prison complex were designed in house for use by the terrain team. And while this solution was satisfactory, if future training missions were to be conducted in American cities, it would be worthwhile to develop American building, car and tree models. This would make the terrains more realistic and provide greater visual variety.

Smaller Maps are Better

Due to the limits of VBS2, the largest terrain it can currently handle is 50k x 50k. That size terrain is undesirable though because it wouldn't have sufficient detail to accurately represent the training area and would be a tremendous drain on system resources. Instead, smaller, denser maps are preferred as they provide better training experiences.

For this mission a 10k x 10k map was used. The main combat area was a 0.5 square mile section (which accounted for about 9 city blocks) that was created at a higher resolution than the remaining city. This increase in density made for a more realistic setting by including more models such as cars, trees, signposts, light fixtures and debris. Additionally the buildings in this section are of a better quality than those outside the combat zone. And because the majority of combat operations occurred within this zone, improving the fidelity of this area greatly increased the quality of the simulation.

Of course, even at this much reduced map size details begin to be lost the further away from the city center. This terrain required 2 man-months of work to complete. The chart below represents various terrain sizes. In determining how large a terrain is needed, it is useful to compare the size of terrain (see Figure 5) that was created for MCOE (10km, green box) with the area of the city that was actually used (.5 miles, black box).

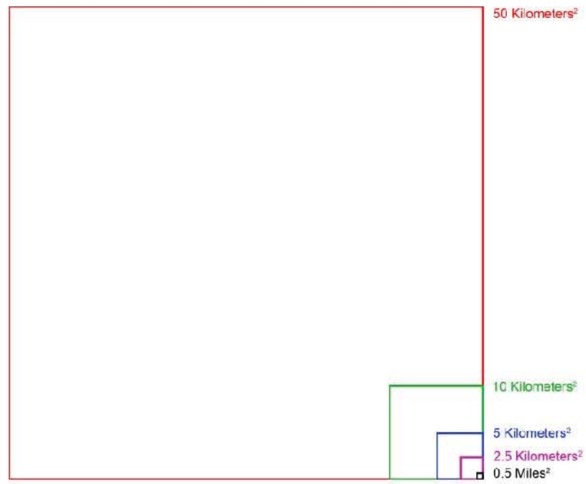

Figure 5. Relative Terrain Sizes, VBS2

Solutions

Taking the time to model American style buildings, roads, cars, trees and other misc. bits of scenery will greatly increase the quality of the terrains. Additionally, adding these types of models is recommended as it is expected that more missions like this will be created.

Focusing on smaller, denser maps will allow terrain designers to make more realistic terrains in less time. Smaller maps also make better use of the limited number of polygons allowing for more realistic environments.

LESSONS LEARNED - SCRIPTING

Once the requirements were completed and the terrain built, the next step was to write the code that would provide the needed functionality. There were two main components needed to control the designated units, the Graphical User Interface (GUI) code and the unit control code.

The GUI code centered on creating a map that would have elements that would allow for the controlling of troops and vehicles.

The control code took the inputs from the map and translated them into commands that would move the vehicles (see Figure 6) to their correct position or give the units their attacking orders.

Figure 6. Strykers Awaiting Orders

Multiplayer Issues Change Everything

The most difficult aspect of programming this scenario was overcoming the multiplayer issues. Behavior that works normally in single player mode doesn't always produce similar results in multiplayer. Particularly controlling units over a network proved to be rather difficult. And since the entire point of this exercise is to control units in a precise manner, this is a rather critical problem.

Correct Path Planning

To conduct a realistic battle a commander has to know that when he gives a unit a command to move to a position, the unit will obey his commands and actually move to the correct point. However, this has proven difficult in game because of issues like incorrectly defined roads. Terrain designers can place foliage and street lights that look correct but actually distort the AI's road network. The result is an AI driver that can't tell how to drive down a broken road.

Complicating matters are situations involving multiple units trying to arrive at the same point simultaneously. Some type of stacking algorithm must be employed to prevent a backup of vehicles.

GUI Development

Creating the MCOE Control Map GUI (see Figure 7) was a significant challenge. Developing a system to provide the desired functionality required considerable development time. Further complications ensued when modifications were needed of the map itself along with the list of units to move and actions to perform.

It is also critical that an action should be able to be executed with the fewest clicks possible. Even if this means sacrificing functionality, it is more important that the interface be easy to use than anything else. As part of this insistence on ease of use, the users should receive feedback from every action. Either a visual or audio cue signifies an action has been completed.

Figure 7. MCOE Control Map in VBS2

Solutions

To perfect the behavior of the units, extensive multiplayer testing and debugging had to occur. Testing the code accounted for almost half of all development time.

In developing the map interface it was discovered that using an open architecture is preferred. Easily extensible maps offer the user better control and can be developed faster. Specifically the map should be dynamic, not have fixed points (the blue dots in the map image) that the units can move to.

LESSONS LEARNED - INFRASTRUCTURE

Once development was complete it was time to field the system for testing by the customer. The scenario would run on a set of 14 student laptops connected to a server hosting the scenario. And even though the software was complete, there were still several problems that would have to be solved for the mission to proceed.

PBO File Types are Preferred

One of the most important lessons learned is that a mission PBO file loads much faster than an editable scenario. PBO files remain the native binary file format of VBS2 content, while an editable mission is instead a collection of files in the %userprofile%\VBS2\mpmissions directory.

When a networked scenario is invoked, the scenario server copies all required files to the connected clients. The MCOE scenario contained a significant number of custom files such as images, audio files and scripts. Unfortunately, VBS2 allocates a maximum bandwidth of approximately 1.5Mb/sec for the server to copy editable scenario files. This maximum bandwidth is shared between all participating clients. Thus the time required to transmit a copy of the mission to each computer depends mainly on the size of the files and the number of networked computers. The function defining this relationship is given below.

The scenario load time in minutes (L_m) is given by:

$$L_m = \frac{[(S_z * 8) * N_c]}{(60 * B_d)}$$

Where S_z is scenario size in MB, N_c is number of connected clients, and B_d is the VBS2 maximum bandwidth in Mb/sec.

Calculating L_m for the MCOE scenario produced the following results:

$$24.57 = \frac{[(15.8 * 8) * 14]}{(60 * 1.2)}$$

To transmit the scenario to every computer took almost 25 minutes, this is an unacceptable delay. The bottleneck here neither the operating systems nor the physical network, it is the maximum bandwidth VBS2 allocates for copying scenarios. Using any other method, copying a 15.8 MB VBS2 mission scenario to 14 clients on a 1Gb/sec network takes less than 60 seconds.

To avoid the slowdown associated with transmitting mission files, the mission should be saved as a PBO and then manually copied to each machine. Only Mission PBOs can be read locally, copying the Mission directories will result in the server pushing out the files anyway, causing the 25 min. delay.

Throughput is Everything

A poor network setup caused the game to become unusable. The setup as it was initially designed is shown below (see Figure 8).

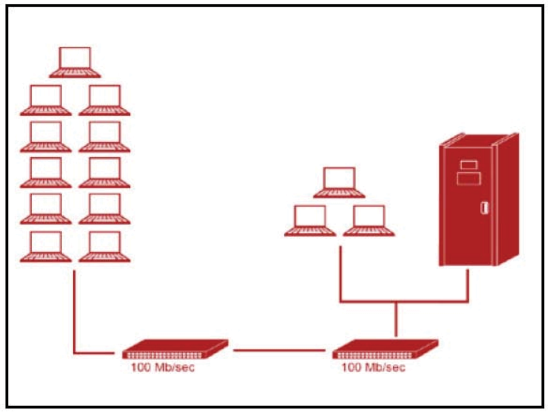

Figure 8. Initial Computer Setup

Because the majority of traffic was going through two slower switches, the server couldn't keep up with the traffic and system crippling lag was the result. The better setup is shown below (see Figure 9). It has everything streamlined to prevent any of the bottlenecks that affected the original attempt and a faster switch is used to ensure sufficient bandwidth.

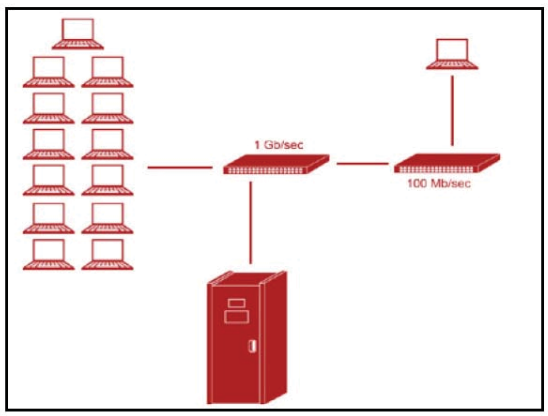

Figure 9. Final Computer Setup

Networking Other Applications

While VBS2 was the main simulation application in use, there were other applications used for specific tasks supporting the MCOE simulation scenario.

Ventrilo was used for VoIP (Voice over IP) communications. The server component was loaded on the VBS2 server while all client computers had the client application. According to the Ventrilo server requirements, each client (voice stream) could consume 8KB/sec (112KB/sec for fourteen clients).

The Situational Awareness Translator (SAT) is used to provide an LVC (Live, Virtual, and Constructive) mechanism via DIS (Distributed Interactive Simulation) broadcast packets which allowed the correlated translation of entities between VBS2 (running in LVC mode) and FBCB2 (Force XXI Battle Command Brigade and Below).

Solutions

The greatest impact on performance was the network the machines ran on. Since the server and all laptops were running on new hardware, the slowdowns could only be attributed to bottlenecks in the network. Once the network was properly configured and using switches with sufficient bandwidth, the problems disappeared.

CONCLUSIONS

After nine months of development a final version of the MCOE training scenario was delivered. Though there were many challenges along the way, the core simulation that was originally planned was successfully deployed. Moreover, once integrated into the training curriculum it provided a high quality training experience that was met with approval from both the instructors and the students.

MCOE can be viewed as a pilot program designed to gauge the feasibility of improving specific types of training using VBS2. Because of the success of this project, more Centers of Excellence have agreed to participate in the next iteration of this training.

However, any organization that would consider replicating this training would be well advised to make use of the lessons learned by the JTCOIC SIMS.

- It is vital that all requirements be generated early on, with specific training goals defined.
- Once these requirements have been determined and agreed to, highly detailed battle plans, maps, protocols and mission parameters must be provided.
- Only then can the mission be programmed and the terrain crafted. After extensive testing with the initial planners, the simulation must be correctly compiled and distributed to all required machines.
- A full dress rehearsal with instructors is a requirement. All key leaders must know the capabilities and limitations of the scenario.
- Only after ensuring that the network has been properly configured can the training scenario start.

In conclusion, using these lessons learned should provide a dramatic shortcut to anyone looking to expand this type of training.

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