FULL SPECTRUM WARRIOR: HOW THE INSTITUTE FOR CREATIVE TECHNOLOGIES BUILT A COGNITIVE TRAINING TOOL FOR THE XBOX

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1. ABSTRACT

Microsoft's' popular game console, the Xbox, combined the possibility of compelling training efficiencies with formidable obstacles to development, both in terms of the business model, the limitation of the Windows 2000 computer inside it and the system's standard human-machine interface. In its mission to leverage the capabilities of the entertainment industry to develop next-generation simulation tools, the Institute for Creative Technologies turned to this inexpensive, powerful platform for its Squad level cognitive tactical trainer. This paper will describe the pedagogical and technological challenges and unique processes that translated Squad level command doctrine to a commercial game interface and a cost-effective, universally-accessible computational medium

2. INTRODUCTION

Founded in August 1999, the Institute for Creative Technologies (ICT) is a University Affiliated Research Center at the University of Southern California. Its mission focuses on the development of enabling technologies for immersive virtual reality that may be used in creating the next generation of virtual training applications for the US Army. In addition to the intellectual resources of the university, the ICT is intended to leverage the technologies and techniques of the US entertainment industry, particularly filmed entertainment and interactive entertainment software.

In 1997, a National Research Council study[1] suggested that, in certain respects, the entertainment industry had surpassed military simulation, historically, the innovator in computational simulation. By refining story, character, graphical and sound qualities, entertainment product developers had, for their very survival, honed their ability to attract and hold users' attention with compelling content. The ICT was an effort to capture that corpus of expertise and apply it to the development of the US Army's simulation needs.

It followed that platforms for the ICT's research and prototype applications would fall broadly into two groups: (a) novel, often large-scale interfaces to display, for example, life-sized entities driven by high-end rendering solutions and (b) readily available, generally inexpensive COTS hardware. It was in this context that Microsofts's Xbox, a popular game console, was considered as the release platform for an application involving the Army's smallest Light Infantry maneuver unit: two Fire Teams constituting a nine Soldier Squad. The application came to be known as "Full Spectrum Warrior" (FSW), the first military training application published for a commercial game console.

3. COGNITIVE TRAINING CHALLENGE

Since the fall of the Soviet Union, US Army missions have changed with an emphasis on critical thinking and decision-making even at the lowest echelons. Operations in urban terrain against asymmetric, insurgent or transnational enemies often put a great burden of responsibilities on the youngest Soldiers.

The ICT sought virtual training opportunities that would exercise a critical faculty of judgment in challenging, real-time circumstances. A Southwest Asian urban and ex-urban terrain environment was developed with an asymmetric enemy in the overarching context of a peace-keeping mission. Missions are simple and, due to the limitations of the computational platform, model the behaviors of a single Squad with a roughly equal number of enemy and civilians. The maximum number of autonomous entities present at any given time in the simulation is approximately forty.

FSW puts the player in the role of the Squad Leader. However, the primary audience for FSW is the Soldiers in a Squad, not the Squad Leader himself. By taking the "boss's" job, Soldiers might deepen their appreciation for the correct execution of dismounted battle drills in the urban context. Moreover, the Squad Leader's role has a greater range of decision-making responsibility and authority than Fire Team members and consequently constitutes a greater cognitive challenge than the role of the individual Fire Team member.

Working with Subject Matter Experts from the United States Army Infantry Center at Fort Benning, care was

taken to adhere faithfully to "schoolhouse" TTP and doctrine in the behaviors of the Soldiers under the player's command. In cases where there was no single unambiguous approach to accomplishing an objective (e.g. room clearing), efforts were made to provide editable choices to the user.

To emphasize the cognitive decision-making aspects of the experience, the player *only* issues orders to on-screen characters. The player has no weapon: a very unusual choice in a military-themed, entity level simulation. In the interest of developing decision-making skills, mechanical skills, e.g. firing a weapon, dealing with equipment malfunctions, were deemed a distraction. Also, the player cannot be "God" and freely move about the environment. He moves with his troops; his situational awareness is limited by their movements and perceptions.

4. THE XBOX PLATFORM

Microsoft's Xbox game console, introduced in November 2001, runs a modified version of Windows 2000 (with DirectX 8.0a) that includes security features that allow Microsoft to rigorously control access to the platform. The Operating System memory footprint in RAM is less than 3MB. It is, like other game consoles, a plug and play component that is intended to have the stability and ease-of-use of an appliance. It weighs 3.86 kg and measures 31 cm X 27 cm X 10 cm.

It arrives equipped to display on a standard definition NTSC television (maximum resolution 640 X 480), but with optional cables it can display at High Definition television resolution (1920 X 1080). Audio interconnects range from RF encoded television mono to AC-3 5.1 optical SPDIF. Its current MSRP is $149.99.

Xbox's 800 internal components include an Intel custom 733MHz Pentium III with a 133 MHz Front Side Bus and 64 MB of Micron DDR SDRAM. The graphics components manufacturer, nVidia, developed a custom 250 MHz ("XGPU") graphics processor for the system. nVidia claims 125 M/second polygons and a maximum anti-aliased pixel fill rate of 4.0 G/second. Xbox comes equipped with an 8GB or 10GB hard drive. There are no user-serviceable parts in the system.

While the specifications are not impressive for modern desk-top systems, the price represents a very attractive value. With complete control over the Operating system, drivers and components, the Xbox is optimized for gaming applications.

The choice of Xbox for the FSW platform was driven by several considerations. First, with a standard-equipped hard drive, the system offered persistence with the ability to capture a session and review in AAR (After Action Review). Second, amongst all game consoles, only Xbox is produced by an American company. Third, its graphical and computational performance matched or exceeded the competition. Finally, developing applications for the Xbox system is, from the standpoint of numerous developers, somewhat easier than writing for Sony's "Emotion Engine" system in PS2.

From the user standpoint, leveraging Xbox meant exploiting a skill set that numerous young Soldiers bring with them to service in the US Army. The majority of new recruits are, at a minimum, casual gamers; a significant percentage are "serious" gamers. Since there is overall intentional consistency between console applications in application management, menu systems and overall system operation, there is a potential efficiency in "training for training" by developing applications for what is already a familiar simulation environment.

5. BARRIERS TO ENTRY: THE XBOX BUSINESS MODEL

The efficiencies arising from Xbox publication do not come without hurdles. Unlike developing applications for personal computers, a developer does not simply write and compile code, make copies and distribute them freely. Access to the Xbox platform, as noted previously, is rigorously controlled by Microsoft.

In this respect, Microsoft does not differ from other game console manufacturers. These are proprietary, incompatible systems which are developed at considerable expense, with estimates of up to $125 lost on every Xbox sold[2]. Profits are made from buyers who purchase discs over time, with each disc paying a platform license to Microsoft of approximately $10.

Given this business model, it is not surprising that Microsoft has concerns about consoles used in circumstances that limit the purchase of new content. If a developer created a business productivity suite for Xbox with email, word processing and spread sheet applications utilizing the Datel Xbox QWERTY keyboard, he would pose a serious threat to Microsoft's Operating System and productivity software businesses. If he used the Xbox's 100BT Ethernet port to connect to an office subnet, he could overcome the platform's storage limitations with server-based storage. A supervised workplace would limit game play opportunities, so no games would likely be purchased or used. This kind of scenario makes console manufacturers cautious about the kinds of applications they certify.

6. THE FSW SOLUTION

The ICT approach in FSW went to one of the basic tenets of the Institute's mission: leveraging Southern California's regional capability in entertainment content creation. Given the abundance of creative talent available on a project-by-project basis in the area, there was no need to duplicate the capability at the ICT. Rather, arrangements were made to contract with a developer (Pandemic Studios) and a special effects house (Sony Imageworks) to execute plans developed at the ICT. In this way, with minimal permanent staffing, the ICT was able to conceive, formulate, direct and manage the process and provide the greatest value-add to the overall process.

As a matter of course, Microsoft reserves the right to deny access to its platform to any developer. Put differently, no console manufacturer will pre-approve an application. This serves to preserve a standard of product content including application stability, user interface and constraints on language, nudity and violence. Additionally, it protects the platform producer from the single-disc scenario described above.

Early on, the ICT bound its contractors to a milestone requiring commercial publication of a version of FSW, thus avoiding a publication shut-out. The Army's FSW, it was determined, could be hidden on the disc with an unlock code made available to Soldiers.

7. THE INTERFACE

Since the ICT's tasking on FSW included the use of the standard Xbox configuration, there were serious design challenges arising from the platform's human-machine interface.

A standard Xbox controller has two thumb-controlled joysticks, a directional key, two proportional trigger keys (mounted below) and eight pushbuttons: two left and six right. There is no keyboard and consequently no convenient way to enter text. There is no mouse, so pointing and clicking, while possible, is more awkward than with desktop and laptop systems (see Figure 1):

Figure 1: Xbox Controller S

All simulation is, to some extent, an abstraction of the real world. If FSW had been a "First Person Shooter" simulation, the user interface would have been a simple matter. Pointing, shooting and steering all map readily to console controllers.

But in FSW, the player only issues commands to characters visible on-screen and, as noted previously, does not carry a weapon.

The solution to the challenge of creating meaningful interaction with the simulation's entities came in part from what was dubbed the "Action Cursor". Moving the left joystick in FSW instantiates a cursor which anticipates movement orders from a Squad Leader to a Fire Team. These choices include an Object Formation, Corner Formation, Door Formation, Breach Door/Building, etc., and are derived from the physical context of the cursor orientation (see Figure 2).

Figure 2: Action Cursor shown on street

Orders are given to Fire Teams; switching between Teams is accomplished by pressing the red "B" button. Once the Action Cursor location is placed in an acceptable location with an implied formation/action, the green "A" button executes the order. Bounding overwatch using buddy teams is ordered by pressing and

holding the "A" button during a movement order. The full interface command set is shown in Figure 3.

Figure 3: FSW default controls

The directional key accesses the "nudge" system. It was determined that typical Squad Leader interactions include the physical "nudging" of individual Soldier's positions and orientations. The nudge system begins with the identification of a Fire Team member. Directional key mapping of the four Fire Team members is visible in the lower-left corner of the screen at all times. Grenade launch trajectories are also accessed through the nudge system.

Once a Fire Team member has been selected for a nudge, the camera switches to a close-up view (see Figure 4).

Figure 4: Nudge view of Team Leader

Nudge commands are limited: it was deemed unrealistic to give players the ability to move Soldiers around like chess pieces. A nudge can move a Soldier a few inches, change his individual cover sector or rotate him. The nudge interface command set is shown in Figure 5.

Figure 5: Nudge interface command set

One interesting challenge arose from the resolution limitations of standard definition television display: optimally, 640 X 480. In the subtended field of view depicted on the main application screen, OPFOR would normally be visible in the mid far range depicted in the simulation. The solution was an iconic widget that floats over the distant OPFOR (see Figure 6) highlighting a character who might not otherwise be seen in this lower-resolution display.

Figure 6: Red icon revealing OPFOR

8. USER PARAMETERS/AAR

FSW is a customizable training tool and has a significant number of user-adjustable parameters for the simulation: density and aggressiveness of OPFOR and civilians, wind speed and direction, training levels of Squad members (untrained soldiers make the application more difficult) and Rules Of Engagement (ROE). All of these are accessible prior to each simulation run. Additionally, Squad equipment is allocable both before and at any time during a simulation session.

For After Action Review (AAR), the entire session is captured on the Xbox hard drive and may be replayed in real or variable time with VCR-like controller functionality (see Figure 7).

Figure 7: AAR Playback Controls

In AAR mode, the camera is freely movable around the simulation terrain map. Finally, FSW includes an implementation of Explainable Artificial Intelligence (XAI) developed at the ICT by Dr. Michael Van Lent. This capability reveals entity "vision cones" (see Figure 8) and threat lines (see Figure 9) during AAR playback.

Figure 8: Entity vision cones revealed during AAR playback

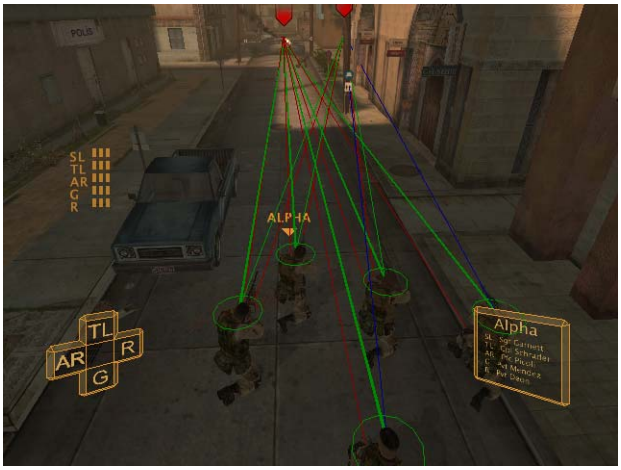

Figure 9: XAI threat lines revealed in AAR playback

9. CONCLUSIONS

FSW, the first military training application published for the Microsoft Xbox, demonstrated the feasibility and utility of leveraging inexpensive COTS game consoles to solve a US Army cognitive training challenge. While the challenges of working within the limitations imposed by console manufacturers are formidable, careful planning can ensure a positive outcome.

A practical and flexible user interface was developed proving that rich entity interactions were possible with standard console human-machine interfaces. A full-featured AAR makes FSW a potentially useful classroom tool. Finally, FSW is a further proof-of-concept for the ICT's mission to leverage the US entertainment industry's wealth of talent, techniques and technology in the development of a new generation of COTS-based cognitive simulation training tools.

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[1] *Modeling and Simulation: Linking Entertainment and Defense*, Washington, DC: National Academy Press, 1997.

[2] *Will Xbox Drain Microsoft?*, David Becker, Joe Wilcox, C|Net News.com, March 6, 2001