

Developing a Platform-flexible Game-based Simulation for Cultural Training

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ABSTRACT

This paper analyzes the design and development opportunities and challenges of creating a virtual cultural training simulation whose core features can be deployed across diverse media platforms such as personal computers, mobile devices, game platforms, the web, and Cave Automatic Virtual Environments (CAVE). This paper describes progress on a platform-flexible design approach for The First Person Cultural Trainer (FPCT), a high-fidelity simulation in which the user must build rapport with culturally rendered Afghan and Iraqi characters in order to unlock key information. FPCT was developed for Army Training and Doctrine Command Intelligence Support Activity (TRISA) at Fort Leavenworth. FPCT is part of the larger Hybrid Irregular Warfare Improvised Explosive Device Network-defeat Toolkit (HI²NT) program of federates and must operate within these architectures. In addition to design and development considerations, this paper explores the additional challenge of balancing the financial costs and performance benefits of developing for yet undetermined game engines and platforms. This paper offers suggested approaches to flexible design that can be applied to the future reuse of assets, training narratives, and core functionality in other simulations.

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INTRODUCTION

The modern warfighter is in increasing need of cultural training as many activities in multiple theaters of operation become more non-kinetic in nature. Cultural training traditionally was reserved for soldiers assigned to special missions or purposes, but the military has recognized the need to train all warfighters how to build rapport and garner trust to successfully gather information from the local population. Game-based cultural simulations, such as The First Person Cultural Trainer developed for Army Training and Doctrine Command Intelligence Support Activity (TRISA), are designed to assist with cultural and decision-making training. Developers, however, face design challenges and new opportunities brought about by today's rapidly evolving environment for videogame platforms and new media technology. This ever-changing technology environment means that developers must consider multiple game platforms and devices in deciding how best to deliver the core training experience using the latest and most situation-appropriate technology.

This paper suggests the development of a nonplatform-specific framework that focuses on the core characteristics and gaming aspects of virtual cultural simulation. Adopting nonplatform-specific strategies and processes would assist developers in efficiently and economically transporting reusable assets to the latest technology. Again, this is significant for the modern warfighter, who is being called upon to rapidly deploy to locations with multiple cultures and subcultures.

This paper discusses the current trends in the technology environment that are affecting cultural modeling and simulation development. These trends are the impact of the social networking communications paradigm on crowd-sourced development and gameplay; the development of more immersive platforms; the growth of mobile gaming; consumer demand driving development on multiple platforms; and the increasing use of cloud computing to bypass hardware devices. We analyze these trends as they influence

our development strategy for The First Person Cultural Trainer (FPCT), a 3D interactive simulation.

This paper also explores ten criteria that are core characteristics of virtual cultural training, factors such as behavioral, psychological and cultural representation, as well as the ability to link to human intelligence data repositories, such as the military's OneSAF and JNEM models. Through the lens of these criteria we analyze the portability of key aspects of game-based cultural training to multiple platforms.

In the last section, we suggest that a nonplatform-specific strategy rests on developing middleware solutions that call from a central repository of vetted game assets to allow for flexible, quick and robust development. This strategy is critical to preserving the core components of virtual cultural simulation and re-employing them on new, emerging platforms.

EMERGENCE OF CULTURAL TRAINING

Cultural training in the military, for many years, has been largely relegated to personnel with a special mission or purpose. This left a large gap, in both training and doctrine, that the general force has had to overcome to be successful in an Irregular Warfare environment. The military has had to go through a crash course in learning about interacting with cultures in environments where even the most innocuous of junior enlisted personnel can have far-reaching impacts. To succeed in this environment, gathering information from the local population is a major key to success. Most soldiers are ill equipped to gather the wealth of information resident in the myriad population centers. Training soldiers to establish rapport, garner trust, and derive information has become a major thrust in the combat commands as they prepare soldiers at all levels for this environment. Live training is superior but very costly and unavailable to all personnel. This has led to a need for a sophisticated cultural trainer that allows contact and discovery opportunities in a given culture.

Game-based virtual cultural trainers are designed to help educate, train and internalize an understanding of different cultures and teach verbal and nonverbal communication, rapport-building and mission-essential tasks that assist in solving problems. Game-based virtual cultural trainers help to prepare war-fighters for non-kinetic tasks. Inherently, game-based cultural trainers must be nonlinear and reflect unpredictable outcomes. This type of development needs to capture the essence of group behavior, such as that displayed in social networks, and different types of culturally appropriate ways of approaching and working with members of the populace, including elders, women, and community leaders. Virtual cultural trainers emphasize verbal and nonverbal communications and the ability to affect mood and emotion in the community through appropriate gameplay decisions, simulating how understanding culture and how good and bad choices affect whether or not the population will help the player to succeed.

THE FIRST PERSON CULTURAL TRAINER

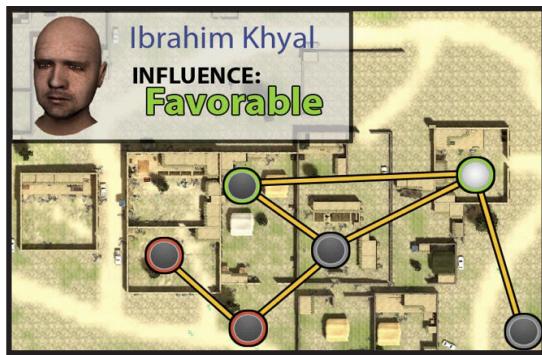


Figure 1. Non-player characters in FPCT display emotion and moods and can influence their social network.

The First Person Cultural Trainer (FPCT), from the Institute for Interactive Arts and Engineering (IIAE) at the University of Texas at Dallas (UT Dallas), has adopted an ongoing challenge to develop extremely high-fidelity representations to create an environment that serves as a cultural training tool before, or during, actual deployment. In spiral one, FPCT was designed to teach the values and norms of a specific culture in order to facilitate intelligence missions. Spiral two builds on spiral one development and focuses on Pashto culture in the rural Afghanistan-Pakistan border region. FPCT includes four clearly defined stages, which are in line with the Tactical Conflict Assessment and Planning Framework by US AID, that lead to the successful completion of missions:

- Step One: Establish a presence in the community and identify influential leaders
- Step Two: Understand community problems and conflicts over resources
- Step Three: Develop an action plan
- Step Four: Gather intelligence-like information about how to resolve conflicts and deter enemy influence.

Conversation with the non-player characters (NPCs) in FPCT is the primary method of interacting with the world. Tactfulness, emotional and cultural sensitivity, and conflict resolution will bring respect and influence among area inhabitants and within social networks. NPCs may become more comfortable with the player over time and become increasingly willing to talk about issues in the area. The player is expected to rate what they perceive the NPC moods to be and their reliability, as well as gather information through each of the four stages described above. At the end of gameplay, the player is assessed based upon the accuracy of his ratings of the populace and the quality of information gathered. To achieve these design requirements, the FPCT development team developed a living-world construct to replicate in-theatre cognitive complexity. Parameters on which FPCT simulates a face-to-face experience include modeling psychology, culture, behavior, and emotion; developing virtual humans and populations; modeling highly accurate environments; dynamically generating gameplay; and assessing player performance.

THE TECHNOLOGY ENVIRONMENT

In this section, we discuss the ever-changing technology environment in which innovation is being driven by major companies operating in a highly competitive market. We highlight five trends in this evolving marketplace: the impact of the social networking communications paradigm on crowd-sourced development and gameplay; the development of more immersive platforms; the growth of mobile gaming; consumer demand driving development on multiple platforms; and the use of cloud computing to bypass hardware devices. These trends support our contention that developing a nonplatform-specific framework is critical to preserving asset development and adapting the virtual cultural simulation to anticipated changes in gaming technology.

The Social Network Paradigm

The nature of communication and information dissemination has evolved dramatically over the last fifteen years because of the web. While social network communication, such as that featured by the

current popular tools like Facebook, Twitter or texting, gets much attention, these trends toward socially networked media and information dissemination have been occurring since the inception of the web. Now this social network paradigm is influencing game development by nurturing organic innovation from all layers of a collective community of end users and developers. This facilitates quick-to-market, recursive development and is influencing commercial companies to move more towards crowd-sourced development, connectedness and portability within multiple platforms.

Crowd-sourced development can also be seen in the current generation of game consoles and the growth of “app”-style development. Instead of developing content themselves, the providers of these app stores rely on socially connected end users to create and submit their own development. This illustrates customers’ growing assumption that they will be able to access and shape gameplay. The social networking paradigm is engendering a concept of “emergent gameplay,” in which connected friends are able to modify game experiences on the fly. For example, troops returning from an assignment could someday update their simulation with the most current information, and this content could in turn inform the next group to head out into the field. This is a significant development for data-driven virtual cultural simulations like FPCT, which is designed to link to simulations and federates that have noncombatant gameplay, such as OneSAF and JNEM.

Increasingly Immersive Game Platforms

There also is an interest in the military in more immersive gameplay on platforms that employ technology such as Cave Automatic Virtual Environments (CAVE) or Motion Reality’s VIRTUALSIM. “Stereoscopic” games are also being developed for traditional game consoles such as XBox 360 to take advantage of the 3D technology used in movies like *Avatar*. Nintendo is developing 3DS technology that promises to deliver 3D gaming without the need for special glasses. CAVE technology is designed around a room-sized, multi-screen, multi-person immersive operating environment. VIRTUALSIM uses a system of motion-capture cameras and suits in tandem with 3D head-mounted displays to provide real-time motion capture and movement input into a simulation space. These immersive platforms change the user experience of virtual cultural simulations from the current single-screen setup. Integration with these technologies fundamentally changes the way that FPCT operates, requiring changes to Artificial Intelligence, pathing, User Interface, custom development and environments.

Growth in Mobile Gaming

The rise of mobile gaming can be attributed to well-marketed devices, such as the iPhone, Android-based smartphones and the iPad. Mobile smartphones are not as graphically capable as consoles and personal computers, but they excel at running programs that are social-media-capable and location aware. These devices also leverage smartphone hardware such as voice and movement input. The latest iteration of the iPhone also has a front-facing camera in addition to a back-facing one. Such a camera orientation could allow for additional development leveraging camera-based face-tracking and recognition, potential key enhancements to virtual cultural simulation. The recent development of the iPad, and other “tablet computers” by extension, offers a unique environment for interaction with a virtual cultural simulation. The iPad features touch and multi-touch inputs, a large screen and high resolution. The high-fidelity 3D nature of a virtual cultural simulation like FPCT could possibly be displayed as originally intended for desktop computers. The iPad also supports GPS and therefore is location-aware; it contains a digital compass and can assist GPS by connecting to Wi-Fi or cellular networks. All of these mobile technology features could enhance cultural trainer gameplay in multiple ways, such as through speech-recognition devices.

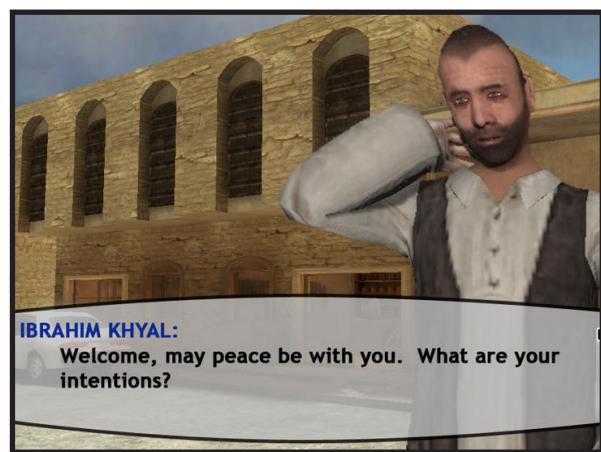


Figure 2. Non-kinetic, conversation-based gameplay is a core characteristic of virtual cultural simulations. Mobile devices like smartphones can enhance gameplay through speech recognition and GPS technology.

Development on Multiple Platforms

Fewer and fewer platform-specific commercial games are being released, and ports or major game releases are often seen for all available platforms, including home game consoles and PC. Developers are delivering their products across many different platforms to fully access their audience. Digital distribution is growing as more homes become broadband-capable, and game developers have begun to offer many of their new releases both online and in a more traditional disc-based format. Platform-exclusive releases require a considerable financial investment by the company to compensate for the lost revenue that the software developer faces by limiting the potential audience size to one platform. Fewer and fewer development studios are willing to negotiate these types of arrangements, and fewer platform companies are risking the outlay of a large amount of money to secure a single Intellectual Property. The trend towards multiple platform development can also be seen in the mobile space, where iPhone and Android platforms both share versions of the same app.

Cloud Computing

The recent launch of a new cloud gaming service, OnLive, which uses broadband connections to deliver gaming that was previously limited to high-end desktop computers, is a harbinger of a trend that could dramatically alter the technology landscape. Cloud computing moves away from hardware and towards processing a game's complex calculations on external servers, or in the cloud. Cloud computing is a viable strategy for a nonplatform-specific framework. Cloud computing centralizes the software development process, using a Software as a Service (SaaS) model to allow access to full versions of software. This means cloud technologies virtualize software, allowing it to run remotely and trickle down to end-user devices. Devices then run apps, making use of network connections as gateways to full versions of software. This allows developers the flexibility to develop using one specific game engine or software platform. Information is housed and updated in a massively expandable central entity or "cloud." This cuts hardware costs and makes changes and updates in development readily available and practically invisible to the end user.

Cloud computing also enhances the potential for high-fidelity gaming on mobile platforms. Mobile devices serve as access points to the cloud repository, which handles the computational and graphical load. This could extend the lifespan of end-user hardware

because the cloud handles updates to software versions. This rapidly evolving technology environment suggests a strategic framework is needed to take advantage of ever-improving gaming capabilities. We offer a conceptual framework in the next section that we believe incorporates the flexibility needed both by developers and by the end user: the warfighters who are being rapidly deployed to new theaters of operation and who need virtual non-kinetic, decision-making training.

A CONCEPTUAL FRAMEWORK FOR NONPLATFORM-SPECIFIC DEVELOPMENT

Cloud computing, as discussed in the previous section, may indeed alter the future of technology hardware needs. Game-based simulations may someday soon be delivered from external servers to all forms of end-user devices: a television, a tablet computer, a smartphone, a CAVE or VIRTUALSIM training center. Any broadband-capable device could be developed to receive high-fidelity gaming experiences completely independent of the device's hardware specs. In the future, the platform may no longer be the hardware but the provider of the streaming content.

All of the technological trends discussed, and cloud computing in particular, suggest the need for nonplatform-specific development. Porting game assets from one form of virtual cultural simulation to a variety of platforms and devices will become important not only for developers but as well for the warfighter because cultural training can be made available in the most situation-appropriate device and form.

This section breaks down the various considerations that go into developing a nonplatform-specific development strategy. In order to discuss possible solutions for developing the strategy, certain terms need to be defined first. These include middleware, application programmer's interfaces (APIs), and game assets. Middleware solutions are further discussed later.

Middleware is a specific form of software that seeks to remove domain-specific tasks into a uniformly accessible library. For example, computer player pathfinding, the ability for the computer to "know" how to navigate from Point A to Point B, has traditionally been unique to each game engine. Now a product like Autodesk Kynapse provides common real-time pathing algorithms. This has two primary benefits. One, it allows developers who use it on disparate engines to learn one tool set and reuse it. Second, it allows for reuse on disparate engines.

Application Programmer's Interfaces (APIs) are the main method by which a middleware solution (as well as other types of applications) provide functionality. For example, when developers purchase Kynapse from Autodesk, they are given a set of libraries that can be integrated into the program. Integration of those libraries is provided by the API. APIs help to provide a uniform and non-changing interface that programmers can rely on to do similar tasks in similar situations on different systems.

Game Assets are anything a game engine needs to run a game. These assets can be almost anything the game uses besides core game engine code. Examples include mesh files for the graphics, animation data to make the meshes move, sound files to provide the aural experience or script files for game-specific logic. This list is by no means exhaustive, and new types of assets can be envisioned for specific domains. For example, personality data sheets might be needed by a personality modeling library.

A middleware solution that isolates a virtual cultural trainer's game logic in one section, its core emotional model in another section, and vetted assets in a central repository best facilitates development across multiple platforms. The game logic can be isolated from the game engine itself. Connectors can be written into almost every game engine that provides integration: either through direct source code access or through wrapping data structures into language extensions for the scripting language that the engine uses. For example, if the game logic were isolated into a C++ library for efficiency, an API can be provided so that to use the virtual cultural simulator on a game engine, the same functions are called, and they are the same regardless from where they are called. The same could be developed for a cloud computing platform.

Assets could be ported from one platform or engine to another through a central repository. Different versions of assets, such as low polygon count art assets for mobile and high polygon count for desktop, could be stored and retrieved as appropriate. These assets could be stored in an engine-specific form for every engine, if speed is the primary concern when porting, or it could be stored in an independent form and translated as necessary. Keeping assets in this independent repository would also save space, although art fidelity may be sacrificed in the end product.

Figure 3 illustrates that a middleware solution with a central repository maximizes the code and art reuse, while optimizing the amount of "architecting" of generic code required.

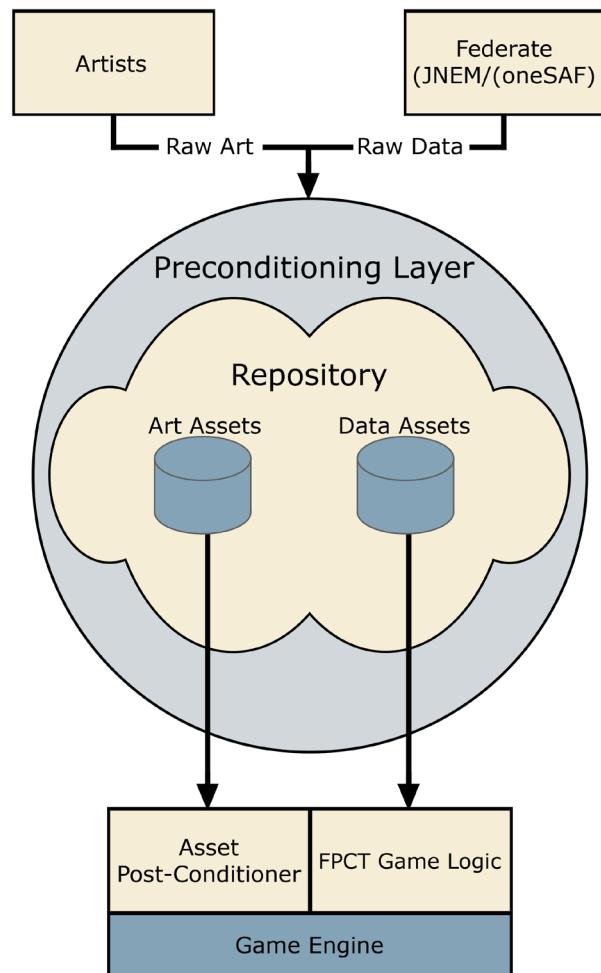


Figure 3. In this middleware structure, raw data flows out of sources like a digital content creation suite (Maya) or a HI²NT federate and is preconditioned so that it exists in a platform independent state.

WHAT WOULD IT TAKE TO GET THERE? CORE CRITERIA FOR VIRTUAL CULTURAL SIMULATION DEVELOPMENT

Designing middleware and developing a central repository of assets are key to addressing an ever-changing technology environment and preserving key components of a virtual cultural simulation for re-use. In this section, we discuss what constitutes virtual cultural simulations and define the ten criteria that distinguish the game-based cultural trainers from other games. Through the lens of these core criteria we analyze the portability of those key aspects of cultural training to multiple platforms. Some key definitions and potential solutions for porting core characteristics are considered in this section.

Table 1. Ten Distinct Development Criteria for Virtual Training Game-Based Simulations

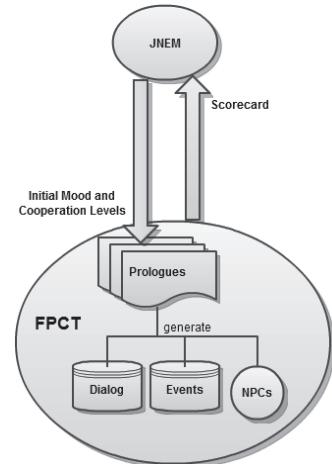
1. Data-base driven culturally appropriate character, group and community development with nonverbal and verbal communication
2. Behavioral, psychological and cultural representation
3. Ability to link to OneSAF, JNEM and other similar models and the respective data repositories that feed them.
4. Well-developed conversation system for story telling that calls other interactive story development elements such as animations
5. Emphasis on ongoing development of layered and nuanced realism to include multi-layered sound. This includes character modeling, environment modeling, sound representation and cultural representation.
6. Speech-to- text/text-to-speech capability
7. Nonlinear gameplay
8. During and After Action Reviews
9. Quick composability to link subject matter experts to the game platform
10. Ability to port community vetted assets to other or emerging platforms

Development Criteria of Game-Based Cultural Trainers

Ten distinct development criteria distinguish virtual cultural training projects from other videogame development that is often focused on more traditional first-person-shooter game platforms. Some of these capabilities are not in any engine platform, per se, and require custom development. When devising a development strategy for multiple platforms, as well as technology that has yet to emerge, it is important to consider these ten characteristics as the lynchpins of the strategy. Table 1 provides a brief description of the ten criteria. Below is an analysis of the implications for development in various game engines, platforms and mobile technology.

- 1. Database-driven, culturally appropriate character, group and community development with nonverbal and verbal communication:** Emphasis is on being able to represent characters in culturally appropriate emotions and body language and for the characters to be able to read the nonverbal communication as expressed through conversation, actions, or facial and body expression. Characters should be able to express a language that is appropriate for the culture in question.
- 2. Behavioral, psychological and cultural representation:** The characters should not only act and sound culturally appropriate, but they should act both individually and as groups as representations of the culture.

- 3. Ability to link to OneSAF, JNEM and other similar models as well as the respective data repositories that feed them:** Simulations and data repositories can be used to provide information that is used in the cultural game. This includes cooperation level, mood, golden nuggets or critical pieces of information, and other data. These repositories are key because they integrate information created by subject matter experts into the game, they provide centrally vetted information, and they effectively allow game players to work with the data – for example, trying to change community mood – and put this data back into the repository to study further affects.



4. **Well-developed conversation system for storytelling that calls other interactive story development elements such as animations.** Essentially, the cultural game play unfolds through the story of the environment told through conversations with the NPCs that the player meets and the nonverbal communication and other reactions to the other characters of the story. The story includes the golden nuggets of the environment.
5. **Emphasis on ongoing development of layered and nuanced realism to include multi-layered sound.** Adding realistic layers and nuance to the environment is an ongoing task with FPCT. For example, sound is represented currently on four layers in the environment to include conversation, local, regional and global. In addition, the physical representation of the area should present a geotypical environment that would be seen in an actual area. Nuanced realism does not only refer to the physicality of the game-based cultural trainer. Behavior representations and enhancements are also ongoing. So, for example, social network models can be added to the behavioral, psychological and cultural representations to make the character and group interactions, and therefore the quest for golden nuggets, more realistic.
6. **Speech-to-text and text-to-speech capability:** The gameplay of cultural training needs to be as realistically nuanced as possible. The ability to hear the local language spoken improves the realism of the world. In interactions with a foreign society, an attempt to speak the local language, even if only common greetings, often makes building rapport easier. Also, gameplay should reflect the common way of talking with the local population. Therefore, the ability to speak through verbal communication directly to game characters, or through an in-game interpreter, is advantageous. This is because it is so deeply entrenched in cultural nuance, golden nugget discovery, mood determination and other similar factors.
7. **Nonlinear gameplay:** Life does not unfold linearly, whether in a war theater or otherwise. Further, compelling gameplay demands that successful participation is not predictable or obvious, so a slightly different action could have a totally different gameplay outcome, which makes the players think about the whole picture, not just the current dialogue they are working through.
8. **During and After Action Reviews:** The During and After Action Reviews are where the players receive feedback on their effective navigation of the culture to accomplish missions. The information needs to occur during and after gameplay. Players can win the game based on their successful identification of particular cultures, their ability to identify and affect moods in the community, and their ability to uncover golden nuggets and accomplish missions. One common requirement of the reviews is to be able to determine cause and effect of the above outcomes.
9. **Quick composability to link subject matter experts to the game platform:** Cultural representations are usually very nuanced and can also be different depending on the situation. They also can be a reflection of the point of view of the subject matter expert (SME), which can also differ from SME to SME. For this reason, it is important that the game engine platform offer the capability for the SME to quickly and easily adjust the cultural representation.
10. **Ability to port community vetted assets to other or emerging platforms:** Once a model, asset or another type of development is successfully completed, it is important to be able to reuse the asset in other situations, or perhaps in conjunction with other situations. So, for example, an accepted way of representing social networks could be used on a variety of platforms and enhanced by the community over time.

WHAT WOULD IT TAKE TO GET THERE? PORTABILITY OF GAMING COMPONENTS

Because a game is comprised of many aspects (audio, visual, logical), and each aspect has its own set of assets (sound files, meshes and animation, scripts), it is important to consider each aspect individually as it relates to game portability. The following categories are non exhaustive and feature a rating by FPCT developers as to the ease of portability. A one means that code can be ported from one system to another with no consideration for the system. A one means that code is completely intrinsic to that system.

- **AI/Pathing:** AI decision-making and character personality models are intrinsically in the FPCT game logic domain and can be isolated pretty easily. Normally pathfinding is integrated into the engine proper, but Autodesk Kynapse is becoming a viable alternate middleware solution to this problem. Portability: 5/5.

- **Animation:** Animations are fairly engine agnostic as long as they can be converted to a file format that the engine accepts. Some of the animation re-targeting onto other characters would have to be redone in each engine as well as some of the animation blending and synchronization, but these tasks are not that time consuming compared to the creation of the animation. Portability: 4/5.
- **Character Generation:** The visual object that represents a character and its corresponding physics object are engine dependent. However, the model of a character is bound to the AI object model and thus can be isolated from the engine. The connector would be responsible for attaching these AI objects to their engine visual/physics counterparts. Portability: 4.5/5.
- **Materials:** The easiest way to create material assets for use in multi-platform development is by creating high-resolution Photoshop files of each texture. This way the files can be batch converted from Photoshop in any size or format required. Materials themselves will still need to be re-created in each engine, as shader codes and material assembly differs engine to engine. Portability: 3/5.
- **Multiplayer:** Most of the engines have some sort of multiplayer that they support, but they are closely tied to the architecture of the engine. Portability: 2/5.
- **Scripting:** Scripting for game logic can be completely custom and isolated if necessary because of previously discussed reasons in the middleware section. Portability: 5/5.
- **Sound:** All sound files should be cut, mixed and compressed outside of the engines even though the engines support built-in mixing, so that audio doesn't have to be retuned when bringing it from one engine to the next. Sound streaming does not seem to be supported by all engines, so any sound streaming should be specific to mobile engines. Portability: 3/5.
- **User Interface:** All button graphics can be created and sized outside of the engine. The buttons would have to be coded into their respective engines using different methods, but if the graphics and resolution stay consistent outside, that may avoid trouble. Using Scaleform would also open up some possibilities for agnostic engine development between engines that support Scaleform. Portability: 3/5.
- **World Space:** Creating nonplatform-specific assets would require the use of Maya and 3ds Max for conversion of assets. This assumes the fidelity of each asset is retained across all platforms. Portability: 4/5.



Figure 5. The representations of an Afghan village in spiral two of FPCT are built in Unreal Engine 3 using assets created in Maya.

ONGOING DESIGN CHALLENGES AND OPPORTUNITIES

As operations in war zones continually demand improved cultural training for warfighters, the evolving technology environment presents both opportunities and challenges. The conceptual framework outlined in this paper suggests the importance of maintaining core characteristics of cultural training and transporting them to multiple platforms and devices. Trends towards open-source and crowd-sourced development, as well as the growth of app-store model, are likely to continue to nurture innovation from a more robust collective community. Ideas can flow more freely in a non-hierarchical environment that draws on grassroots perspectives. Expert developers can focus on improved User Interfaces and new, higher-level development and turn content development over to the collective community. Development, in turn, could become more recursive, building upon the usage patterns of the community. This non-hierarchical environment also could result in quick-to-market development by involving end users. This could lower the barriers to entry and make content development more affordable.

At the same time, the trend toward organic development introduces other considerations. Developers must weigh the value of input from a robust development community against the need for assets that have been vetted by subject matter experts (SMEs). As end users create new content, SMEs may need to shift focus on mining the content for new rules and themes for training standards. Another consideration could be balancing security concerns with the ease and potential affordability of organic development and the advantages of cloud computing. The social network paradigm will likely require the creation of new security paradigms.

These are but a few of the considerations that underline the importance of developing a strategic framework. Many other opportunities and challenges are likely to emerge. Further research will be needed on an ever-evolving environment.

SUMMARY

This paper offers both an analysis of the state-of-the-art for current virtual cultural game development and prospects for future development in a rapidly changing environment. Ongoing analysis will be necessary as trends in the expanding social-networked communications space, the increasing reliance on cloud computing, the crowd-sourcing of middleware solutions and the development of new mobile platforms will

reshape strategic considerations. The criteria for virtual cultural training in a game-based environment still serve as a core means by which to analyze ongoing development strategies. The most powerful virtual cultural training will be more effective if it has nonplatform flexibility. At the same time, market forces may continue to reshape the game engine space and the types of devices are likely to evolve. The iPad, for example, may create a catalyst to the tablet computer space as the iPhone did for smartphones. To this end, regardless of how the various engine competitors and devices shape up, the nonplatform-specific development that is advocated in the paper should make the key assets and development of virtual cultural training viable and enduring.



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REFERENCES

Apple, Inc. (2010) *iPad technical specifications*. Retrieved June 2, 2010 from <http://www.apple.com/ipad/specs/>.

Autodesk, Inc. (2010) *Autodesk Kynapse information*. Retrieved June 2, 2010 from <http://usa.autodesk.com/adsk/servlet/pc/index?id=11390544&siteID=123112>

Google, Inc. (2010) *Android specifications*. Retrieved June 2, 2010, from <http://developer.android.com/index.html>.

Isabelle, Scott K.; Gilkey, Robert H.; Kenyon, Robert V.; Valentino, George; Flach, John M.; Spenny, Curtis H.; and Anderson, Timothy R. *Defense Applications of the CAVE (CAVE Automatic Virtual Environment)*. Retrieved June 2, 2010 from http://www2.cs.uic.edu/~kenyon/Conferences/GILKY/CAVE_DOD.html.

Mirkovich, Sean (2010). *Cameron's Avatar Game First to Utilize 3D Stereoscopic Technology*. Retrieved June 25, 2010, from Gamepro.com. <http://www.gamepro.com/article/news/210555/camerons-avatar-game-first-to-utilize-3d-stereoscopic-technology/>.

Motion Reality Force Simulation, Inc. (2010) *VIRTSIM information*. Retrieved June 2, 2010, from <http://forcesimulation.motionrealityinc.com/>.

Nintendo, Inc. *3DS game system*. Retrieved June 25, 2010, from http://www.bestsyndication.com/?q=20100615_nintendo_3ds_game_system_3d_video_games_and_photos.htm.

Reardon LLC (2010). *OnLive information*. Retrieved June 2, 2010, from <http://www.onlive.com/about.html>.

Software & Information Industry Association (2001). *Software as a Service: Strategic Backgrounder*. Retrieved June 24, 2010 from <http://www.siia.net/estore/pubs/SSB-01.pdf>.

Zielke, Marjorie (2010). *DARPA Transformative Apps Call for Proposals Whitepaper, A Mobile-Based Cultural Training Game*. Submitted April 19, 2010.