The Fort Ross Virtual Warehouse Project:

A Serious Game for Research and Education

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Abstract— **In March 2011, California State Parks entered an agreement with University of California Merced (UCM) to create an interactive, learning game able to educate students, schools and visitors about Fort Ross: the "Fort Ross Virtual Warehouse Project" (FRVWP). It is a web-based 3D game platform developed in Unity 3D that currently supports single player use, and in the near future will be developed for multiplayer functionality. This pilot program indeed demonstrates the value of an educational pre-learning tool for parents and students along with the teachers that come to the Fort to re-enact history. Through the use of this game, students have the opportunity to experience educational content and "role-play" in an environment that is immersive and highly interactive. The narrative, digital storytelling, and virtual reconstructions of buildings and environment, all count an accuracy based on scientific, historical and archaeological data. Ultimately, through user interaction, PCs and NPCs (non player characters) create an interesting dialogue between the site (real) and the experience of place (virtual and real).**

Keywords—serious games; digital-based learning; virtual reconstruction; remote sensing; Fort Ross Historic Park; Unity 3D;

I. INTRODUCTION

California State Parks manages more than 270 parks, which contain an impressive collection of natural, cultural, and recreational resources to be found within California. Thus, it has come to be part of State Parks mission to educate the public about California's natural and cultural resources. The State Park's School Program aims to break new ground in the area of Educational applications by providing an experience that teaches and entertains at the same time. Different programs are using edutainment to share the wealth of California history with students. One of the most popular of these programs is the Fort Ross Environmental Living Program, which is a realistic historic reconstruction of Fort Ross and its occupation by the Russians in the 19th Century. Students and Parents travel to the fort to re-enact the time period during 1820's. They stay for 3 days and wear the vintage costumes and role-play real individuals from the time period. In March 2011, California State Parks entered an agreement with University of California Merced (UCM) to create an interactive, learning game able to educate students, schools and visitors about Fort Ross: the "Fort Ross Virtual Warehouse Project (FRVWP). The goal of the project is to provide school-age children and visitors with virtual access to the dynamic California State Parks System so that they may experience a significant period in the state's history. The application is similar to the Fort Ross Environmental Living Program, but differs in that it offers users a virtual experience. This pilot program is indeed demonstrating its usefulness as an educational pre-learning tool for the parents and students along with the teachers that come to the Fort to re-enact history. Through the use of the virtual game, students have the opportunity to experience educational content and "role-play" in a highly interactive application capable of working on stand-alone Windows or Mac systems deployment or networked environments. This ambitious role-play history simulation gives school children the opportunity to virtually act in an important historical period of the state while being immersed in a real-time 3D networked environment. Children indeed learn by interacting directly with the subject matter and their peers.

II. SERIOUS GAMES

The category of serious games embraces all the applications whose purpose is scientific and/or educational and not created for pure entertainment [1]. Thanks to the development of specific game engines for personal computers such as Virtools, Unity 3D, Vision Engine, Panda 3D, etc. several applications on cultural heritage and museums have been developed in the last years. Key factors are represented by the engagement and involvement of users, narrative experience, and multiplayer features. In the domain of virtual heritage great attention is paid to embodiment and cultural presence in a virtual environment [1]. According to Dagupta, "cultural presence as a feeling in a virtual environment that people with a different cultural perspective occupy or have occupied that virtual environment as a place" (p.97). In other words, cultural presence represents the enactive code for interpreting a cyber world and its social relations [1] [2] [3].

Figure 1. View of Fort Ross from the south west corner.

The project, based on a 3D web based interactive platform, is developed in Unity 3D, currently the most powerful and programmable platform for games available on the market. There are many possible outcomes for this application. A 3D web open digital reconstruction of Fort Ross allows teachers, schools and students to have a pre-experience of Fort Ross before the visit and a post-experience elaborated after the visit. For all the users unable to visit Fort Ross, the virtual experience can represent an unforgettable opportunity for being immersed in this reality. The digital implementation of the data from UC Merced involves very advanced instruments and techniques, such as laser scanners, remote sensing, computer vision and digital photogrammetry.

III. Story Board and Game Planning

FRVWP seeks to compliment the Fort Ross Environmental Living Program (ELP) and in accordance with that goal, many aspects of the FRVWP storyboard have been designed to embody and mirror features and goals of the ELP. The ELP is a pro-active learning experience that allows children to experience and learn California history in a hands-on manner. The program is geared towards elementary school students-generally in the 4th and 5th grades-and focuses on the history of Fort Ross, an early 19th century Russian settlement located in the northern coast of California.

A. Fort Ross Historical Context

The establishment of Fort Ross came about as a result of an effort by the Russian American Company to locate another outpost for the sea otter fur trade as well as a supply center for its Alaskan colony. The company, which was owned by the Russian government, had been granted a charter that awarded them rights to most of Alaska's natural resources, as well as a monopoly on all foreign trade. Although the Alaskan colony proved to be a successful trade outpost, it was not self-sufficient and needed to be supplied through external means. Supplying the Alaskan colonies from the Russian mainland proved to be lengthy and expensive, which initiated the search for another outpost nearby [4]. Ivan A. Kuskov was sent by the company to scout the Western Pacific coast for ideal locations. After two scouting trips Kuskov chose an area along the northern California coast, as the area promised great potential for the hunting and trade of sea otter pelts. Furthermore, Kuskov was well-received by the Spanish officers further south and was able to create solid relationships with the forts native Kashaya and Coast Miwok neighbors as well [4]. Kuskov, along with a number of skilled Russian company employees and Alaskan hunters, returned to California in 1812 to establish Fort Ross. By the September of the same year, the stockade walls had been erected and Kuskov became the Fort's first commandant. The sea otter hunt was initially successful at Fort Ross and people present at the Fort consisted of Russians, Creoles, California natives (Kashaya and the Coast Miwok), as well as Aleut and Kodiak hunters [4]. Nevertheless, agriculture at the Fort had become challenging as the cold and foggy coast conditions, along with the lack of expertise, created a problematic food supply situation at the Fort. Furthermore, after nearly three decades of intensive hunting, the sea otter population experienced significant decline, which decelerated the fur trade. By 1838, Fort Ross was no longer a profitable enterprise. The Russian American Company officials finally decided to pull the plug on the Fort Ross colony in 1841 and ordered Alexander Rotchev, the Fort's last commandant to sell all non-removable company holdings in California and return [4]. Rotchev sold everything that was to be left behind to John A. Sutter. The land, however, was not sold as the Russians did not own it and was claimed by the Mexican government. Sutter tore down many of the Fort buildings to reuse their material. A number of other people owned Fort Ross after Sutter until the Fort became a state park in 1906. Later that same year, the San Francisco earthquake destroyed what was left of the original standing buildings. Since then, many of the buildings inside the stockade have been reconstructed and made available for public viewing [4].

B. Environmental Living Program Goals

The Fort Ross Environmental Living Program (ELP) is designed to teach students about California history through direct experience. Students usually spend a day and night at Fort Ross. Each student is given a historical character of a Fort Ross resident and is supplied with a homemade costume. The students are expected to perform different tasks that would have been performed two centuries ago at Fort Ross [5]. The ELP experience begins at school, although it culminates at Fort Ross. Students, teachers as well as parents are directly involved with the program, as the ELP requires prior preparation at home, in addition to, at school. At school, students are taught contextual information regarding the

Figure 2. Commodities on sale at the Warehouse.

history of the Fort and are then assigned a character. The characters have been grouped by occupation (e.g. cooks, militia, artisans, blacksmiths, etc.). Teachers and parents who volunteer are also assigned characters, although their characters usually consist of Fort Ross commandants [5]. Additionally, students are also tasked with creating their own costumes at home. A number of other home/classroom activities are also suggested by ELP to familiarize students with the responsibilities of their assumed characters and further prepare students for their time at Fort Ross [5].

C. *Fort Ross Virtual Warehouse Project*

The Fort Ross Virtual Warehouse Project (FRVWP) was initiated along with the commencement of the reconstruction of one of the original Magasins at Fort Ross in 2008 [6]. Along with the reconstruction of the Magasin, the clerk occupational group, along with its curriculum, was added to the ELP program. The purpose of the FRVWP is to streamline and simplify the pre-Fort Ross education that the parents, students and teachers usually go through. FRVWP achieves this by creating a tool that delivers pre-learning lessons, available by a closed network, for teachers and students over the Internet. Pre-learning lessons will be created in accordance with the ELP curriculum and tasks [6].

D. *Storyboard Development*

The object of the game is for the user to survive and prosper as a clerk at Fort Ross by learning and displaying historical, cultural and economic knowledge about the Fort. Once a user has completed all missions, they will win the game and will obtain a certificate of completion, for surviving colonial Fort Ross. In order to tie in the FRVWP and the ELP, students who complete FRVWP will also receive a medal of completion once they make it out to the Fort. The storyboard for the FRVWP was developed in close association with the tried and tested ELP curriculum. The emphasis of the storyboard, at the current stage of production, is on the clerk's curriculum. Another resource utilized for the production of the storyboard was a survey conducted by ELP of participating teachers in July of 2008 [7]. For example, when the teachers were asked how likely their usage of a computer-based learning program in connection with their students' visit to Fort Ross would be, 61.7% said that it was very likely and another 29.8% said that it was somewhat likely. Additionally, 51.1% of the teachers preferred to use this program before visiting Fort Ross and another 44.7% would use the program before or after the visit. Using thematic modules in the program was also preferred by 63% of the teachers. Other opinions, including the length of the modules, as well as, a desired connection between the program and the actual Fort Ross visit were considered [8].

1) *Characters*

The characters utilized in the FRVWP have also been selected from the ELP curriculum and the preparation manual. The ELP manual includes a list of characters that were at Fort Ross once and also provides background information on the characters. The clerk, Vasilii Starkovskii, is the main and only player character (PC) at this point. The non-player characters (NPC) include the last commandant of the Fort: Alexander Gavrilovich Rotchev, as well as a carpenter (Vasilli Vanovich Grudiinin), a militia officer (Timofei Osipovich Tarakanov), a Spanish monk, a blacksmith (Leontii Ostrogin), a farmer (Vasili Khlebnikov), an Aleut hunter (Osip Shaia), a Kashaya woman (Ayumin Mar'ya), and lastly, the clerk's supervisor (K.T. Khlebnikov) [5].

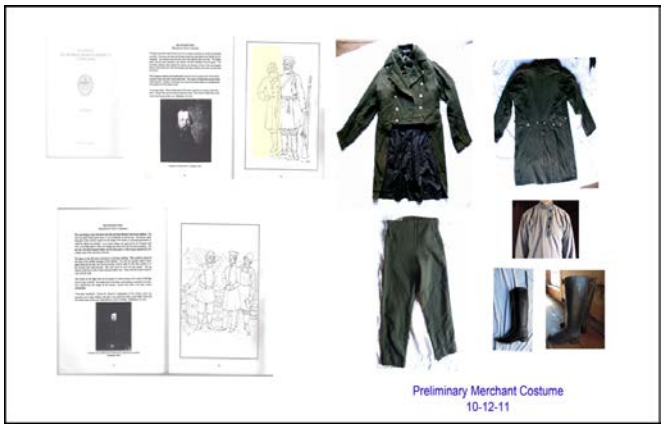

Figure 3. Example of sources used for character design.

2) *Challenges and Rewards*

As with characters and the storyboard, the challenges and rewards featured in the program have also been created and fine-tuned based on the ELP program manual and especially the new clerk curriculum. Below are the proposed in-class activities, as outlined by the clerk curriculum [6].

- Researching what items were traded at the Fort.
- Learning the names of common items traded at the Fort in the languages of the places from which they originated.
- Making a clerk costume item.
- Learning about the geography of the Fort's trading partners along California and across the pacific and mapping the trade routes.
- Color and cut out rubles or create a company script.

In accordance with the above activities, the following challenges have been created.

- The Inventory Challenge: the clerk must inventory a number of items at the Fort warehouse and learn about their function and names (in original language).
- The Language Challenge: the clerk's must help repair the windmill by displaying his/her knowledge of the items, learned in the previous challenge.
- Reward: a printable certificate indicates that the clerk has passed the first level successfully and can go onto the next challenge.
- The Trade Challenge: the clerk must go around the Fort and gather trade goods from different people (e.g. the Kashaya, the Spanish, etc.).
- The Magasin Puzzle Challenge: the clerk must help unlock a chest by displaying his/her knowledge of Fort Ross's trade items and relationships.

Figure 4. View of the Russian windmill.

- Reward: a printable certificate indicates that the clerk has passed the second level successfully and can go onto the next challenge.
- The Rubles Challenge: the clerk is finally entrusted with one of the most important jobs at the Magasin, counting the Rubles. This will allow the user to familiarize him/herself with this monetary system.
- Final Reward: the user will finally obtain his/her certificate of completion, which will be exchanged for a survival badge once the user is at the Fort.

IV. HISTORICAL SERIOUS GAMES DEVELOPMENT

A. An integrated approach towards virtual reconstruction

The virtual reconstruction of heritage sites and complex architectures via 3D technologies is presently a well-established practice that is widely used by museums, universities, research centers, and cultural institutions worldwide [9] [10]. It can be defined as a multimodal rendering of historical, archaeological, or cultural data realized through 3D graphics and other digital means of communication with the aim to document, visualize, preserve, and study cultural heritage. A virtual reconstruction acquires an outstanding and broadly recognized scientific value when it is accompanied with a thorough and transparent documentation reflecting international standards such as the guidelines proposed in the London Charter [11]. Yet this complex procedure entails knowledge and expertise belonging to both the Humanities and Information and Communication Technologies and takes the simulation of cultural phenomena, events, and places to a new level. Presenting these features as a virtual reconstruction enables new ways of interpreting and preserving our past and heritage. Virtual reconstruction as a communication method is still far from being an accrued convention even if several articles and books discussed relevant case studies [12]. A number of projects carried out by the authors of this paper in recent years proposed successful best practices for philological historical virtual reconstruction [13] and communication of historical data in museums [14]. The specifics of the FRVWP permitted us to perform an accurate virtual reconstruction that has been validated by historians working for California State Parks. Our integrated approach combines data obtained by digital documentation through laser-scanning, remote sensing surveys, and other information derived by the historical sources mentioned above. But an accurate and scientifically valuable virtual reconstruction does not imply per se the construction of knowledge in its target audience. As Mark Prensky underlined, even if there is no agreement on how the general public-in this case visitors of the Fort Ross Historic Park-retain knowledge after the visit, engagement is universally recognized as a key element of any *Digital Game-Based Learning* process [15]. According to these principles the FRVWP aimed at transforming a virtual reconstruction of Fort Ross Historic Park into a cyber experience which could be enjoyed by the largest attendance possible, in particular by elementary school students. Our initiative sought to enhance the educational relevance of the ELP providing a precise representation of Fort Ross historical landscape, buildings, costumes, and characters. To achieve our goals we decided to add a narrative horizon to the reception of such cultural data. In particular we designed a user experience that promotes fun and literacy employing mechanisms and principles that belongs to the serious games domain as defined by Anne Derryberry [16]. Specifically our project references to a long tradition of educational computing started in the mid 1970's by the Minnesota Educational Computing Consortium (MECC) which lead to the publication, in 1981, of the renowned digital learning tool *The Oregon Trail* [17]. Thus a good balance between narrative/fictional and historically accurate elements enriches the FRVWP, specifically for what concern the game objectives, PC and NPCs design, user interaction, and reconstruction of the cultural virtual environment. Our focus on historical accuracy and education brought us to embed in the game an *in-app* documentation in the form of a precise knowledge base that contains a vast set of historical information provided us by the historians working at Fort Ross along with a great amount of metadata generated by the project itself. The integrated approach we used supplies our serious game with an element of extreme playability and endows users the possibility to virtually access and consult *in context* a vast amount of historical data. This is particularly important for the young students involved in the ELP who can learn and have fun while experiencing the cyber-visit, but is also relevant for educators and professional personnel at the Park who can finally employ

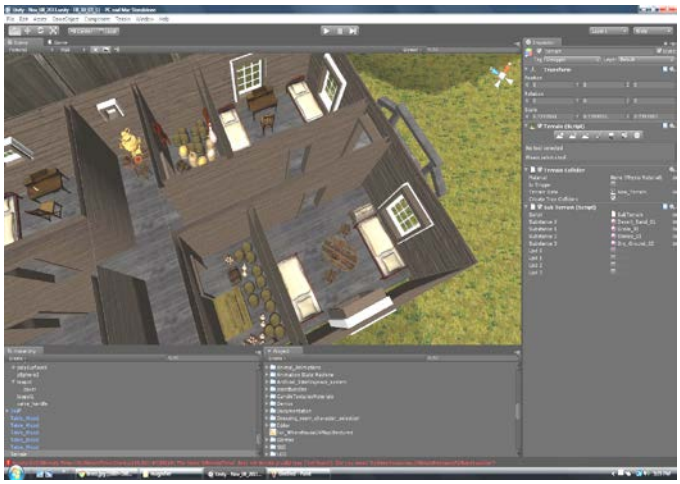

Figure 5. Scene editing session in Unity 3D.

a reliable and robust 3D simulation instrument which will help them enhance their teaching or research activity on the history of Fort Ross.

B. Digital documentation

One of the goals of this project was to incorporate state of the art digital documentation tools for the recording of various historical structures and artifacts. The idea behind this undertaking was twofold, the first being that those objects that were digitally recorded would eventually be incorporated as digital models within the environment of the virtual learning environment. The other main reason for the employment of such advanced artifact documentation was for cultural resource management purposes. Cultural resource management involves the recording of landscape, texture, and state of conservation details, which makes future preservation and conservation possible. To date, a systematic and comprehensive digital documentation of historic structures and artifacts had not been undertaken at the fort, and so this project presented the perfect opportunity begin such a process. For this digital documentation, we employed two different laser scanning technologies-that of an optical laser scanner in the form of a NextEngine HD 3D scanner, and a Trimble FX time of flight/phase-based hybrid laser scanner. Each of the different laser scanning technologies was particularly adept at documenting objects of different constitutions and scale. Laser scanning of any type inherently has its limitations, and as we encountered in our field work at the fort. Lighting issues, size, and the color and material consistency of the artifact, all influence how well an object can be scanned. The NextEngine HD 3D optical laser scanner was used to digitally document artifacts smaller than 30 centimeters. With an accuracy of up to 130 microns and a sample density of 400 samples per 2.54 centimeters, the NextEngine is capable of producing highly detailed textured models of artifacts [17]. There are however a wide range of objects that the optical scanner is not adept at producing good results. Objects with surfaces that were shiny or metallic (i.e. candle holders and small pots), dark or brightly colored (i.e. pained bowls), or that were overly porous (i.e. fabrics) could not be documented fully with the scanner. This of course has to do with the general reflectance and transmittance properties of the objects being scanned and its impact on the scanning laser light. For the digital scanning of the historic structures in Fort Ross we relied on a Trimble FX time of flight/phase based scanner. This scanner works primarily by emitting a pulse of laser energy and measuring the time taken to bounce back off of the object being scanned. Because this scanner also incorporates phase based scanning, it sends multiple pulses of laser energy at various wavelengths in an effort to maximize returns. Several tests run by the authors of this paper in a recent fieldwork season permitted us to develop an efficient laser scanning workflow to be used also in the FRVRP. Specifically our laser scanning activity can be subdivided into several steps such as site evaluation, project evaluation, hardware selection, scan setting evaluation, actual scanning, followed by a number of additional steps of post processing through which a final 3D model is generated, including point cloud cleaning, registration, triangulation (meshing), texture application, and optimization for viewing. [18]. The Rotchev House, Officers Quarters, and the Kuskov House were all scanned using the Trimble FX, and with a data capture rate of approximately 24 lines per degree (LPD) by 24 points per degree (PPD). Each scan took approximately 5 minutes with an average of 6 scan stations per building. Ultimately the models that we created from the laser scanning survey proved to have too high a polygon count to be effectively incorporated into the virtual learning environment, and so we choose instead to model our own buildings based on survey data that had been previously conducted at the site. The laser scanning documentation and models we created has been provided to California State Parks as the first comprehensive digital documentation of the historic structures at Fort Ross and will be used for both archival and management purposes enhancing the interpretation and conservancy of this historic park.

Figure 6. Detail of the fur press in the Warehouse.

C. Remote sensing and landscape design

The recreation of a realistic landscape environment is arguably the most important aspect in any virtual reconstruction. As this project was at its core, an academic endeavor, it was important that the creation of the virtual learning tool's terrain be recreated utilizing one of several remote-sensing technologies familiar to our team. Our team investigated several different data sources from which to create a digital terrain model (DTM) of the site, mainly radar and LiDAR sources, and settled on free United States Geological Survey (USGS) utilized data acquired from the National Elevation Dataset (NED) 1/3 arc-second data, or data that is roughly accurate to within 10 meters. The resolution of the data made publicly available varies widely from one geographic area to another, based upon the different mapping techniques that have been undertaken at those locations, however Fort Ross, and the surrounding areas have been LiDAR mapped on several occasions, and so detailed elevation data is publicly available free of charge for the site. Fort Ross is situated on a small flat between the crashing surf of Northern California's scenic coastline and the green rolling hills of California's Coastal mountain range. Any attempt at recreating Fort Ross without including such prominent geological features would do a disservice not only in not showing why Fort Ross came to be picked as a site for permanent settlement, but also to the natural beauty of the forts setting. It was for this reason we eventually settled on a larger scale landscape of 1400 square meters or roughly .86 of a square mile, as the limits of the environment. A landscape of

this size would allow us to include the different microclimates that contributed to food production on the coastal bluffs, and the coniferous forests of the adjacent hills that served as a source of timber for ship construction at the ocean cove. While conventional mesh DTM's are a reliable method for most terrain modeling, the creation of a highly detailed terrain mesh posed several problems for our project; Unity3D-the game development platform we used- has a 500,000-mesh threshold beyond which the game engine does not run efficiently [17]. Unity3D does however have a powerful heightmap terrain creation tool, so instead of importing a mesh DTM into Unity 3D, we created a heightmap and used Unity's internal terrain generator to create our terrain.

D. Sources-based 3D Modeling

The 3D modeling activity has been performed using industry standard software such as Autodesk Maya 2012, 3D Studio Max 2012, and Mudbox 2012. Texture editing has been performed in Adobe Photoshop CS4 and 2D Graphics design for the graphic user interface (GUI) using Adobe Illustrutor CS4. Below is a description of the specific procedures used:

- Historic buildings – Buildings were modeled in 3D Studio Max based upon CAD drawing generated from historical survey data of buildings present during the historical period of Fort Ross.
- Props – Artifacts, tools, and other historical objects relevant to ELP were modeled in 3D Studio Max upon pictures of replicas present in the visitor center or at the fort. Some props like animals and other 3D assets were purchased in the Unity Asset Store. For further explanation of this asset purchasing procedure please see the following paragraph.
- Historic characters – PC and NPCs were modeled in Maya using NURBs modeling. Accurate description of historical costumes and characters were provided by California State Parks and ELP guidelines [4]. All the characters were later textured in Mudbox and semi-automatically rigged and animated using Mixamo's Unity Store plug-in.

E. Game development

The Fort Ross Virtual Warehouse serious game is both a stand-alone and an online advanced digital learning tool created using the previously mentioned Unity 3D. This software is a very powerful, completely integrated development engine designed for the creation of high quality, real-time, interactive 3D content. Unity is able to publish visual and aural content on multiple platforms, including the most popular operating systems, web browsers, and mobile devices [19]. The versatile structure of Unity 3D allowed us for reducing outstandingly the cost of the initiative both in terms of money and time. In particular in a time span of only one year a small developing team of 2 modelers, 1 content expert/researcher, and 1 computer scientist could complete this serious game with a budget ten times smaller than the one of any similar industry production. Such a low-cost and short-time development has been possible thank to a rich and accurate historical information provided by California State Parks and several digital assets purchased in the Unity Asset Store [20]. Such store feature embedded in Unity3D changes the way a team of digital humanists can approach the production of serious games. 3D models, scripts, plug-ins, and modules can be purchased online via the Unity Asset Store at a convenient price.

Figure 7. View of the Officers' Quarter-left-and Warehouse-right.

Despite the limited total expense, FRVW has a great value in terms of research and education. The game includes a long list of custom developed cutting-edge features and Unity3D advanced gaming techniques specified as follows:

- Proximity triggered graphic user interface (created with NGUI asset) able to permit users to communicate with NPCs and learn historical data, and also manage user interaction with the scenario and other game objects.
- 3D sound, soundtrack, custom high quality 3D artwork, character and props animation, and advanced atmospheric effects (UNI Sky asset) to enhance the realism of the virtual environment.
- Custom character controller based on a moving 3rd person camera placed behind the player character. When the character is stationary, user can selectively rotate the camera around the player. The controller features a "WASD" keyboard-based and "mouselook" mouse-based movement control.
- Smart pathfinding system (developed using NavMesh) to manage NPCs and props movements and interaction.
- Advanced lighmapping calculated in BEAST, screen space ambient occlusion (SSAO), advanced shading techniques (shader model 3.0).
- Occlusion culling and Unity AssetBundles for improving performance in web deployment.

F. Playability

The Fort Ross Virtual Warehouse serious game entails two different modalities that give users and educators a complete control on the cyber experience. More specifically the game is based on:

- Explore Mode. Simple movement throughout the Fort Ross area using the clerk PC. This modality permits users to acquire spatial knowledge about the area of the

Figure 8. View of the harbor at Fort Ross Cove.

fort and its surrounding. In order to enhance the user experience this version presents some constraints in terms of time, 10 minute free roam only, and space, some invisible boundaries preclude the possibility to reach remote areas of the scenario.

- Play Mode. It provides a single player with interactive activities such as quests and tasks, face-to-face interaction with NPCs, and standard third-person navigation of the Fort Ross area. Play mode utilizes the clerk PC as well. The game narrative for the clerk character is based on the completion of the 5 objectives described above. Each objective is an interactive task that the Merchant has to accomplish before proceeding to the next one. A limited number of "in-engine" cut-scenes enhance the game narrative providing a better identification of the users and high quality, cinematic opening and closing.

V. CONCLUSIONS AND FUTURE PLANS

The creation of serious games for research and educational purposes opens new perspectives for the digital enactment of historical and archaeological reconstructions, providing a specific narrative validated by scientific and historical data. In fact the game is able to reproduce digital alive and active spaces where multiple actors can play and interact developing new knowledge and experiences. The role of PC and NPC in fact increases the sense of place and embodiment of the users and the sense of (cultural) presence inside the virtual environment. Textual, verbal and visual communication between PCs and NPCs makes the game experience more effective and able to stimulate an enactive learning in the cyber space.

Ultimately the rewarding mechanism of the game encourages the users to explore and discover the landscape around the Fort and all the places and characters "hidden" in different buildings and structures. This process enforces the virtual sense of place and is able to orient the users firstly in the virtual space and later in the real site. The partial fictional reality of the game is compensated by the historical validation of all the documentation and by authentic chronicles and reports dated to the past life of the Fort. The digital enactment of the game stimulates the users to be completely immersed in a specific historical period, to ask new questions about the social roles of different stakeholders (Russians and native people) and their relation with the environment. Narrative and digital storytelling play a central role in the learning experience and in human abilities to transmit this knowledge to others. In the specific case of Fort Ross, schools, teachers and students could experiment a virtual preparatory experience to the Fort by the virtual game (pre-visit). Secondly, they could have a real experience of enactment on site (visit) and finally they will go back to the virtual one (post-visit) for further comparisons between real and virtual learning. The alteration of Virtual and Real [22] in the dynamics of cultural learning and social presence is actually essential (when it is possible) for a very effective educational and communicational process. The reconstructions of buildings, site, characters and the entire landscape and environment (including plants and animals) are very accurate and based on site maps, laser scanning, computer vision and 3D modeling.

FRVWP is still a work in progress but a first release is scheduled by the fall 2012 in standalone version-single player. A future second release, multiplayer, could be implemented after a beta test phase of the game involving selected group of schools and teachers. The game can be released for students, teachers and visitors on site (in stereo or mono visualization) and in remote thanks to the Unity 3D web player.

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