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SIMULATING CULTURE: AN EXPERIMENT USING A MULTI-USER VIRTUAL ENVIRONMENT

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ABSTRACT

With increased levels of global trade, foreign policy making, foreign travel, and distance collaboration using the Internet, the issue of culture takes center stage. One needs to better understand how cultures form, and what culture means in terms of behavior norms, history, and sociology. We have constructed a simulated multi-user virtual environment using the technology *Second Life*, to facilitate the learning of Chinese culture. On our virtual island, *Second China*, we have constructed a set of immersive scenarios, buildings, and interactions with virtual humans. We have also constructed spaces for culturally relevant entertainment, as well as spaces for exploring news and current affairs. Content is created using 2D web pages and 3D objects with hyperlinks and teleportation that connect media and people. We present the technical and cultural implementation of the island, and we cover issues, challenges, and lessons learned.

1 INTRODUCTION

What is culture? Culture is defined as “the learned, socially acquired traditions of thought and behavior found in human societies” (Harris and Johnson 2003). The term “culture” is usually associated with a life-world as well as a set of behavioral rules, forms of thinking or norms that emerges from human group interaction. This might mean a group of five people who work in the same office, or a geographically partitioned landmass such as the United States or China. In the latter instance, culture is strongly correlated with socio-historical events, traditions, and natural language. Given the proliferation of travel, business transactions, communications networks, and military operations, understanding another culture becomes an important and valuable task. Our goal is to construct a multi-user virtual environment (MUVE) based on Chinese culture, and so, to afford the participant with the ability to learn more about China as a specific world with its language, mentalities, customs, and peoples. We have used *Second*

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Life (Weber et al. 2008) as the technology. *Second Life* is a multi-user virtual environment that supports a large population of avatars (e.g., human and computer-controlled, artificially intelligent agents) and user-created content.

The use of MUVEs for education is still in its infancy. The field of modeling and simulation has a potentially significant role to play in future research in this area. There are many technical challenges that must be overcome to create an integrated virtual environment, but also, this sort of environment has feedback into new ways in which to construct and visualize models, as well as to perform analysis and explore execution results.

We begin placing our research within the context of related work (Section 2). We then describe the architecture of *Second China* (Section 3), which includes the use of virtual humans (Section 4) and media communication (Section 5). We close with comments on learning using *Second Life* (Section 6), issues and challenges (Section 7), and conclusions (Section 8).

2 RELATED WORK

Within the simulation community, related research includes the following areas: training, education, agents, and aesthetics. We will take each of these areas in turn and cite literature that creates a foundation for our present and future work.

Part of our study involves training. For example, we may wish to train someone in how to enter an office building and be seated on the correct side in a meeting room. While cultural education and learning play a role in this scenario, one must be trained on how to listen to a human guide who will assist in the seating, and where to sit. The military, within the context of simulation literature, has a rich history of using simulation to train both officers as well as soldiers (Andrews and Bell 2000). Page and Smith (1998) provide an introduction to this sort of simulation for those most familiar with discrete event modeling (i.e., a historically central topic for the Winter Simulation Conference). The training objective is to provide an experience that transfers closely to real-world experience (i.e., the experience of a troop extraction mission or driving an Abrams M1A2 main battle tank). Hays and Singer (1989) provide a comprehensive overview of the fidelity of training simulators. Andrews and Bell (2000) discuss the concept of *fidelity* (physical, functional, and psychological),which is defined as how closely the simulation maps to physical-world experience. Fidelity should be considered within the context of learning design (i.e., a high degree of fidelity is not a sufficient condition for learning).

The inclusion of entities that appear in human form is a form of agent-based modeling and simulation (Oren et al. 2000), and can also be seen within the context of simulating larger scale social systems (Prietula et al. 1998). Our work includes both avatars and artificially intelligent bots. Avatars are mostly driven by human control; however, avatars may interact with specific sensors that can take partial control over the avatar with the avatar's permission. Bots are avatars that are under programmatic, or autonomous, control but in appearance are identical to avatars. One example of group behavior is the synchronized Tai Chi bots located in the park area of *Second China*. This sort of social behavior is fairly simple, but provides for cultural awareness of a common park-related Chinese activity. Our bots are specifically oriented toward narrowly defined tasks such as greeting, guiding, and question-answering, but do not exhibit cognitive awareness or introspection (Yilmaz et al. 2006). The concept of "agent" can be broadened, as well, to include a simulation where many independent entities move and interact often as a result of physical laws (Luke et al. 2005).

Virtual reality and simulation have a long history of working together: most of the training simulations are tied with virtual reality, where the use of specific hardware simulators and display devices are commonplace. However, there is considerable future potential in laying new groundwork between virtual environments and computer simulation. Macredie et al. (1996) present the historical basis for these environments and their relation to the simulation discipline.

Our project builds upon previous work, and contributes to the field of simulation in the following ways:

- Exploring the manifold means and methods supporting cultural simulation by blending connecting several areas together: agent-directed simulation, multi-user virtual environments, and the goals of cultural education, learning and communication (Section 3).
- The efficient control and synchronization of bots in a multi-user environment. This has been a challenge for the team, resulting in message protocols between the Linden Labs servers (controlling the virtual grid), server-side scripting in Linden Scripting Language (LSL), and an in-house Ubuntu Linux server running Mono (Section 4).
- Using simulation models (Fishwick 2007) as vehicles for delivering messages to visitors. For example, using a control flow diagram in 3D to educate visitors using Western vs. Chinese perspectives on controversial issues (Section 5).
- Exploring new learning approaches that combine many forms of media from sound, 2D images, and 3D objects. These approaches are based on prior work in combining multiple representations and in the relevance of hyperlinking to supporting educational goals (Spiro and Jehng 1990) (Section 6).

3 SECOND CHINA

We have developed a three-dimensional multi-user environment called *Second China* using *Second Life*. *Second Life* supports two main grids: main and teen, with most activity related to research and education occurring on the main grid. The grid is composed of a large number of connected land parcels and separate islands. The grid is inhabited by avatars that can be customized in size, shape, and appearance as well as clothing. Avatars log-in using the *Second Life* client software and teleport to a specific destination. While it is possible to have full VR (virtual reality) immersion, the majority of users are interacting with *Second Life* using Desktop VR. The general architecture is shown in Figure 1: there are major learning modules on the left and *Second China* on the right. It is possible to move between the largely 2D web content and the 3D content—back and forth as required by the participant according to existing knowledge of the target content

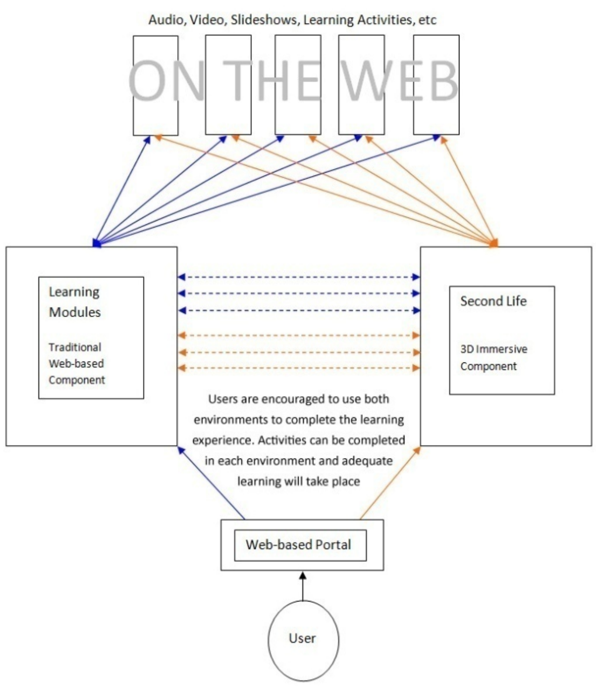

Figure 1: The overall architecture of *Second China* containing a primary interface through the web, as well as web-based and *Second Life* content.

This architecture of *Second China* has requirements that we specified before beginning the design and implementation:

- Construction of educational scenarios
- Development of real-world Chinese buildings, containing objects, artifacts, and media placed within the appropriate context.
- Creation of interaction for objects to allow for natural as well as enhanced exploration through linking and teleporting.
- Guided (i.e., formal) and unguided (i.e., informal) learning
- Elementary artificial intelligence in the form of bots, who take the form of avatars but are responsive to the participant as a result of interaction events (i.e., proximity sensing, text messaging, and assessment responses).
- Design of a news, issues, and public affairs area to promote more in-depth understanding of Chinese culture as well as different viewpoints.
- A variety of multimedia, including sounds, speech, artwork, photographs, posters, and movies.

Key requirements will now be described in further detail. *Second China* is structured fundamentally around scenario building. For instance, one scenario is inside of an office building. Developing the scenario is similar to the construction of computer game design, animation, and effects (Kerlow 2004) using the following steps:

1. Storyboard the scenario providing visual and textual cues as to what should happen, and when.
2. Create a rough, coarse-grained, 3D geometry for all items in the scenario, including building(s) and rooms as well as positions of bots, to be discussed in further detail in Section 4.
3. In parallel with step 2, create cultural content using web-based technologies. For example, create a web page on seating arrangements in a business meeting, or typical Chinese phrases that a bot may use when greeting the visitor.
4. Build interaction (a) between the participant and the environment, and (b) among all 2D and 3D content.

Figures 2 through 4 show the outside of the office building, moving toward the front glass doors, entering the reception desk, and the proceeding to the conference room. The participant (i.e., visitor) moves toward the office building and is given instructions on the proper attire for a business meeting. The visitor can then put on the clothing and enter through the doors, at which time, Lu (the receptionist and bot entity) will greet the visitor. Immediately, after the greeting, the visitor will be tested on the meaning of the Chinese phrase. This interaction with Lu, which is defined further in Section 4, involves the visitor answering questions that test for an understanding of the language. These questions may also be regarded as a means by which the user is given the opportunity to develop prediction skills. These events aid in the progress of the scenario and can be applied within a real world context.

Figure 2: The office building in which the meeting room is located.

As an example of Lu's interaction, when the visitors enter, they are greeted with "Welcome to *Second China*'s meeting room. I will guide you into the meeting room". Lu bows slightly, and then says "*Ni hao"*, which means "Hello." There is a blue pop-up dialog box that says "The person at the counter has just greeted you in Chinese. What did she say?". Possible answers are: "a) Hello, b) Good morning, c) Good afternoon". A wrong answer will result in the visitor receiving the correct answer, and then Lu proceeding to the next waypoint on the path toward the meeting room.

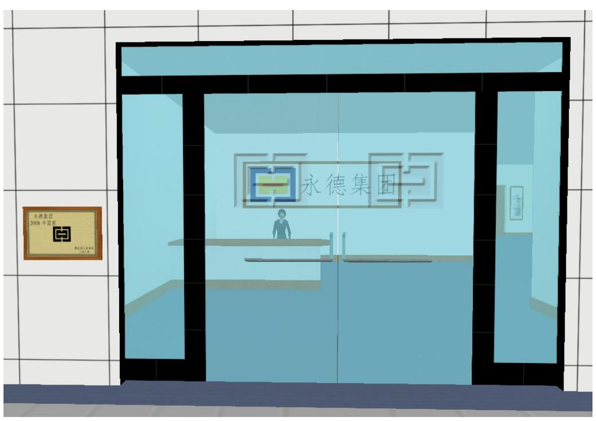

Figure 3: Entering the office building through the double glass doors.

Interaction within the office building is accomplished by interacting with Lu (Section 4) as well as touching the artwork on the walls or the teacups. These objects contain touch sensors that map to web content. News and public affairs are found in appropriate locations (i.e., a movie about the state of doing international business in China in the business meeting room) and in the *Sky Oracle,* which is positioned in the sky and carries a range of journalistic and public relations material on China.

Figure 4: Inside the business meeting room.

Figure 5 shows the inside of a separate building—the tea house, where the visitor may watch opera and drink tea.

Figure 5: Inside the tea house.

The *ground truth* used to design the geometry and interactions contained within objects show in Figures 2 through 5 is found in reference photographs, textures, and videos where available.

4 VIRTUAL HUMANS

A virtual human is an artificially represented entity rendered using computer graphics. The concept of virtual human builds upon a rich history of several research areas including artificial intelligence, synthetic human geometry and dynamics, and virtual reality (Magnenat-Thalmann and Thalmann 2004). Figures 6 and 7 depicts the receptionist, who guides the visitor to the meeting room, once the visitor has put on a business suit and entered the office building's main area. Lu has specific gestures that have been created through skeletal animation software. For example, she bows and then later positions her hands to guide the visitor's orientation when the meeting room is encountered.

Figure 6: Lu behind the reception desk in the office building.

Figure 7: Close-up of Lu from Figure 6.

Lu's behavior is made possible through our development of an augmented finite state machine (FSM). The first state is "at desk" and a sensory proximity event triggers the "hello" state. Additional waypoint states are achieved based on the visitor correctly answering the language questions. Figure 8 shows additional bots implemented on the island.

Figure 8: Three additional examples of bots. From left to right: the island greeter, musician playing an *erhu*, and residents performing T'ai-chi.

Figure 9 overviews the technical architecture that supports all of the bots, including Lu. The figure shows a typical interaction associated with a single state involving one walking action.

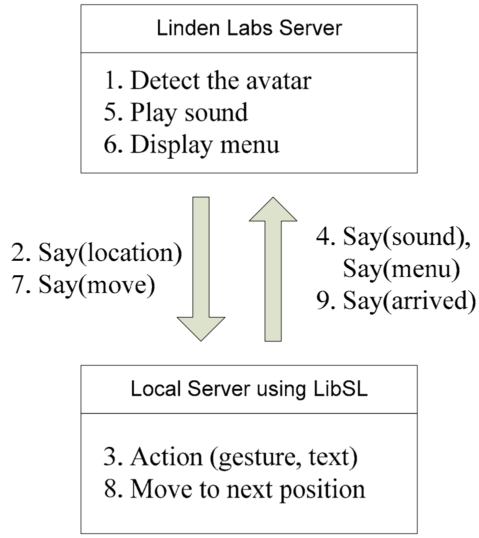

Figure 9: The communications protocol developed to create functioning bots.

The steps in Figure 9 are described below:

1. Detect the avatar
2. Say the location of the avatar for the bot to turn toward the avatar
3. The bot performs an action using gesture (bow, direct…) and accompanying text
4. Say the name of sound (nihao…) and menu (menu1, menu2 …) at this place
5. Play sound
6. Display menu
7. After receiving the answer from the avatar, say move
8. Move to next position
9. Say "arrived" when the bot arrives the next position

5 MEDIA COMMUNICATION

We have constructed a *Sky Oracle*, which is where news, public affairs, and issues are covered. The approach that we are taking is based on taking simple diagrammatic models of these issues and presenting them in 3D (Fishwick 2008). The following steps are used:

1. A news item is chosen from an outlet, or obtained by interviewing sources who are expert on the item. For example, an item may be the relations of Tibet and mainland China, or how China has changed as a result of hosting the 2008 Olympic games.
2. The item is coded and represented as a 2D simulation model. For instance, a news item may be encoded using the System Dynamics method, or a control-flow chart.

3. The 2D model is transformed into a 3D architectural space with rooms or segmented areas capturing the semantics in the flowchart nodes.
4. The 2D model is used as a map or heads-up display within the 3D model.

This type of mass media creation is different than the more traditional approaches of using story text and video. The extent to which this approach can complement the more traditional media is being studied through experiments. A key question is whether 2D diagrams and charts have any significant effectiveness in 3D, and while this is an ongoing debate across several fronts, the 3D incarnations must take full advantage of presence if they are to be most effective. Research needs to be performed to test for several social science and educational variables such as attitudinal or behavioral change, learning, and memory retention.

6 LEARNING

A critical question that one asks of 3D immersive environments, and of *Second Life*, is "Is this going to help learning, and how?" There are many facets to the question and to attempts in answering it. We'll present our informal results and observations to date as direct result of having constructed *Second China* using an interdisciplinary team and set of goals.

The main observation, and heuristic, is that media must be used where they are appropriate. A frequently posed question is of the "2D vs. 3D" variety. Why use 3D when 2D would work? Let's assume that "2D" means human sensing using a web browser that displays formats such as HTML, Java applets, and Flash. "3D" can refer to *Second Life* as it relates to our paper, but other sub-classes exist – the Virtual Reality Modeling Language (VRML), for example. Two dimensional media have specific purposes: text uses our ability to read or speak and captures a linear narrative. Pictures provide static images, and diagrams have a "map like" function of showing connectivity among concepts (i.e., "x points to y" or "x is to the left of y"). If 3D environments are judged in terms of factors that are performed well in 2D, then they are bound to fail. Instead, a 3D environment such as *Second Life* affords the user with options such as: 1) increased sense of embodiment (Johnson 1990) and presence, 2) clearer transfer of activities from the real-world, as in situated learning theory (Lave and Wenger 1991), 3) engagement, 4) interaction, and 5) social behavior.

Regarding a sense of presence, there are apparent perceptual and cognitive differences between viewing a web page and becoming an integral, and possibly social, part of a learning experience. Mikropoulos (2006) performed experiments regarding tasks in an ancient city that had clear real-world transference (i.e., locating a vase, or meeting the housekeeper). Higher levels of presence were correlated with improved task performance.

We suggest that both 2D and 3D content be used together where each seems relevant to learning objectives, and meets the needs of different phases of learning. For instance, one may learn how to interact with Lu as she guides us into the meeting room, but learning the exact phrases used and the explanations for certain cultural content within the 3D environment may be more efficiently conveyed with traditional web-based content. In addition, while constructivist learning theory is valid within the 3D learning environment and is well suited for both novice and more advanced learners, certain stages of knowledge acquisition may require different approaches to learning and instructional design. It has been posited that the initial acquisition phase may be more effectively and successfully addressed by learning materials and experiences based on classical instructional design techniques (Jonassen, Mayes, & McAleese, 1993).

Some capabilities, such as engagement, and interaction, are somewhat limited in 2D. Three dimensions provides additional visual cues (perceived textures, shadows, depth, materials, orientation, and position). To the extent that additional cues provide for increased variety, this may be the basis for increased duration spent at a location (i.e., as opposed to time spent on a web page). We plan on issuing surveys to assess learning objectives, and to attempt to further tease out rules for when specific media are the most effective. Moreno and Mayer (2002) present the relative roles of the medium (i.e., a MUVE) and the instructional method (i.e., instructor-led or exploratory). Their particular experiment reported that there was *no immersion effect on learning*. However, in more recent work, Moreno (2006) provides a theory of learning based on ten design principles, many of which can be leveraged using Second Life. Since these principles can be satisfied within a standard 2D web framework, what remains to be seen is the effect of immersive environments on potential contributors to learning such as interest, emotion, and motivation. Additional studies are required to derive principles for *immersive media*.

7 ISSUES AND CHALLENGES

Our work to date on this project has uncovered many issues that need addressing. Some of the issues are general, and others are specific to the MUVE technology that we are using.

A general challenge that arises is in effective human communication among team members of the project. We have taken the approach of listening closely, and allowing as much cross-fertilization as possible during scenario building. The classic assumptions of (1) the content developers don't understand the technical underpinnings of scenario development, and (2) the technical team doesn't understand content, are not valid. We have numerous instances where content developers suggest something that yields a novel technical contribution, and technical team members create cultural content. As team members, we have more in common that may be initially presumed given our highly vertically oriented academy.

How does one manage time effectively? We have found that to do a proper scenario from initial concept, to preliminary design, artwork, and technical implementation is challenging and time-consuming if that scenario is to be of high quality. We can learn from computer game design here, since the pipeline is not that different: start with the concept, do the storyboarding, define the scenarios and interaction, do the artwork, and follow-on with technical solutions that create a compelling experience.

Who is the audience? Or in the case, of MUVEs, it may be more appropriate to ask: who are the participants? We are targeting a broad range of the people who wish to learn about Chinese culture. Some participants may be more interested in business culture, and others in listening to Chinese musical instruments or watching Peking opera. We are exploring creating different layers of content as a means of making one scenario applicable to a wider range of participants. If, in the business meeting room scenario, someone wishes only to explore the meeting room itself, the bot (Lu) may not respond. Making this kind of layering option available requires a heads-up display in-world or some other means of selecting exactly the sort of interaction that is desired. It may be impossible to provide unique, personalized education and training for each participant; however, it should be possible to identify a small number of target interactions and then design accordingly.

How does one retain participants on the island, or get them there in the first place? If there is an administrative or corporate hierarchy that dictates participation in Chinese cultural education using *Second China*, then this is not as much of an issue; however, attraction and retention are key problems in *Second Life*. Many islands and otherwise well-constructed locales are vacant. In general, educators aim to interest students in educational content in such a way that students are motivated to access content on their own time. It is for this reason that we ask ourselves if there is a way to attract and keep visitors short of forcing them through grades or job-training requirements. For attraction, we need to create better approaches of building 2D web presences that are natural lead-ins to the 3D *Second China* environment. This 2D ↔ 3D linking should help in getting people into *Second China*. When people come to the island, retaining them and encouraging them to revisit the space is the next challenge. If participants are engaged, retention may improve. This means that, in addition to providing solid content, we must develop methods of delivery and activities in which users can participate that are engaging, dynamic, and warrant a second, third or fourth visit. Another possibility is to hold regular social events and meetings in the space.

What is the proper balance between guiding the participants versus allowing them to explore and construct their own meaning within the environment? We are taking the approach to support both modes, providing specific training and educational delivery mechanisms while simultaneously encouraging hyperlink-based exploration. A pure training goal would place less emphasis on exploration, for natural reasons. Yet, if the goal is to educate and promote a constructivist learning option, having both guided vs. exploratory learning seems appropriate. Within our commitment to developing this multi-layered constructivist learning environment, we must also address the range of needs from novice to expert learner in order to successfully deliver meaningful content to the diverse audience for which the environment is intended.

How does the participant connect the semantics of one object to another? This is partly a corollary to the previous question. If one clicks on a porcelain teacup in the meeting room, can one be transported to a part of the island where Chinese pottery is exhibited? Or, can one be teleported to another *Second Life* location that has extensive information on pottery? While hyperlinking with 2D web pages allows for semantic connections, virtual world environments, allow for even more with teleportation serving to create a higher level hyperlinking function.

What are the many ways that virtual humans can be used to facilitate learning and communication? We feel that we have only begun to scratch the surface on the possibilities. Virtual humans are certainly appropriate and proven in training, but there is more potential—virtual humans used as artificial intelligence entities, greeters, and general guides. If we stretch the definition of virtual human to include the concept of avatar, then we must ask how role-playing can help with our simulations. We must also try to leverage the existing *Second Life* community. Can avatars controlled by native Chinese speakers be enlisted on the island?

8 CONCLUSIONS

Cultural modeling and simulation is based on the convergence of several areas: modeling methodology, virtual environments, agent-directed simulation, and simulation-based learning. We have combined these areas together into a single implementation called *Second China* using the *Second Life* multi-user environment software. The progressively improving state of computer graphics is yielding 3D displays on cellular phones as of this writing. This new technology creates a new type of media—one that must be explored within the context of existing 2D media and web content. Working on *Second China* has given us a new appreciation for the potential that this technology for interdisciplinary culturally-related research. We hypothesize that our installation can be generalized to the learning of other cultures as well.

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