Using Games as a Means for Collaboration

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Abstract

The availability of a good interface for online user collaboration has been a sore point for most collaboration applications to date. While MUD's, MOO's, IRC and other chat applications are well suited to impersonal communication, the meaning of a single message can often be misconstrued or misunderstood, and the effort often required to learn control of a new application while understanding navigation in a virtual world, can be difficult to overcome. The Nexus promises to aid in the intuitive act of communication, interaction and movement and in the process enhance the collaboration experience for the user, through the use of a game engine.

1. Introduction

The interfaces of most modern collaboration applications leave much to be desired. Where software in other fields has perfected its interfaces to become intuitive and easy to learn, online collaboration software can often leave the user bewildered and unsure of what to do. The Nexus is a virtual collaboration tool built on the foundation of a 3D game engine, which utilises the visual navigation and interaction of virtual game-worlds. The Nexus has been designed using an interface that is well known and tested, and is considered not only easy to use, but also fun. Through examining the ways in which people interact online and looking at short-comings in current collaborative tools, the aim was to design and produce an application to enhance online collaboration in the fields of distance education, virtual presence and online work practices.

2. Rationale

The Nexus was designed to illustrate a possible improvement to the interfaces of currently available Collaborative Virtual Environments (CVE). The relevance of using CVE's is shown in the work of one of the pioneers of the field, Steve Benford. "CVE's represent a technology that may support some aspects of social interaction not readily accommodated by technologies such as audio and videoconferencing and shared desktop applications"[1]. In consideration of these advantages, the Nexus aims to maximize the application of the immersive world, by drawing on the framework of successful game engines.

Changing the context of Half Life, a popular computer game, allowed for specific use in collaboration. Half Life was chosen for several reasons: Half Life's software development kit (SDK) is open source, visual C++ is widely known and available, the simplicity of function integration, the low network bandwidth requirements, Half Life's enduring popularity as a gaming platform, and its 3D environment rendering capabilities.

The last two of these criteria contribute most beneficially to a positive user experience. The Nexus aims to allow efficient and effective group collaboration with minimal utilisation of network bandwidth, while providing an aesthetically pleasing atmosphere in which to work communicate and educate.

The Half Life SDK was the optimal choice for creating The Nexus. The SDK features support for menus, environment production, sound and lighting, and code comments that made learning and adapting the code easier. The low hardware requirements allow it to run on any computer with specifications better then a Pentium 133 CPU with 24mb RAM running Windows 95. Half Life dynamically redefines its performance to be playable on slow connections (28.8kbs) using graceful degradation of features like sound quality, shadowing, lighting and image frame rate. These requirements are lower than for other modern games and along with the features described above, made this more viable than other game engines.

3. What is it?

The Nexus is a modification of the Half-Life engine. More specifically it uses the Half-Life code base to allow the use of features available only in a game interface, and extends this code to perform the extra collaborative tasks.

Imagine walking into work and sitting down for a typical day. You have a major report to finish and several meetings to conduct to get the next project rolling along smoothly. All of your meetings are spread across the world, some with team members overseas and others two floors up in your current building. You login to the Nexus and leave it running in the background. While finalising the report you hear a colleague's voice attempt to grab your attention from the Nexus. Glancing

to the world you see Sarah walking across from the London office portal to your location. She tells you about an important appendix file which was left out of the last version of the report. Walking up to you she pushes her briefcase at you to initiate the file transfer. You thank her and add the file to the report. The report is finished and ready to submit. On the way to the downtown office portal, you pass a colleague on the next project who warns you about potential complications in the client meeting coming up that afternoon. You submit the report to the boss and discuss the details. While downtown, you mention in passing some issues with the next project.

While this is a simple interaction described through the world of the Nexus, it leverages several aspects of physical office environs, such as chance interaction and recruitment to a current task. As explored by Backhouse and Drew, chance interaction was found to be highly efficient in aiding office co-ordination and productivity. The probability of interaction was also dramatically increased by line of sight and proximity to journey around the environment [2]. Through applying the element of physical distance in the Nexus, these office interactions can be utilised to improve collaboration.

3.1. Half-Life and CVE History

Half-Life was released in 1998, by Sierra, as a first person shooter (FPS) game, which was viewed from the perspective of the user's digital representation, or avatar. It was considered in gaming circles to be advanced for its time [3, 4], providing artificial intelligence (AI), rendered environments and avatars that were more advanced than other games on the market.

In recent years the benefits of utilising game engines outside their intended area of application has grown [6-8]. Their ability to render 3D environments quickly and efficiently is an obvious advantage, especially when fast services and connections are not only expected, but required. Some relevant work is described below.

Wayne Piekarski et al have used game-like interfaces and AR to enable 3D modelling in real space with awareness of digital and virtual actors. This was first demonstrated by their use of Quake as a proof of concept for merging Augmented and Mixed Reality. "We extended an existing desktop game and developed it into … the first system that allows users to play augmented reality games outdoors" [5].

The most detailed proposed re-adaptation, in the Nexus, involved the examination of mixed reality presentation, conducted in the work of Boriana Koleva et al [9]. Using both physical and virtual speakers, Koleva et al studied the reactions of a small lecture group, to determine the effectiveness of mixed reality presentations. Interviews showed that most participants felt comfortable when dealing with the boundaries between realities, and it was seen throughout the lecture that they were willing to interact between the realities with little or no prompting.

The use of game engines has not just been limited to the realms of collaboration and learning. Dennis Chao of the University of New Mexico has applied the rendering engine from another popular game, Doom, to analyse a computer's processing operations. Chao hints at the potential for visual mediums to enhance understanding as he describes the interface. "Using a computer game vocabulary may broaden an application's audience by providing an intuitive environment" [10]. By viewing complex data in a visual format, users are able to analyse and gain a faster and clearer understanding of context through CVE's in a games environment. "Of all the methods for analysing and communicating … well designed data graphics are usually the simplest and at the same time the most powerful" [11]. Drawing upon Tufte's rationale, the use of FPS game environments can be supported, providing the context of spatial understanding & relationships for online collaboration.

4. Design of the Nexus

The Nexus, as was previously mentioned, is based upon the Half-Life game engine as shown in Figure 1. The system utilises standard features of the Half-Life interface to achieve functionality. These include the first person view of surrounds, visibility of hands and current active tools and of other users within the field of view, and radar for awareness of other users who are currently out of view. In order to craft this into a tool for a collaborative work environment, it was important to consider what was currently lacking or could be improved with regard to these features.

Figure 1 – Nexus Interface

Consideration of interactions already undertaken within physical work and education environments was also important. Understanding these interactions was achieved through several means. An analysis of research into office work environments was conducted, drawing upon the work of Lucy Suchman, in the area of organisational procedures in the office environs, and Backhouse and Drew, in recruitment and chance interaction in workplace environments. "The goal of

building office information systems requires a representation of office work and its relevant objects ... research into the practical problems of office work, and to suggest preliminary implications of that research for office systems design" [12].

This consideration of physical constructs stimulated the mimicking of 'real' environments. The game engine and development tools enable the appropriate interactions for the related activity. Similar methods to this have been employed by Koleva et al who, through study of existing applications and teaching practices, were able to successfully simulate a suitably immersive lecture theatre environment which promoted interaction and learning [9].

Benford also discusses some of the affordances of awareness through virtual spatial constraints.

"*implicit awareness of the presence and activity of others afforded by space enables a range of subtle negotiations among its inhabitants. Continual awareness of others allows people to flexibly modify their own activity in social situations. (You can easily see when someone is heading across the room to talk to you or when they are heading for the door)" [13].*

Using the familiar direct representation of the physical office environs, the likelihood of 'chance meetings' occurring is high, adding an extra dimension of interaction to the environment. Observational studies of collaboration within a physical office were conducted to establish further context for the studies of Backhouse and Drew. The findings supported initial observations of discussion, file sharing, discussion around a document(s), presentation of material and general team interaction as major aspects of the work environment to address. While observational techniques are qualitative in their nature, the data obtained was relevant for the initial stages of prototype design. By addressing issues of physical collaboration, users will have a familiar starting point when adapting to the new interface.

Figure 2 – Real Office Hallway (Left), Nexus Representation of the Office Hallway (Right)

The environment and the avatars of the Nexus are entirely remodellable. It is simple to customise the building layout or the avatars' digital appearance using character or terrain modellers. So not only can users interact and collaborate with virtual co-workers whose avatars mirror their physical appearance, they can also interact within a virtual replica of their own work environment. This adds a further physical familiarity based on facial recognition in the environment. Users also have the freedom to access the Nexus from potentially anywhere in the world, bridging the chasm of distance. There is also potential for firms with overseas offices to have those spaces virtually available 'down the hall', so that collaborating with the overseas office is a matter of 'walking' to the next room for a virtual meeting.

5. Tools and Interactions

An advantage which the Nexus has over traditional collaborative tools is the ability to utilise an existing set of tools and functions, which can be reapplied to perform new functions.

Most collaboration applications provide very few tools that can be used to enable and enhance the collaboration experience; however among the features that some include are file transfer, real time verbal communication, and virtual co-location. The Nexus facilitates these tasks, and a selection of other advanced features, by use of digital phicons [14], (digital versions of physical icons e.g. a microphone or a briefcase). The following are the major tasks included in the current version of the Nexus.

5.1. Vocal Communication

Vocal communication is an integral part of human interaction [15] and is used to convey emotion and authority [16, 17]. In order to provide the ability to talk to others within the Nexus, the VOIP (Voice Over Internet Protocol) has been utilised. VOIP works by converting the input from a computer microphone into a digital signal, sending this information in digital packets over the Internet, and decoding it on the receiver's computer. This process is invisible to the user and allows them to speak as if they were in the same room as the recipient(s). VOIP is included in the latest version of Half-Life.

In the Nexus an icon appears above the head of the person talking, thus identifying them as the current speaker. The addition of distance-based volume and facial deformation of avatars will utilise features of Half-Life 2 (released soon), which features advanced facial morphing seen in a game environment to date, mimicking realistic human movement in real-time.

Volume degradation over distance imitates the way sounds become quieter the further from the source you are. This is an integral part of several social interactions, for example, standing just beyond hearing so as not to intrude on a discussion, while still alerting the other party to your presence. This topic was inspired by Benford et al [13] where Mr. Nimbus, a virtual creation in a DIVE system was given an audio aura to show the area within which he could communicate.

One possible implementation of volume degradation is to include spaces in which these rules do not apply.

This is potentially an efficient way to create a lecture theatre or meeting room, similar to that proposed by Koleva et al [9]. The rooms can be implemented so that they negate the degradation rules for anyone standing at a lectern or with a "right to speak" at a meeting table, thus allowing their speech to be heard equally by all within the room.

Another extension of the volume degradation system is audio focus. This would again allow for more realistic sound degradation by allowing users standing directly in front of a speaker to hear louder and more clearly than what someone behind (or to a lesser extent beside) would hear. (Based on principles in Benford et al [13]).

These two audio enhancements enable the Nexus to handle more common interactions, with virtual meeting rooms and the individual user 'acoustically designed' just as their physical counterparts are. Ultimately the Nexus becomes more intuitive, allowing for private or group meetings in a shared space, as in the real world.

5.2. File Transfer

Workers in distributed groups are confronted by the problem of how to easily share files. Rather than using e-mail, FTP, and version control applications separately, the Nexus has been programmed to integrate these transactions with a minimal amount of user effort. To transfer a file, the user selects the briefcase.

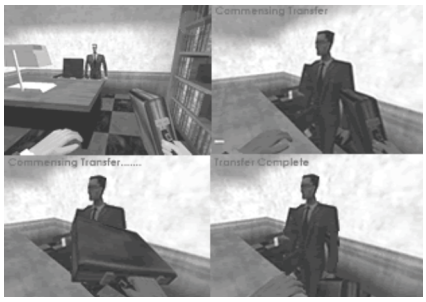

Figure 3 – Interface for user to transfer files.

The briefcase serves as a visual icon for all users to acknowledge that this user plans to transfer files. The user wishing to transfer then walks up to the receiver's avatar and clicks on it. The transaction is represented by the sender's avatar hitting the recipient's avatar with a briefcase. A dialog prompts the sender to input an ip address of the local file and a user name and password for the recipient's ftp server. Once entered, the user clicks the Send file button (Fig 3). Section 8 discusses further improvements in dynamically linking avatars.

5.3. Movement and Radar

Movement inside The Nexus is made possible by the use of the Half Life game engine, allowing the user to walk through the environment as they would in the real world. The animation of movement in avatars is limited to preset and pre-rendered animations; however future work could provide the ability to create facial expressions or even let the user have free movement (the free use of arms, etc). The user controls the movement of their avatar by use of the keyboard and mouse with relatively simple and easily learned keys. These keys can be changed to suit the user's preference, but have a default that is intuitive for those familiar with typical FPS game control interfaces. The reason intuitive movement within the Nexus was deemed to be important is best stated by Schnãdelbach and Penn et al "Indeed movement through virtual space, which is providing the chance for encounters and therefore the potential for social interaction, can be shown to be statistically similar to movement through an equivalent physical space" [18].

This also relates to the creation of spaces, which mirror the real world (as shown in figure 2), creating virtual representations of the physical that can then encourage serendipitous encounters similar to those experienced within the physical environment.

To assist in the location and tracking of other users of the Nexus, the inclusion of a radar display was deemed essential. The radar appears as a blue circle in the top right hand corner of the screen, with other users represented by red stars. The radar continuously updates to reflect the location of other users relative to the tracker (located at the centre point). The triangular lines (45 & 315 degrees) symbolize the viewable area in front of the user. Currently, to track another user the tracker walks in the direction that makes the trackee (their representation) move closer to the centre of the radar.

5.4. Video Walls

Video walls are another tool, which can be used to increase the sense of connection with the outside world. They can be used in a variety of ways including video conferencing, and mixed reality presence awareness; providing a more seamless way of interacting with people unable to immerse themselves within the Nexus. Similar work to this was carried out by Dourish and Bly [19] at Xerox Parc. That study highlighted the informal interactions that occurred, and showed qualitatively that people form bonds over this type of media. The main difference between that work and the Nexus is in representation of the distributed group, however the acceptance of a digital representation of a person as *being* that person has also been well demonstrated [7-9, 20]. It is possible to facilitate design through shared whiteboards, which mimic the collaborative nature of those in more popular collaboration tools (NetMeeting & Messenger). This would allow more interaction between users, and precipitate the actions seen in physical meetings.

5.5. Background Processing

The low levels of processing and rendering required to run this modification of Half-Life make it comparable to running other collaboration tools such as email or instant messaging. This means it can be displayed in a window in the corner of the screen, maintaining a user's online presence while allowing the user work elsewhere.

This style of interaction utilises the approach of chat programs such as IRC and messenger, enabling users to maintain a virtual presence for possible conversation / interaction with work colleagues while continuing with other tasks. Mimicking the nature of physical work interaction, users can maintain awareness of their surrounds and choose how interruptible they are. Users in the virtual world could walk up to a person in their office, knock on the door, and interact with them. just as people do in the physical world. The inclusion of this kind of interaction was informed by the work of Dabbish & Kraut [21], & Kuzuoka &Greenburg [22], which showed that providing a user with knowledge of the activeness of a recipient allowed the user to time their interruptions so as to cause the smallest impact.

6. User Response

Over the course of the project, the idea of a work based collaborative environment evolved from the suggestions and opinions of people who use, or could see the advantage of using, a CVE. Two major presentations allowed industry representatives from the collaboration field, and the public, to examine the Nexus and comment on its use and potential improvement.

As an exploratory study to gather a cross section of user responses, the following display was organised: Two computers were networked, to demonstrate how the Nexus worked and to display the improved graphics and interaction capabilities. Both computers easily addressed the minimum requirements of Half-Life.

Potential users were then brought to the computer and the purpose and potential of the Nexus briefly explained to them. Users came from various backgrounds, including the IT industry and academia, and were of various ages. Several claimed to have used collaboration applications previously, including net meeting, MSN and IRC, however none had used anything more sophisticated. Several had also had experience with FPS games, though there were a few who expressed that they had no experience with games. Overall, 20 people tested the system in this initial study.

Users were shown the controls of the system and given several minutes to familiarise themselves with the interaction. Each user was asked to complete a set of tasks: enter the system, navigate the virtual space, locate a remote user, converse with them, and transfer files.

In informal interviews several users commented on deficiencies in CVE's that they had used. Some of these shortcomings included the slow progress and image quality of applications like Net Meeting, relative to its high bandwidth requirement, and the impersonal face shown by MUDs, Moos and chat applications such as IRC, MSN and ICQ. It was immediately apparent that the Nexus allowed a higher rate of communication than within most other CVE's, and the ability to whom you were talking to helped communication become more personal and interactive.

New users learnt the game interface quickly and were able to navigate the environment and communicate. Several people stated that they liked the fact that there was a 'physical' action in giving people files, they remarked that it added an extra dimension to the interaction and helped them understand exactly what was taking place. The face to face style of communication seemed to take them by surprise, indicating that their past experiences led them not to expect a realistic and intuitive interface. Non-vocal interaction seemed to surprise and excite the users more then the improved graphics or lack of bandwidth usage. They spent extended periods of time standing near each other and experimenting with the reactions expressed as a result of their interaction.

Overall potential users were impressed with the prototype. Almost all said that they could imagine its application to a work environment.

7. Social & Cultural Implications

The potential social and cultural implications of this system could be quite involved. Transformation of what is essentially an FPS game engine into a virtual education or work environment has several ramifications.

There is a potential for users to perceive this environment on a subconscious level as having both the positive game attribute of fun and the negative attributes associated with the level of violence in this style of game. The latter could distract from the task it is designed to assist. This is addressed by Prensky [20]. However once an equilibrium is found, the benefits of this style of interface would outweigh the drawbacks.

The authors are aware of the need for more analysis. To date, only limited research has been undertaken on the implications of re-applying a game interface in a different use context.

The authors anticipate potential problems in adding an interface similar to a computer game into an office or learning environment, especially that of encouraging 'extra curricular' activities in the virtual world. One solution is removal of game play aspects from the

Nexus, while allowing specific rooms /buildings, or linking portals, in which normal game rules apply.
The application of the Nexus to an educational setting is also currently under development. Maps created of the authors' university campus are being utilised in conjunction with distance-education courses to explore interactions in collaborative educational projects. Initial data reveal that the familiarity of local environs in the virtual world does shape the type of interactions and behaviour that people undertake. Familiarity with the social rules and norms of the original physical environ helps to construct rules of engagement amongst the users involved. Further analysis of these issues will be undertaken in future usability analysis of the Nexus.

8. Future Work

While considerable implementation was involved in the initial prototype of the Nexus, there are still several areas, which could benefit from additions and improvements. These include: Drag and drop FTPr - The client is dynamically linked to the recipient via the avatar and file transfer will be more intuitive. Facial deformation for talking avatars - reducing reliance upon the speaker icon above avatar's heads to indicate speech, while increasing the realism. Improvement of the radar - this will more accurately represent users and their positions within the system.

By implementing these improvements, a more intuitive system, which further addresses the interactions of a physical workplace, can be developed. In order to substantiate these adaptations, a thorough usability analysis is necessary. This will assist in establishing the beneficial elements, and the relevance of the interaction between tools and users in a synchronous manner.

9. Conclusion

The Nexus provides an opportunity to improve the quality of virtual collaboration with new interactive systems. Through utilisation of the Half-Life engine, qualitative display, connectivity and familiarity can be increased to aid virtual interaction. The integration of services, such as merging of file transfer into avatar collaboration, enables virtual workplace efficiency to be improved, by mimicking the interaction of a physical workplace. This not only produces an intuitive system, but one which potentially can interface seamlessly with the physical work environment and provide mixed reality interactions. This new usable hybrid system produced through the adaptation of tangential technologies presents the potential of new interactive systems in the future.

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