

THE POTENTIAL OF SECOND LIFE AS A PLATFORM FOR VIRTUAL WORLD RESEARCH IN BUILT ENVIRONMENT

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The advances in Internet and Web technologies enabled the development of virtual worlds such as Second Life. Second Life allows participants, called residents to interact with each other through motional avatars, providing an advanced level of a social network service combined with general aspects of a metaverse. Second Life is being used as a platform for education by colleges and universities. Many companies are exploring the way to improve communication and collaboration with their customers through Second Life. Architectural firms are also exploring the use of Second Life to enhance their real-world business. Second Life provides scripting and modelling capabilities for developing content and applications, however integration with external databases and applications is required if more advanced applications are to be supported. This paper introduces Second Life and then investigates its potential in the built environment. It then demonstrates how a whole life cycle costing application can be implemented using Second Life.

KEYWORDS: architecture, building design, second life, virtual world

INTRODUCTION

The advances in Internet and the World Wide Web enabled the rise of online computer games and the dominance of networked computers for information transfer and communication. These have enabled a new media form, the virtual worlds. Virtual worlds are similar to the computer games with which they share technology and terminology, virtual worlds take their participants to new places beyond the physical and geographic limitations of the real world (Ondrejka, 2008). Yet virtual worlds go far beyond games in their leveraging of social connections and learning principles (Livingstone and Kemp, 2006).

Salen and Zimmerman define a “game” as “a system in which players engage in an artificial conflict, defined by rules, that results in a quantifiable outcome (Juul, 2003). Virtual worlds are something different. While still massively multiplayer, meaning that thousands of players simultaneously experience the world in a shared space, they possess neither strong fictions nor leveling. Instead, their defining characteristic is the ability of residents to generate creations of value within a shared, simulated, 3D space. Strong, predefined fictions are not appropriate, as they limit the design space available to the residents. Instead, residents create their own fictions and communities, imbuing them with meaning through interaction (Ondrejka, 2008).

Within the possibility space afforded by virtual worlds, residents become engines of creation themselves, working as the producers of content in the world, designing and reshaping the space around their own ideas and interests (Wired Travel Guide, 2006). The emergence of

virtual world applications such as Second Life and ActiveWorlds provides potential for supporting learning communities in new ways. Virtual world applications clearly have the potential to support communications between learners, to support problem-based learning opportunity and to support exploratory learning experiences (Saunders, 2007). Virtual world applications, like immersive serious games applications, offer the capacity for using three-dimensional spaces as new learning spaces (de Freitas, 2008). This can support seminar activities, streaming lectures, create cyber campuses and help to support distributed and remotely located learner groups. This may add value to existing educational provision, as well as extending new provision of learning.

Real life architectural firms are also starting to explore the use of Second Life to enhance their real-world business. It is especially appealing for architects looking for feedback on buildings long before construction begins. For example, Crescendo Design showed how it uses its virtual land in Second Life to build virtual models of its design concepts and redesigns the virtual site so that it is similar to the actual site. It then lets clients access this virtual model in Second Life and spend as much time in it as they want, get a sense of the design, and provide their feedback. It conducts meetings in virtual "real time" where both the architect and client meet in the form of their respective avatars at the virtual site and tour it together. It also uses its virtual studio as an educational model which describes the value of several green design features. (Khemlani, 2007)

However, there are number of limitations with Second Life in terms of programming and modelling. This paper first introduces Second Life and then investigates the potential of Second Life in the built environment discipline, with applications in architecture and building design. It then demonstrates how a whole life cycle costing application can be implemented using Second Life as a platform.

SECOND LIFE

Second Life is an Internet-based virtual world launched in 2003, developed by Linden Lab (Second Life, 2008). A downloadable client program called the Second Life Viewer enables its users, called "residents", to interact with each other through motional avatars, providing an advanced level of a social network service combined with general aspects of a metaverse (Wikipedia, 2008). Residents can explore, meet other residents, socialise, participate in individual and group activities, create and trade items (virtual property) and services from one another. Second Life has its own virtual currency, Linden Dollar, which is exchangeable for US Dollars in a marketplace consisting of residents, Linden Lab and real life companies. In all, more than 8.9 million accounts have been registered in the virtual world. (Wikipedia, 2008)

The 3D modelling tool of Second Life allows any Resident with the right skills to build virtual objects: buildings, landscape, vehicles, furniture, and machines to use, trade, or sell. This is a primary source of activity in the economy. Outside Second Life, Residents can use various graphics, animation, and sound tools to create more elaborate objects, and upload them into the world. One of the distinguishing characteristics of Second Life is that the Residents create and own most of the content of the world (Wikipedia, 2008).

Second Life also includes a scripting language called Linden Scripting Language, or LSL. LSL is used to add autonomous behaviour to many of the objects in Second Life, such as

doors that open when approached (Wikipedia, 2008). LSL has been used to create relatively advanced systems, such as the artificial life experiment on the island of Svarga, where a complete ecology runs autonomously (including clouds, rain, sunshine, bees, birds, trees and flowers) (Svarga, 2006). Geometric primitives, called prims can be created and manipulated for different purposes by modifying their size and texture. Every item in the Second Life universe is referred to as an asset. Figure 1 shows the Second Life interface with object and script editors. More complex objects can be created linking different prims together. Second Life also allows collaborative design and creation of content where same objects can be simultaneously designed with several other residents.



Figure 1: Second Life Interface with Object and Script Editors

Second Life is being used as a platform for education by major colleges and universities. One example of how Second Life is being used is the use of Teen Second Life (for use by teenagers only) by the Open University. The students from the National Association for Gifted and Talented Youth (NAGTY) are taking lessons in virtual classrooms. The pilot developed under Schome, is a project aimed at developing new education systems in both real and virtual worlds (Schome, 2008). Imperial College, London and the National Physical Laboratory have developed Second Health, a 3D vision that provides a vision of health of the future (Second Health, 2008). Another example is SciLands, the science and technology region of Second Life. The region includes many highlights including the International Spaceflight Museum and Nanotechnology Island.

Within Second Life, the Arch is dedicated to exploring the convergence of virtual architecture with real-world architectural practice. It also describes other examples of classic works being recreated in Second Life, such as Palladio's Villa Venete. If all the architectural masterpieces are recreated online, it will be experienced in a far more interactive manner than photographs or videos alone (Khemlani, 2007). However, there are still limitations in the current form of Second Life. One of the biggest problems is that there is no easy way to

transfer building models created in real world practice into the virtual world of Second Life. The building in Second Life has to be created using its internal modelling system. This could be a huge barrier for construction industry to enter this powerful and exciting virtual world. There are attempts by researchers to develop tools to bridge this gap, but it is still at very early stage. It would be terrific if the vendors of modelling tools used in AEC can work with the creators of virtual worlds like Second Life to ensure that building models created in professional practice can be seamlessly published in the virtual world, complete with all details and textures. When that happens, Second Life can really take off in construction industry (Khemlani, 2007).

The next section outlines the potential of using Second Life in architecture and building design. It briefs some of the application areas that can be further researched with the use of Second Life.

SECOND LIFE FOR ARCHITECTURE AND BUILDING DESIGN

Architectural Design and Collaboration

Currently, architectural design uses commercial CAD systems for visualisation and collaboration through exchanging data file or sharing a common database. The virtual world, such as Second Life has the advantage of allowing users to be immersed in the development environment as well as facilitating real-time walkthroughs and collaboration. DesignWorld (2006) take advantage of virtual world to maintain different views of a single design in order to support multidisciplinary collaboration. Second Life also has an internal modelling system, which enable user to manipulate geometric shapes to form more complex objects. It is possible to interface with external data or building model with its internal modelling system. This creates possibilities to the integration of the AEC building model in Second Life. This paper demonstrates an example how the second life model can interact with external database.

User-Centred Design Evaluation

Typically, user design evaluation can be done through post occupancy evaluation, or in a virtual reality environment. The Second Life presents an opportunity to accommodate both requirements. Building can be built in the virtual world, which provides similar immersive virtual reality user experience. Furthermore, the advantage of virtual world provides environment that facilitate creating online experiments that can automatically recruit potentially thousands of research subjects, over a short period of time, and at low cost (Bainbridge, 2007). The Second life design evaluation can take advantage of this feature to attract large number of virtual world residents. Experiments such as accessibility analysis, fire evacuation can be conducted. The challenges will be how to organise and motivate the second life residents to participate the evaluation without comprising the integrity of the research and lack of technology to capture real time user feedback during the evaluation in second life.

Urban Planning and Design

Second Life presents opportunities to city planners, urban designers or members of the community to use virtual worlds to describe, discuss and even co-create design concepts. The second life shows how multiple contributors can work together simultaneously on an architectural design concept. Wikitecture (2008) is exploring Second Life for such collaborative design. Its central aim is to explore that question by applying an open-source paradigm to the design and production of architecture and urban planning. In much the same way Wikipedia enables a loose, self-organizing network of contributors to collaborate on content creation, they have been experimenting with ways to bring together a diverse and geographically dispersed community of individuals to create an architecturally noteworthy design that, in the end, is more than the sum of its parts.

User behavioural modelling and simulation

The Second Life can also be used to conduct experiments to capture user behaviour information in a built environment, such as way finding, evacuation, accessibility analysis, etc, to refine and improve simulation environment. Simulation environments are often based on the game Artificial Intelligence (AI) which refers to techniques used in computer and video games to produce the illusion of intelligence in the behaviour of Non-Player Characters (NPCs) (Diller, et al, 2004). The process of producing the intelligence in the behaviour is often referred as behaviour modelling (Nareyek, 2004).

The techniques used typically draw upon existing methods from the academic field of artificial intelligence (AI). Techniques such as navigation, decision making, sensory mechanisms, and learning will be deployed. The key requirement of developing of intelligent behaviour in games and simulation systems is able to describe and specify the desired behaviour accurately for programmers to implement them. However, constructing explicit behavioural or cognitive models can be very challenging and time consuming. Technologies such as AI Implant from Engnunity Technology, Kynapse from Kynogone Technology, have been developed in the game industry to simplify the process. The behaviours defined for the virtual characters in simulation environment are usually translated from the domain experts. The Second Life presents good opportunities to capture and validate the behaviour information with virtual world residents because the virtual character in Second Life is controlled by real human and their behavioural information is probably the closest to the actual human behaviour. Once the behaviours have been validated, the behavioural models can be applied any simulation environment to make simulation more realistic. However, it is important to be aware that the behaviour information in virtual world may not be fully representative for real world. Therefore, the methodology to capture the information has to be carefully designed and real life experts have to be consulted.

Architecture design education

In addition to being an alternate design and presentation medium for architects, Second Life can also emerge as a useful educational tool. In San Francisco, Architecture professor uses second life to teach collaboration, and students develop their design in the virtual world (Wong, 2007). At the Montana State University School of Architecture, students are using Second Life's group creation platform, and they can work in the same interface to manipulate geometric shapes and link them to make a variety of structures. It was found that it is a good tool for showing students how building parts fit together (Kieran, 2007).

The next section demonstrates the second life as a design evaluation platform with an example of integrating external applications with second life.

SECOND LIFE AS A DESIGN EVALUATION PLATFORM – A PRELIMINARY STUDY

While Second Life provides the Linden Scripting Language (LSL) (LSL-Portal, 2008) that allows to control object and avatar behaviour and provide the basis for incorporating additional functionality to the Second Life environment, integration with external databases and applications is required if more advanced applications, such as user behavioural modelling mentioned above, are to be supported. We have used the example of a Whole Life Costing application that we have developed in the past to examine the degree in which integration with external applications can be achieved.

Integrating External Applications with Second Life

The Whole Life Costing application consists of a ‘Resource Database’ that stores unit based historical performance and cost data of building components and a CAD based application that retrieves these data to calculate the whole life costs of building components based on the components’ physical properties (Bakis et al. 2003). We have ported the CAD application to Second Life allowing users (avatars) to select a component of a Second Life building (e.g. an external wall), see the available types for this component defined in the Resource Database (e.g. brick wall, stone wall, etc), see the whole life costs for each type calculated based on the component’s physical properties retrieved from Second Life (e.g. wall dimensions), specify the type of each component, and see the whole life costs for the whole building once the type of each component has been specified (figure 2). The following paragraphs highlight the main issues in achieving this integration.

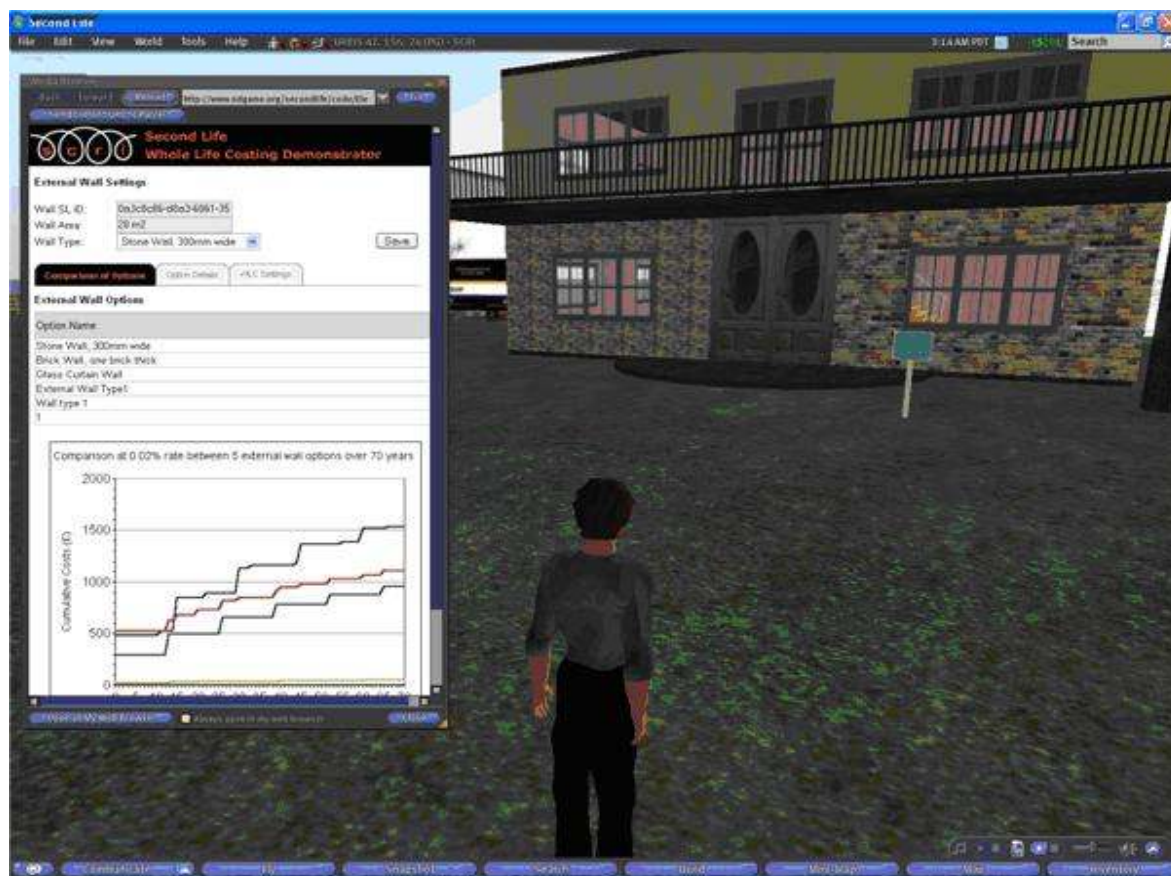


Figure 2: Integrating a Whole Life Costing application to Second Life

A number of mechanisms allow LSL scripts to communicate with users and other LSL scripts in Second Life as well as external applications running on computers outside Second Life, as Table 1 illustrates. The main mechanisms that can be used for communicating with external applications are Email, HTTP and XML-RPC. HTTP has been used for sending messages (requests) to the Whole Life Costing application (via a .NET interface). XML-RPC has been used for receiving data from the application. The XML-RPC.NET library has been used in creating the XML-RPC messages (XML-RPC, 2008).

Table 1: Communication mechanisms in Second Life

	Script Delay	Object owner	Other users	Other objects	Scripts in the same object	Send to computers outside SL	Receive from outside SL	Comment
Chat: Whisper, Say, Shout	No	Yes	Yes	Yes	No	No	No	Must be within chat distance to be able to receive.
lIOwnerSay	No	Yes	No	No	No	No	No	Owner must be in the same sim
lIDialog Create	Yes	Yes	Yes	No	No	No	No	Only the directed user can receive and

								they must be in the sim
IIDialog Response	No	Yes	Yes	Yes	No	No	No	Receiver must be within chat distance of where the dialog box was created
Instant Messages	Yes	Yes	Yes	No	No	No	No	
Link Messages	No	No	No	No	Yes	No	No	Only scripts contained within a given linked object may receive
Email	Yes	No	No	Yes	Yes	Yes	Yes	Link messages are better for intra-object communication
XML-RPC	No	No	No	No	No	No	Yes	Only connections from an external computer to SL can be initiated
HTTP	No	No	No	No	No	Yes	No	Only connections from SL to a non-Linden Lab server can be initiated

Most of the processing and user interaction is handled by the web server side (where the .NET interface to the Whole Life Costing application resides). An LSL based interface on the Second Life side handles only the communication requests and retrieves information from the Second Life environment. In a simple scenario, for example, the user (avatar) touches a building component. The LSL interface sends an HTTP request to the .NET interface on the web server indicating that the component has been touched. The dimensions of the component are passed to the server as HTTP query string arguments.

On receiving the request, the .NET interface retrieves the available component types from the Resource Database (e.g. brick wall, stone wall, etc), calculates the whole life costs for each type and creates and returns an HTML page that lists the types and allows the user to make a selection (through a drop down list). On receiving the HTTP response from the .NET interface, the Second Life client automatically launches the internal or an external web browser (depending on user preferences) that displays the HTML page (figure 2). The user can select the type of the component from there. On clicking on the 'Save' button on the web page, a message is send to the LSL interface, using XML-RPC this time, of the type of component selected. The type of component is stored in the Second Life environment for future reference.

This thin client architecture, where most of processing and user interaction is implemented on the server side, has been followed due to Second Life's limitations as a software development platform. The Second Life LSL scripting language and editor are rather basic in comparison

to standard programming languages and their integrated development environments. Scripts have to be attached to and replicated with each object (no global modules/routines can be defined) making the maintenance of complex projects difficult. Furthermore, the user interface controls provided by Second Life for handling user interaction are rather primitive. For example, there is no drop down lists or combo boxes for selecting among multiple choices. The Second Life standard dialog box may be used for displaying different options (each option represented by a button) but the number of buttons or caption size for each button is limited. User input can be only provided through the Second Life client chat line. On the other hand, the rich HTML controls available provide the opportunity for developing sophisticated user interfaces.

Regarding the HTTP based outgoing communication, the maximum body length of the HTTP messages is restricted to 2048 bytes (LSL-Portal, 2008). While there is no such restriction with the incoming XML-RPC messages, the implementation of the XML-RPC communication presents some challenges. An XML-RPC communication channel needs first to be established by an LSL script. The channel remains persistent for the life of the script and its number needs to be known by the external application sending the XML-RPC messages. However, as the communication channels are script specific and scripts are identified by the objects they are attached to, a new XML-RPC channel number needs to be added to the sending application each time the application needs to directly communicate with a Second Life object (on copying and attaching a script to another object, the script becomes a new one and a new channel is established). This is impractical as the number of objects may be large and not known in advance.

In order to overcome this problem, we have created a hidden 'listener' Second Life object that receives the XML-RPC messages and re-directs them to the appropriate objects using the communication mechanisms provided by Second Life for sending in-world messages between Second Life objects. The problem however is that these in-world messages have a limited range, i.e. they can only 'heard' by objects within 'chatting' distance (Table 1). Multiple listener objects need to be installed if a large area has to be covered.

As noted by IBM, the adoption and mainstreaming of Second Life technology depend on improving user experience, easy to use interfaces, improved graphics, better tools, open standards and more business and societal applications (IBM, 2007).

CONCLUSIONS

Second Life is not a mere 3-D multi-player online game. The immersive, rich experience that such environments offer combines many of the features of Web 2.0, such as group instant messaging, voice chat, profiles and real-time social networking, and a unique form of online social interaction that involves sharing various objects and creative collaboration on building and running places and services in the virtual world (user generated content). Second life offers great potential for creative architecture and building design, but more work is needed for a wider adoption in AEC industry.

This paper has outlined the potential of Second Life in the built environment, particularly in architecture and building design and demonstrated the integration of building whole life cycle application in Second Life. Future work includes development of application to monitor user

behaviours in the built environment and also to develop tools to bring CAD models to Second Life.

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