# 3D Modeling and Animation in a Virtual World

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## Abstract

The Second Life ® virtual world provides 3D building tools and scripting capabilities which facilitate the prototyping and presentation of engineering designs. A physics engine is also supported which provides the effects of gravity and collision detection. Within the Second Life virtual environment, engineering designs, physical models, and prototypes can be constructed, tested and evaluated in a collaborative fashion. Users from the international community can access and interact with 3D designs, as well as communicate and share experiences. As a result of the internet-based, persistent and collaborative nature, Second Life may offer advantages over traditional modeling tools. Virtual worlds, such as Second Life, have been demonstrated to be a useful educational and research tool, and will play an important role in the future.

## 1. Introduction

Second Life® is an online, virtual world platform which was first released in 2003[1]. Since that time, the number of universities, organizations, and corporations exploring Second Life has steadily grown. Currently, there are many universities (estimated at over 300) with a presence in Second Life. Typically, there are between 60,000 to 80,000 people online at any given time in Second Life and there are over a million registered users. Many organizations use Second Life for online meetings and collaboration, presentations and conferences, training, distance education, and fund-raising and social awareness. In addition to educational entities, corporations such as IBM [2] and organizations such as NASA [3] and NOAA [4] have an active presence in Second Life. Each user logged into Second Life assumes the appearance of a customized avatar which can navigate throughout the 3D virtual world, communicate with other avatars and also access online media and resources within the virtual platform.

The Second Life virtual world provides 3D building tools and scripting capabilities which facilitate the prototyping and presentation of engineering designs and models. Scaling, translation, rotation and shaping tools enable residents of this virtual world to create a variety of objects including automobiles, motorcycles, ships, buildings, furniture, bridges, amusement parks, etc. A native scripting language provides the ability to animate and transform objects programmatically and also permits the interaction of objects with avatars and the environment. A physics engine is supported which provides the effects of gravity, friction and collision detection. Due to the immersive and socially interactive capacity of Second Life, designs and prototypes may be constructed, tested and evaluated in a collaborative fashion, unlike many traditional modeling tools. Designs constructed in this virtual environment are of a persistent nature and can be viewed and accessed by avatars controlled by people throughout the world via the internet, thus providing the potential to interact with an international community. In addition to other educational successes, undergraduate students at Penn State Abington have been utilizing Second Life for several years and have successfully constructed a variety of projects (including furniture, robots, etc.) and virtual exhibits.

Several case studies which demonstrate the successful application of Second Life in the area of design and modeling will be presented below, including several educational projects at Penn State Abington. The basic building and scripting tools provided in Second Life will also be outlined, and the advantages of virtual prototyping and the future of virtual worlds will be discussed.

## 2. Virtual Design Case Studies

In the following section, several examples and case studies of the successful application of design in Second Life will be presented. One of the unique features of a virtual world platform is the ability to design 3D structures which encourage a high degree of navigation, interaction, collaboration and exploration.

### 2.1 Memorial University Virtual Shipyard Project

Students at Memorial University in Canada designed and built a realistic shipyard facility in Second Life [5]. This innovative approach was facilitated by the Distance Education and Learning Technology (DELT) services of the university. The engineering course title was “Marine Production and Management” and the students were able to collaborate on-line in Second Life to achieve the desired layout and design of a realistic shipyard, as shown in figures 1 to 4 below. One of the apparent advantages of using Second Life for this project was the ability to construct a 3D model which is on a larger scale and which allows avatars to navigate through the virtual build. This improves the spatial understanding of the relationships among the various components and systems in the layout of the entire shipyard. The team reported an improvement in student performance using the Second Life tool. This virtual educational experience was the recipient of a national award for innovation at the Canadian Network for Innovation in Education in 2009.

**Figure 1: Shipyard Exhibit**

**Figure 2: Shipyard Exhibit with avatar**

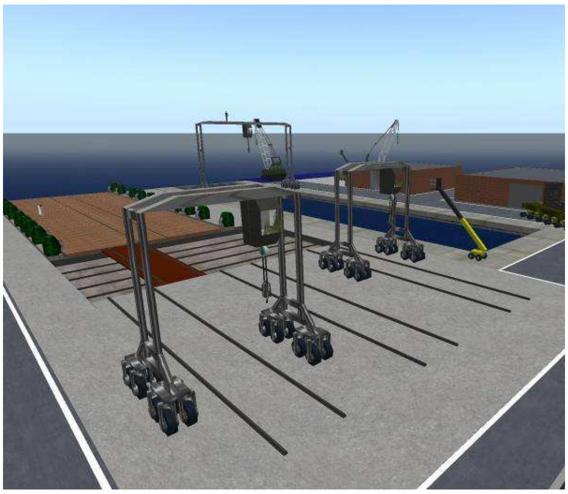

**Figure 3: Shipyard Exhibit**


**Figure 4: Material Yard at Shipyard Exhibit**

## 2.2 Frank Lloyd Wright Virtual Museum

The Frank Lloyd Wright virtual museum in Second Life hosts several 3D recreations of famous buildings designed by the famous architect Frank Lloyd Wright (1867 – 1959). In addition to 3D rendering of buildings, there is a photo gallery and links to information about the architect and his work [6]. The advantage of a virtual exhibit is that users can explore and navigate though the models of the homes, collaborate with other avatars on-line, and access this persistent site at any time during the day from anywhere in the world. Several images of a model of the well-known Fallingwater structure (physically located in Bear Run, PA) are shown below in figures 5 – 8. As can be observed, the models are embedded in a realistic landscape that reflects the architect's emphasis on the relationship between structures and the natural surroundings. Figure 7 depicts an avatar (this author) navigating the stairs in the Fallingwater 3D model. The ability to move throughout the structure and to interact with the structure enhances the immersive experience and has instructional and educational benefits. A user in Second Life also has full control of the camera view and the user can translate, pan, tilt, and zoom the view independent of the avatar position. This build also contains a few animated, scripted features such as doors which open and close when activated by any avatar visiting the site.

The 3D architectural replications accessible in the virtual world are not designed to necessarily replace the experience of visiting these exhibits in real life, but they can supplement a real-world experience or stimulate further interest or research. Moreover, it is also potentially possible to extend or modify or improve upon these designs in the virtual world, and this type of modification and experimentation would not be possible or feasible in the real world. These features, in conjunction with the ability to design collaboratively, and on an international level, make virtual worlds attractive to educators and researchers. The choice of these approaches would depend on the education and research objectives.

**Figure 5: Fallingwater exhibit welcome sign**

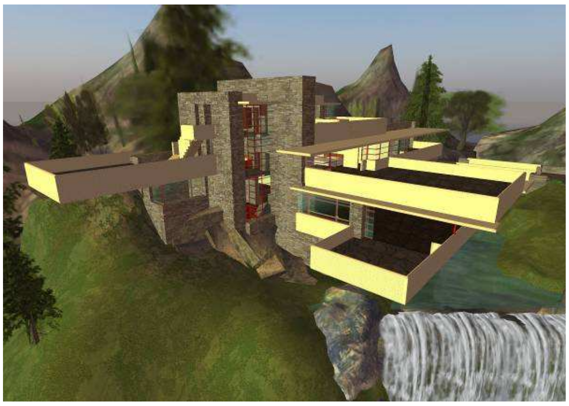
**Figure 6: Fallingwater model**

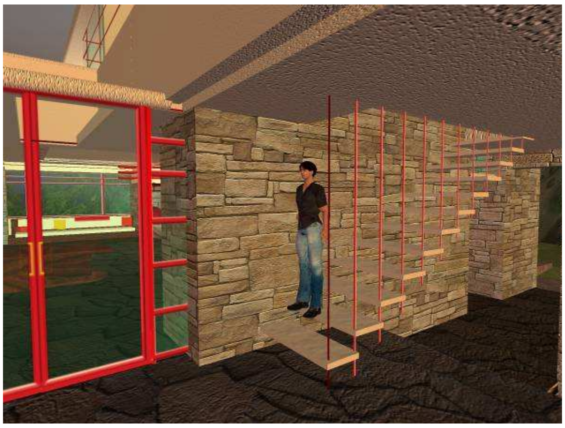
**Figure 7: Avatar inside Fallingwater structure**

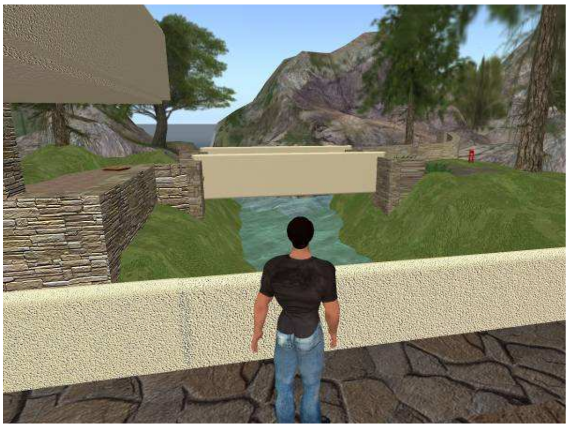
**Figure 8: Avatar at Fallingwater**

## 2.3 Penn State Abington Virtual Projects

Freshman students in an information sciences and technology course at Penn State Abington have used Second Life over the past few years to explore the value of virtual worlds and take advantage of the prototyping, networking, collaborative and international capabilities of Second Life. The course objective is to examine the role of a variety of digital technologies and their impact on society. The course, offered each fall semester, is an elective for honors students of any major and typically there are 15 students in the course. Second Life is used as a tool in this course to expose the students to the capabilities of virtual world technology. Teams of students have participated in the 3D design of virtual objects such as furniture and vehicles, and have participated in online virtual tours of such organizations as Sun Microsystems, Amnesty International, and Thomas Jefferson University Occupational Therapy Lab, all in Second Life [7]. Additionally, these virtual tours were led by real-life professionals connected to the organizations, who operated their avatars from varied locations throughout the USA. Students have explored various aspects of Second Life and have participated in a virtual poster session exhibit of their results, all hosted in Second Life at the Penn State virtual space. Educators and professionals from around the globe were invited to attend the virtual fair and interact with students. The ability to exhibit and communicate student work and research results to an international community is a strong argument in favor of virtual world technology for education. Undergraduate students in engineering have also been engaged in projects to construct mobile robots, scripts, and demonstrations for a variety of coursework. A picture of Penn State Abington students along with their virtual exhibit, which explored endangered animal awareness in Second Life, is shown below in figure 9.


**Figure 9: Student Exhibit at Virtual Poster Fair**

As can be seen from the above examples, virtual world technology can be used in a very creative and diverse manner to achieve many goals. Virtual worlds offer the ability to model existing real-life 3D structures and also offer the ability to prototype and create objects not possible in real-life, as well as to share experiences with a community of on-line users.

## 3. Building and Animation Tools in Second Life

The entire virtual environment and landscape is designed by the residents of Second Life. Houses, offices, cars, boats, art galleries, malls, jewelry, works of art, museums, towns, villages, college campuses, road systems, railroads, furniture, media players, classrooms, etc., are created by residents using tools provided by the virtual world software. Some of these items are sold to other avatars for a nominal fee, and others are created for personal use, or are made freely available to the community. This section will provide a brief overview of some of the key building and scripting tools which makes the design of realistic models and interactivity possible.

The basic building block in Second Life is a “prim” (primitive) which can be a cube, sphere, tube, torus, ring, cylinder, or prism. Prims can be rotated, stretched, cut, twisted, and manipulated in many ways. These primitives can be linked together to form more complex structures. Textures (examples include brick, stone, asphalt, wood, wallpaper) can be applied to the objects to give them a realistic appearance. Textures (including PowerPoint slides or any JPEG image) can be uploaded from the client machine into Second Life to be applied to objects. The building tools are built into the Second Life environment and every avatar can engage in building if they are in an area or venue which permits the creation of objects. The figure below (figure 10) shows an avatar under user control who has created a 3D box. On the left panel in the figure below the user may alter some of the object features including setting the object to be either physical or non-physical. Physical objects respond to gravity and other forces, and consequently, place a heavier computational load on the Second Life simulation. As an example, the models of the home and shipyard described above were composed of non-physical prims, but robots and vehicles that move in the virtual environment would generally be set to be physical, depending on the application. Students have generally mastered basic Second Life building skills within a couple of hours and were able to successfully design objects such as furniture and basic vehicles. The 3D building skills are introduced to students, who work in a computer lab, through short demonstrations.

All objects created by users are persistent in the virtual world and can be viewed by other avatars. Collaborative building in Second Life is also supported. Permissions and attributes can be set on virtual objects to restrict or permit editing access for other residents in Second Life. There is no cost in creating objects in Second Life, but in general, it is necessary to purchase virtual land in order to provide a permanent venue for objects and structures which are created by users. Also, the total number of prims that can be used in any given area is dependent of the size of the parcel of virtual land purchased. However, even with these restrictions, the building tools in Second Life have been utilized to create some very successful venues.

**Figure 10: Building in Second Life**

In order to bring motion and interactivity to objects in Second Life, it is necessary to use scripts written in the Linden Scripting Language. These scripts are placed into the virtual objects themselves and can result in many forms of animation and motion. A simple script might result in a door or window opening and closing when activated by an avatar. A more complicated set of scripts might be used to animate a variety of rides in a virtual amusement park. Vehicles such as cars, motorcycles, boats, airships and rockets are all controlled by some form of scripting. Scripts also can control communication, teleporting of avatars, and the exchange of currency for purchasing items in the virtual world or making a donation to a charity.

The scripting language in Second Life is based on a finite state machine model. Each state generally contains event listeners which respond to avatar and environment events such as clicking or collisions. Based on these events, the software may execute functions which might result in the motion of objects, change of object color, the playing of a sound clip, numerical calculations, etc. The language offers a rich set of functions and event handlers, and the syntax of the scripting language resembles C++ and Java. Data types such as integer, float, strings, vectors, lists, quaternions (rotations) are supported. Scripts can be created, modified, compiled, and tested directly in the virtual world without any special tools. An example of a short script is shown below.

```
default     // every script has a state called "default"
{
   touch_start(integer total_number)   // event handler
   {
      llSay(0, "An avatar clicked on me!!!.");     // display message every time object is  touched
   }
}
```

The script above results in the display of a message in the public chat channel every time the object (which contains the script) is clicked by the operator of an avatar. Every script contains the "default" state, and other states can be defined. The "touch_start()" function is an example of a predefined event handler. The function "llSay()" is also a library function which is used to display text in the chat window of the virtual world. Although a full treatment of scripting is beyond the scope of this paper, the author has found the following resources to be useful for scripting in Second Life [8, 9, 10].

## 4. Summary and Conclusions

Second Life has been shown to be a useful tool for prototyping and sharing 3D models for educational or research applications. Several case studies have been described as well as an overview of an educational application. A rich set of building and scripting tools are available to the user in Second Life. Key features include support for collaborative design, low cost, access to a rich set of existing content and resources, and access to an international community. This virtual world tool may offer advantages over other design tools depending on your educational and research objectives. It is hoped that the overview of building and scripting capabilities in Second Life will be a useful resource for educators and researchers evaluating the role of virtual world technology.

## 5. References


1. Second Life website: http://www.secondlife.com
2. NASA CoLab Second Life website: http://colab.arc.nasa.gov/virtual
3. NOAA Second Life website: http://www.esrl.noaa.gov/gsd/outreach/secondlife.html
4. IBM Virtual World website: http://www.ibm.com/virtualworlds/innovationinvirtualworld.shtml
5. Memorial University: http://today.mun.ca/news.php?news_id=4643
6. Frank Lloyd Wright Virtual Museum, http://franklloydwrightvirtualmuseum.ning.com/
7. Avanzato, R.L., "Second Life 3D Virtual World in a Freshman Information Sciences and Technology Course," Proceedings of 2008 ASEE Annual Conference, Pittsburgh, PA, June 2008.
8. Second Life wiki: http://wiki.secondlife.com/wiki/Help:Getting_started_with_LSL
9. Heaton, Jeff, Introduction to Linden Scripting Language for Second Life, Heaton Research, 2007.
10. Moore, Dana, et al, Scripting Your World, Wiley, 2008.