

**GNG 1103 - Engineering Design**

**Deliverable K: User Manual**

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## **Abstract**

DevelopU has created a VR BIM viewing solution which allows EllisDon's construction team in the field to easily view multidisciplinary Building Information Model (BIM) in Virtual or Augmented Reality (VR/AR) on a mobile device. This increases productivity since there is less information lost in the transition and interpretation between 3D and 2D models of the building. This allows for less people to work on buildings over a much shorter time period. Our team produced a solution to this problem using the software development platform Unity 2019.4.12f1. In its current form, our solution allows the user to view a pre-loaded BIM and traverse it via User Interface buttons and mouse movement. We have not yet built a working application for mobile devices but our solution has the potential to be used in Google Cardboard VR goggles or simply held and used as a lens for viewing the BIM in 3D.

## Table of Contents

Abstract.....	II
Table of Contents.....	III
List of Figures.....	IV
1. Introduction.....	1
2. Main Body.....	1
2.1 Overview of DevelopU Solution.....	1
2.2. Creating Our Main Menu Scene in Unity 2019.4.12f1.....	3
2.3. Creating Our BIM Model Navigation Tools in Unity 2019.4.12f1.....	5
2.4. Future Improvements.....	7
3. Conclusion.....	8
4. References.....	8

## List of Figures

**Figure 1.** Overall view of DevelopU’s Main Menu

Scene.....2

**Figure 2.** Snapshot of the permanent user interface with the key tools for navigating BIM

models.....3

**Figure 3. A)** Built-in UI elements in Unity 2019.4.12f1. **B)** The hierarchy of UI elements in

DevelopU’s Main Menu scene. **C)** Demonstration of the function of the buttons.....4

**Figure 4.** Closer look at the screens in the Main Menu scene.....5

**Figure 5.** Commands executed when “View Uploaded Model” button is

clicked.....6

**Figure 6.** Toggle for the architectural

system.....6

**Figure 7.** The movement scripts attached to the player camera.....7

**Figure 8.** Toggle of the movement scripts to enable or disable them.....7

## **1. Introduction**

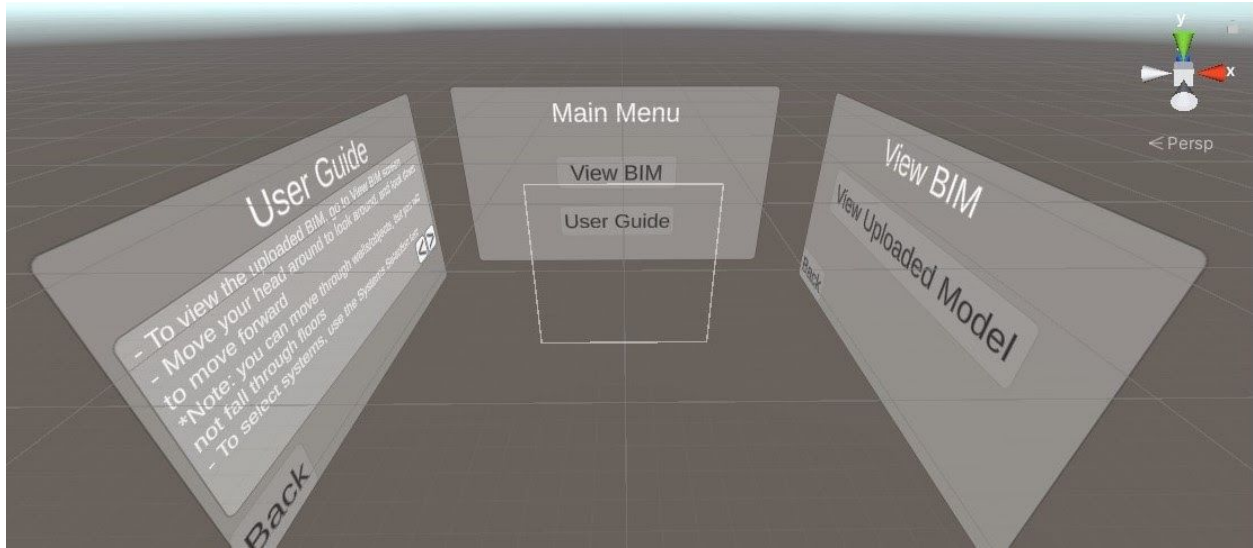
The goal of this deliverable is to create a user guide for our Final Prototype of DevelopU's VR BIM Viewing Solution. This project was designed for EllisDon to view BIMs anywhere, to help on-site construction, and to teach employees. We intend to discuss the overview of our solution, the details of our features, how we created the prototype in Unity, as well as future improvements that could be made. We hope this document will help anyone wanting to reproduce or further develop our product.

## **2. Main Body**

### **2.1. Overview of DevelopU Solution**

As of now, one would have to use Unity in order to access our prototype and test its functionality as we haven't successfully built an application yet. When starting the program, the first feature to greet the user is our Main Menu. An overall view of the menu contents in the Scene is shown in Figure 1. The first screen gives the options of viewing a BIM model or reading the user instructions explaining how to use our products' functions. After selecting the User Guide button, the user's view will be directed to the instruction screen. These instructions are meant to help someone use our product properly.

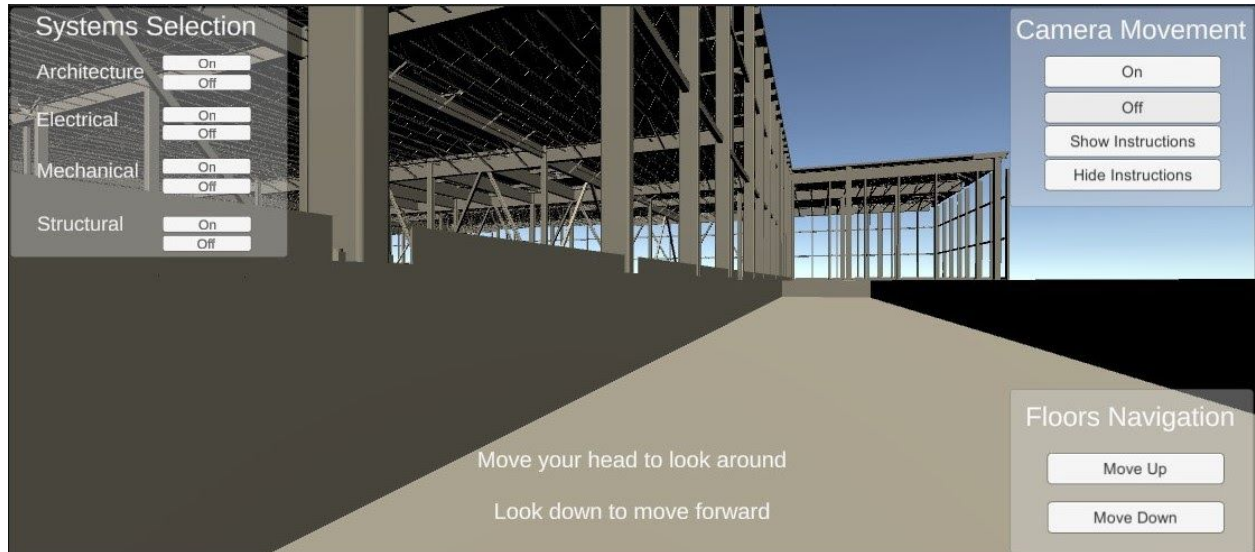
If they choose the View BIM button they will be directed to the View BIM screen where they can choose to view the uploaded model of the STEM building at uOttawa. In the future there could be another button for uploading custom BIMs. Moreover, there is a back button on each screen to let the user go to the previous menu screen. Currently, these buttons are selected with a mouse or trackpad but once uploaded to a mobile application they would either be selected by touching the screen or, in the case of VR goggles, you could implement a method of button selection activated by focusing on it for a specific period of time.



**Figure 1.** Overall view of DevelopU’s Main Menu Scene. The Main Camera is centred at the origin of the scene facing the Main Menu. View BIM and User Guide screens are at 90° on either side of the camera.

Once the user chooses to view the uploaded BIM they will be entered into a scene that includes the STEM model as well as a comprehensive User Interface. The UI includes functionalities such as the ability to select which disciplines are visible, to show or hide UI instructions, to freeze the camera in place, and to move up or down floors. Like most BIMs, the different disciplines architectural, electrical, mechanical, and structural are already separated by the designer and can be viewed independently when using typical BIM viewing software. Our prototype is able to access this functionality with the UI buttons and allow the user to choose which ones are visible while viewing the model in VR. In addition to the comprehensive instructions included in the main menu of our prototype, we have also included some basic instructions about user movement on the scene. These can be toggled on or off with the buttons on the top right of the screen, as shown in Figure 2. Another important feature of our project is the ability to navigate between floors at the touch of a button. This feature is explained in more detail later on but each button essentially changes the position of the camera up or down a certain height. The final feature of the User Interface is the buttons that enable or disable camera movement. We decided that we wanted to accommodate Google Cardboard VR goggles for our solution, so we made the camera move forward when the user looks below a certain critical angle. The camera movement button stops this movement and lets the user look down if they want without moving around. In

our current prototype, the STEM model is uploaded as an asset into the BIM scene. In future prototypes the user should be able to add to and remove models from the application without having to upload or delete them using Unity.

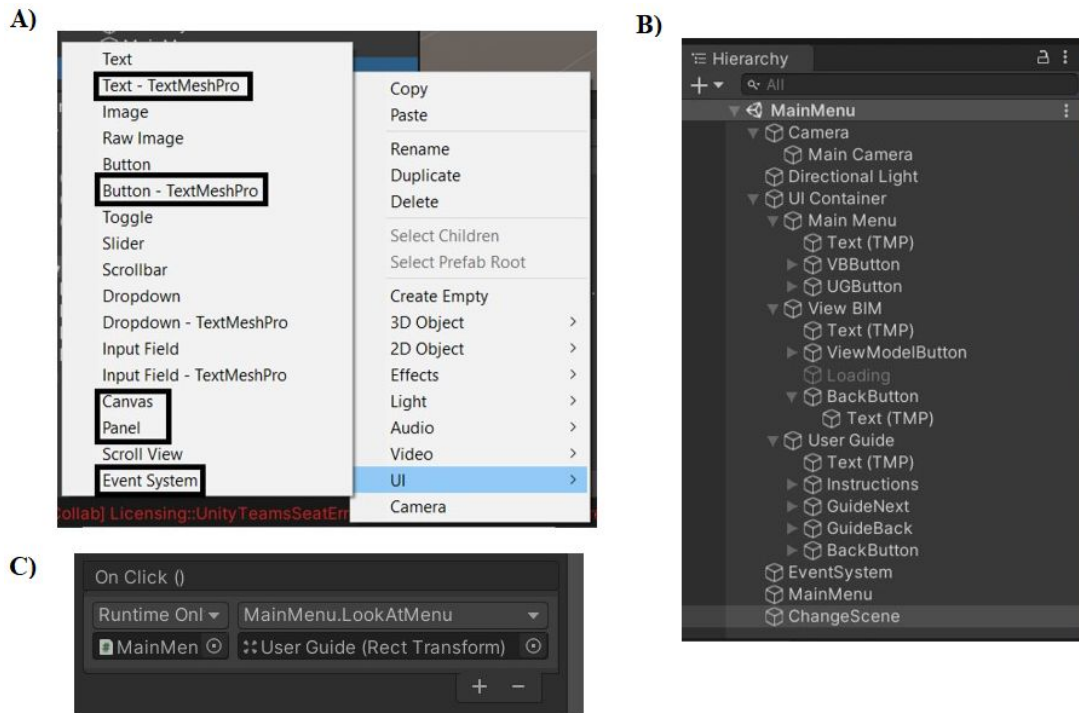


**Figure 2.** Snapshot of the permanent user interface with the key tools for navigating BIM models. The top left panel allows the user to view any desired combination of systems. The top right panel enables the user to turn on or off the camera movement, and to show or hide instructions. The bottom right corner allows the user to move up or down floors.

## 2.2. Creating Our Main Menu Scene in Unity 2019.4.12f1

The scenes in our prototype are made up of several built-in UI elements in Unity, including Texts - TextMeshPro, Buttons - TextMeshPro, Canvases, and Panels, as shown in Figure 3A. The user sees the surroundings through a Main Camera centred at the origin of the scene, and facing the Main Menu screen. As depicted in Figure 1, The User Guide screen is located 90° to the left of the camera, while the View BIM screen is located 90° to the right of the camera. All the three screens are children of an empty Game Object which we call UI Container. Each screen is a panel, which we make a parent of text boxes and interactive buttons that allow the user to easily move around the main menu. The hierarchy of objects involved in our Main Menu scene are shown in Figure 3B. For instance, the Main Menu screen contains a text box, called Text (TMP), that stores the title of the screen. It also contains two buttons for either viewing the BIM model (we call it VBButton), or going to the user guide (we call it UGButton). The buttons in

this screen are linked to a script called MainMenu, which upon being clicked, rotates the Main Camera so that it is looking in the desired direction. The script was adapted from a Youtube video [1] and is available in the Assets folder on our Makerrepo page [2]. A demonstration of this functionality is illustrated in Figure 3C. All the other buttons that shift from one screen to another in this scene do so in the same manner.



**Figure 3.** A) Built-in UI elements in Unity 2019.4.12f1. B) The hierarchy of UI elements in DevelopU’s Main Menu scene. C) Demonstration of the function of UGButton, the button that, once clicked, shifts the Main Camera from the Main Menu screen to the User Guide screen. All similar buttons work in the same way.

The other two screens in the scene are structured similarly, and include a Back Button to go back to the main menu. The User Guide screen has a smaller panel inside it. This panel contains two text boxes which resemble two pages of in-depth instructions, and the user can navigate through them using the arrow buttons, whose function is the same as the buttons for systems selection in the next section. Moreover, the View BIM screen has a button with a script called ChangeScene (see our Assets folder on Makerrepo [2]) which takes the user to the pre-uploaded model. In this



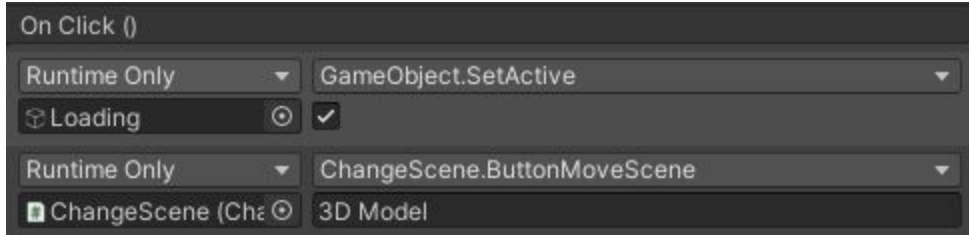
case, we had uploaded the BIM model of the STEM building at the University of Ottawa. All the screens in the Main Menu scene are shown in Figure 4.



**Figure 4.** Closer look at the screens in the Main Menu scene. The top left screen is the Main Menu screen. The top right screen is the View BIM screen after clicking the View Uploaded Model button. The two screens at the bottom are the two pages of in-depth instructions for the key features in DevelopU’s solution.

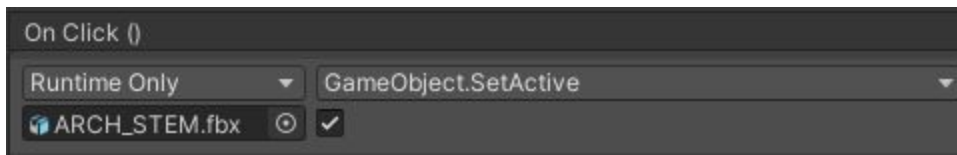
### 2.3. Creating Our BIM Model Navigation Tools in Unity 2019.4.12f1

To switch from the Main Menu to the BIM model a script named ChangeScene (see our Assets folder on Makerrepo [2]) was used. The script is binded to the “View Uploaded Model” button as seen in Figure 5, when clicked it takes the user to the 3D model scene which contains the BIM model. In addition, when the “View Uploaded Model” button is clicked the loading screen is activated.



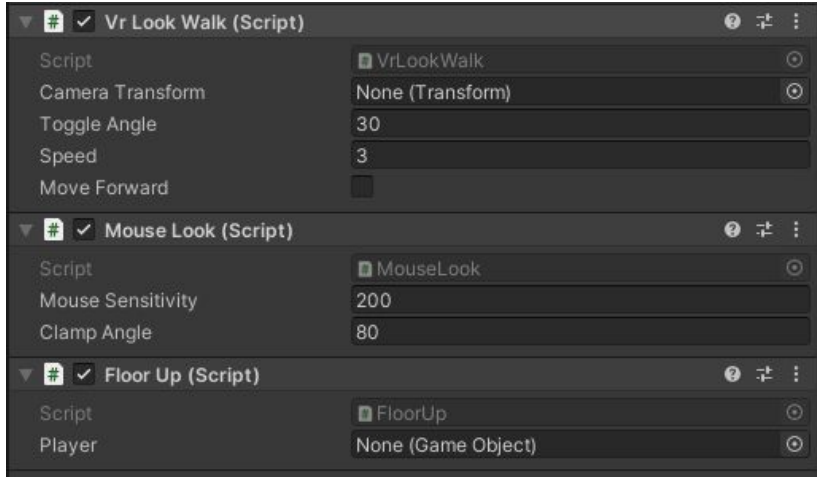
**Figure 5:** Commands executed when the “View Uploaded Model” button is clicked in the Main Menu.

Once in the BIM model the user is greeted with a UI as seen in Figure 2. The UI has a system selection, camera movement, and floor navigation. Since the BIM model included each system independently, they can be shown or hidden. The system selection buttons allows the user to either hide or present a different system as seen in Figure 6.



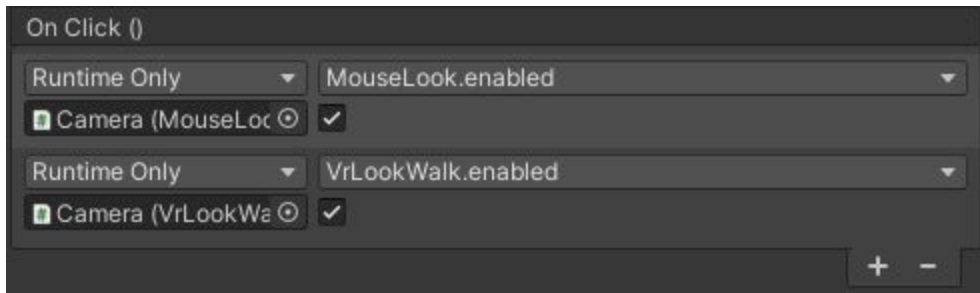
**Figure 6:** Toggle for the architectural system.

The movement of the user in the BIM model functions by the head angle of the user. The movement utilises two scripts, Vr Look Walk, and Mouse Look (see our Assets folder on Makerrepo [2]). The Vr Look Walk script allows the user to move forward when looking below a certain angle. The angle at which the toggle works best is 30 degrees below the horizontal. The Mouse Look script allows the user to look around the BIM model. To navigate between floors the Floor Up script was utilized (see our Assets folder on Makerrepo [2]). This script moves the user up or down depending on the duration they hold the button. It also allows the user to go through floors. As seen in Figure 7, the scripts were attached to the player camera to allow the user to utilize them.



**Figure 7:** The movement scripts attached to the player camera.

An option was added to turn on and off the movement of the user because it allowed the user to use the other parts of the UI more efficiently. The on and off buttons for the camera movement enable or disable the MouseLook and VrLookWalk scripts on click of the buttons, as seen in Figure 8.



**Figure 8:** Toggle of the movement scripts to enable or disable them when clicking the on and off buttons.

## 2.4. Future Improvements

There are several improvements that could be made to our final prototype. First, we could refine the existing features such that they are compatible with Google Cardboard using Android or iOS mobile phones. As a matter of fact, we had already uploaded a GoogleVR folder to our project Assets folder, but we have not had the chance to utilize it. The GoogleVR folder contains several essential features for using our application via Google Cardboard [3]. One such feature is the gaze feature, which would allow the user to interact with the scene and select buttons simply by

looking at them for a given time period. We were unable to implement this feature in our prototype due to the lack of time, but this is a realistic feature that can easily be added in the future. Moreover, we have focused in our prototype on primary key tools for viewing BIM, and did not spend much time on secondary features or aesthetics. Therefore, future improvements to our prototype also include adding nice visuals to the scenes, as well as adding supportive features such as the ability to make annotations or live measurements. Overall our prototype could have a future as either an app that uses VR goggles such as Google Cardboard or it could simply be handheld and used as a more user-friendly BIM viewing platform.

### **3. Conclusion**

In this guide, we have summarized the key features of DevelopU's solution for viewing BIM models using Google Cardboard VR goggles. Our solution's key features include a main menu scene with three screens: Main Menu, View BIM, and User Guide. There is also another scene where the BIM model is loaded, and it has a comprehensive UI panel with essential tools for navigating the model. We have briefly explained how we created our key features in Unity 2019.4.12f1, and the Assets folder of our project can be found at our MakerRepo page [2]. Finally, we made some future recommendations for those who may be interested in improving on our prototype. We recommended that the key features of the uploaded GoogleVR folder, such as the gaze feature, could be implemented easily, especially by consulting the Youtube video [3]. It would also be possible to improve the aesthetics of the prototype, and add secondary supporting features such as taking notes or live measurements.

### **4. References**

[1] N3K EN. Unity Mobile Game Tutorial. (2016). Retrieved from <https://www.youtube.com/watch?v=S1fRoRbNwSs&list=PL LH3mUGkFCWCsGUfwLMnDWdkpQuqW3xa&index=4>

[2] <https://makerepo.com/Jdudt018/gng-1103b3developu>

[3] Valen. Google VR Cardboard Tutorial - Unity 2019. (2019). Retrieved from <https://www.youtube.com/watch?v=qZzhXHqXM-g>