Deliverable D:

Conceptual Design

Team 1

Engineering Design - GNG 1103 - Section B03

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Abstract

The purpose of this report is to develop a set of conceptual designs for our problem statement based on the previous user benchmarkings, as well as analyze and evaluate these concepts and choose the concepts or combination of concepts that will best represent a solution to our problem statement.

1.0 Introduction

In this deliverable, we will be creating a set of conceptual designs based on our problem statement and our other previous deliverables. Our customer, EllisDon, has expressed their need for the modernization and digitalization of their construction methods, in order to increase production speeds and remain competitive with competitors. EllisDon has expressed that their continued use of 2D blueprints in design and building process of construction has limitations. EllisDon's current design process involves using Computer-Aided Design software that allows for a full 3D view of the entire construction site. However, the currently utilized 2D blueprints do not offer the same level of clarity and scale that a 3D model does. This leads to misunderstandings and a lower level of communication on the construction site, as well as a less efficient building process.

The implementation of Augmented Reality software, containing a 3D view of all necessary building components, would greatly benefit the efficiency of EllisDon's building process, as well as the efficiency of the company. We have received a list of requirements and preferences from EllisDon that are being implemented into our product, all of which contribute to a more efficient construction process. The requirements include the ability for our AR software to be used entirely by an employee's smartphone, being accessible on both iPhone and Android mobile phones, having a simple user interface that any employee can operate without any expertise, and a log-in system for multiple employee access.

2.0 Conceptual Design

The following conceptual designs are components to three core subsystems that every team member cultivated with their personal touch.

2.1 The Development Process

This step-by-step process was the method the group utilized to come up with their conceptual design components to the subsystems, the three global concepts, and the final design.

Step 1 - Brainstorming
Members generated as many alternatives as possible, even if they were aspects the user didn't desire or considered them too complicated or unrealistic. These possibilities were eliminated in step 2 of the process.

Step 2 - Choosing the Best Alternative
From the ideas cultivated in the brainstorming aspect, members determined the best alternative as other possibilities were eliminated. Realisticity was the core element every member strived for and as well as to ensure the concept fit the criteria of the client.

Step 3 - Prototype for Best Alternative
From knowledge attained in the laboratory sessions, it was concluded that a prototype operating on Unity with an augmented reality element would be the ideal solution. As building files have not been provided at this time, we simply described what we imagine our prototype would be like and what features it was composed of. Simple drawings or web-aided design was utilized to bring our ideas to life, visually. Inspiration was also drawn from pictures that the client showed us in the first client-meet. For instance, the process from the user's perspective on operating the application can be given (i.e. as we open the app, a menu is displayed (include images), launches a tutorial for first-time users, etc.). Additionally, features including viewing the building as if the user were physically present at the location, overlaying virtual on top of reality, the user can enable/disable multi-disciplines, add annotations, view 2D blueprints, etc. All in all, a detailed walkthrough of what the app does and is capable of is discussed.

Step 4 - Test the prototype: client feed-back
This document details the process of team members coming up with personal ideas, working together to group them into subgroups of three global concepts, and coming out with a final conceptual design. However, after developing the prototype and obtaining client feedback from our presentation from our second meeting, we can analyze the response such as his likes, dislikes, and what we can improve upon. The prototype testing is done during this step.

Step 5 - Redesign
After obtaining feedback, modifications will begin to adjust features or add new components.

2.2 Subsystem Concepts

2.2.1 User Interface

Created by Mathuraa Balasundaram

The aspects Mathuraa focused on primarily is the menu component and cloud network storage of users for the application. In specific, when the client first opens the application on their portable device the first element they will view is the language selection option between either English or French. Moving forward, the application allows the user to either 'Sign Up' or 'Log In', evidently the first option proceeds to lead the user into completing a new user application that can allow the new user to upload their data into a cloud network storage. Further, after the new user's details have been uploaded into the cloud, the next time the user accesses the application, they will have the ability to proceed with the login button.

After completing the login or sign-up process, the user will then be able to choose between the option of projecting their building design into reality with the aid of their camera, to choose a specific location to project it to (with the aid of mapping software i.e. Apple Maps, Google Maps, etc.), or to simply project it into a reality scheme of your desire. Once the user is integrated effectively into their virtual reality, they will have the tools to manipulate their surroundings. For instance, the user will be able to remain in either 3D/2D perspective to pinpoint precise details, enable/disable rotation, view multi-disciplines (electrical, mechanical, etc.), adjust lighting, and select floors.

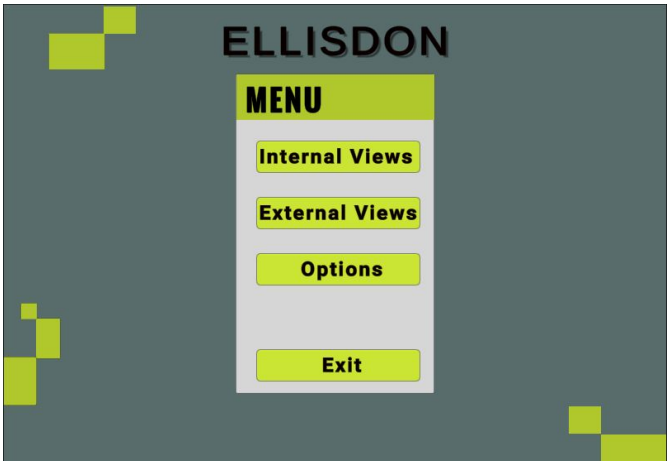

Figure 1. Concept for Main Menu - made in Unity

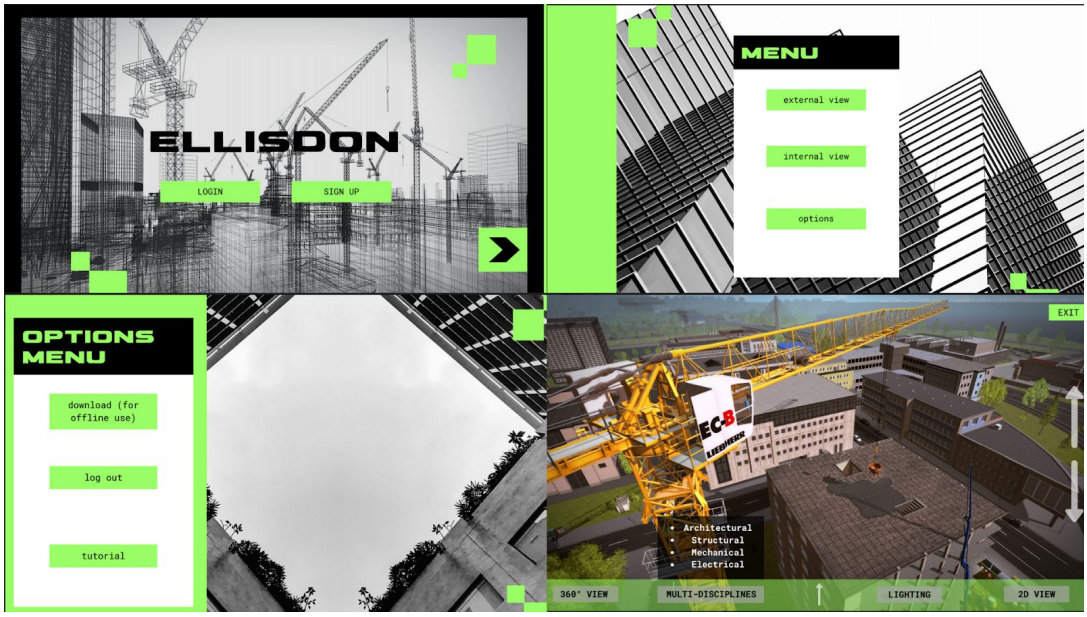

Figure 2. Concept for Application Walkthrough - made on Canva

2.2.2 Gaze Interaction

Created by Isaac Jeaurond

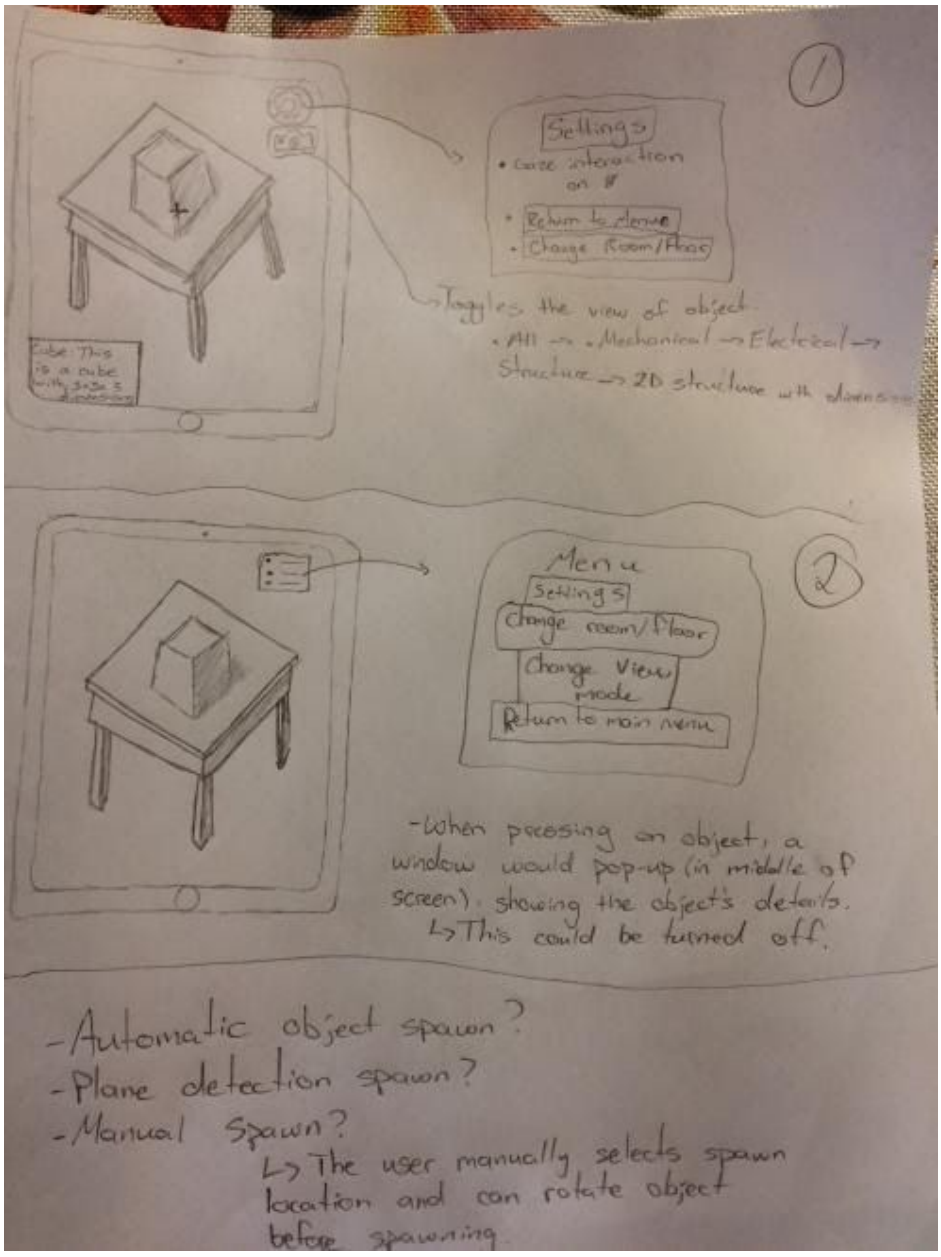

Figure 3. Gaze Interaction Draft

Concept 1: The application would have a feature called gaze interaction, which allows the user to see information about a specific object when the crosshair points towards that object. While in the application, you would see a settings icon at the top right corner, which would allow you to change certain settings such as toggle gaze interaction on or off, change the room or floor that you are currently seeing, return to the main menu, etc… At the top right corner, you would also see a camera icon, which would allow the user to cycle through different types of view such as the electrical view, mechanical, 2D, etc.

Concept 2: This concept would not include the gaze interaction feature; to see information about a specific object, the user would have to click on the object and then a window containing the information would pop up in the middle of the screen. This would eliminate the presence of the crosshair. This concept would feature one menu button on the top right corner, which would allow the user to access the settings, change the room and change the view (electrical mechanical, structural, etc...) This would eliminate the second icon on the screen (the camera icon).

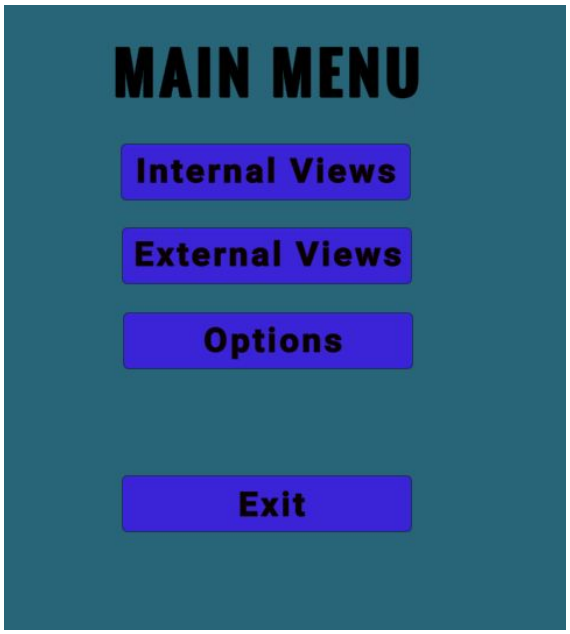

Figure 4. Concept for the Main Menu

Figure 5. Concept for Sign-In Screen

2.2.3 User Interaction & Tutorial

Created by Tesnime Zribi

What it looks like

→ As soon as user opens app, they can see the building from outside and click on it to enter
→ User gets to choose between outside view or inside view from the main menu
→ Colors reflect real-life
→ Elements are color-coded to distinguish between different items (e.g. all doors have their color, all walls of certain types have their color, etc.)
→ Each room has a separate file in the app
→ Building is divided by floors as opposed to rooms
→ User moves up or down using arrows
→ User moves up or down by sliding on screen

User interaction

→ User can only see the building
→ User can change what the building looks like
→ User can add annotations
→ User can click and learn more about the selected item (e.g. click on the window and know it's dimensions; etc.)

Tutorial

→ Tutorial is a file that the user reads
→ Tutorial is a video
→ Tutorial is interactive (when the user clicks on an item, it displays the name and a message (written or vocal) explaining what that feature does)

2.2.4 Building Components & X-ray Visuals

Created by Luke Alessio

The concept behind this feature is that the application would allow the user to select which parts of the building are visible at any given time. The 3D model of the building is made up of different components, including;

- Architecture - The outside (shell) of the building
- Structure - The supporting systems and floors of the building
- Mechanics - The mechanical systems required for the building to function, such as piping
- Electronics - The electronic systems required for the building to function, such as lighting
- Other systems or components that would be practical or necessary can be added as well

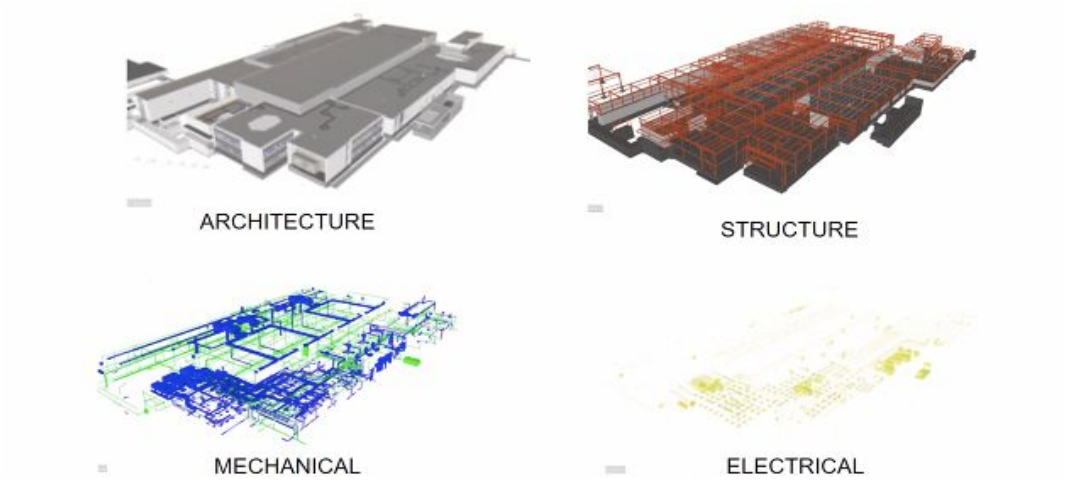

Figure 6. Example of X-ray view of different building components, provided by EllisDon

Each component can be toggled on/off using an easily-accessible menu provided in the user interface. This is useful, as it allows the worker to view only the components of the building that they need to view at any given time, and eliminate the extra clutter from their view that is not helpful. Each component can also be color-coded, in case multiple components are being viewed at the same time.

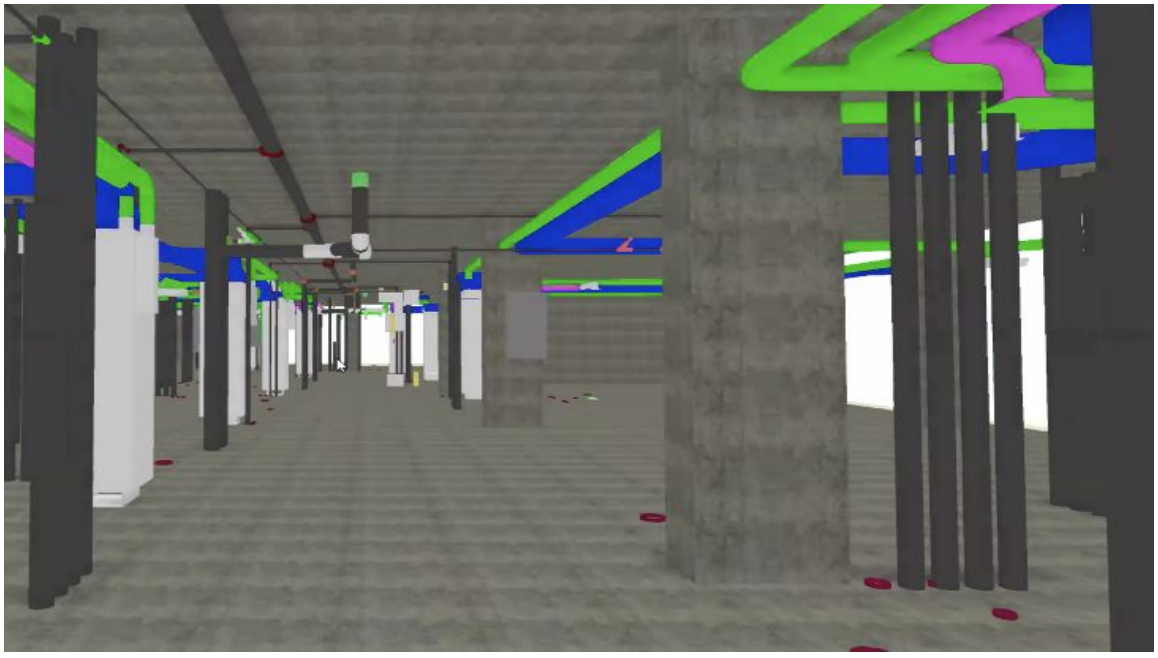

Figure 7. Example of color-coded visuals of different building components, provided by EllisDon

2.2.5 User Interface and Building Alignment

Created by Seyed Ibrahim Hosseini

How it came to be:

This design concept is attempting to maximize the resources within the Application while being as simple as possible. This concept is a mixture of features in Microsoft Office Lense and Ultimaker Cura. Firstly, the feature that could be adapted from MS-Lense is the ability to scan an area and park the parameter for later use. The feature that will be adapted from Ultimaker Cura is giving the user the ability to adjust their design relative to the parameters defined. These abilities will include rotating along 3D axis and shifting along all axis while inside the application.

Using the application:

Once the application is installed and opened, the user will see the main page where they have the option to Add Files, Continue with their previous project or change settings of the application based on their use. In the main page they will see the name of the file that is ready to be opened which will help the user identify where they left off or what they are going to look at.

Once the user has opened a document, they will have to use the scanning feature to place markers to approximate the area which documents will be projected upon. The user has the ability to skip this feature and manually adjust the projection and its orientation.

After this step, the user can walk around the project and see different angles since parameters are set. While looking at the project, there will be a button"Specs" that allows the user to read about the specifications of the document that is open.

The following is a sketch of what this concept would look like.

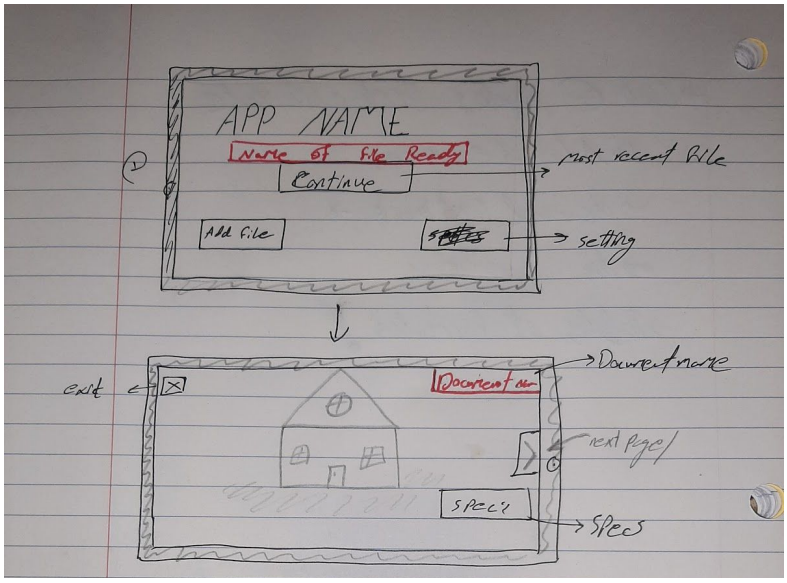

Figure 8. Seyed's Draft

Features:

- Add file: the user can choose any compatible files to open in order to view
    - Continue button:The application will remember the most recent file open so that the use will not have upload it again
    - Setting: The user can control aspects of the application.
    - Next page: the user can change designs that are multi-view
    - Specs: application allows the user to access specifications based on uploaded files

2.3 Global Concepts

2.3.1 Subsystem 1

For this subsystem, the user will open the application for the first time and will face a Log-In page where the user has the option to create an account for themselves. By creating an account, the application will create a local folder in the device where it can log the name of the files the user has opened in order so that the user can continue working on their project if they have to leave the application.
One the user creates an account, they will see the main welcome page with different options and features. In the main page, the will see three different options which would allow the user to open different files to view. The user can use the ‘Add file’ button to open a selection of files from which they can choose one to open and view. Once a file has been opened, our user can view the opened file in Augmented Reality. Another option our user has is the ability to change some aspects of the application based on their need. For example, our use can change the language of application between English and French; they can also choose different font sizes, cameras, and log-in information.

While a file is open, our design team decided that the user should be able to walk through the file that's open for maximum immersion. Before that happens, the application will ask the user to choose a reference point so that it can keep the image still while viewing the opened file via the screen. On the screen, our users will be able to see a button that will pull up the specifications of the file that is open at that moment.

2.3.2 Subsystem 2

Subsystem 2 begins with a home screen displaying the company name “EllisDon”, followed by a login screen, where the user enters their employee number and password to access the application. The login screen includes visuals of example buildings. After logging in, the user is met with the main menu of the application, where a tutorial video will play if it is the first time that the user is accessing the application.

From the main menu, the user may press one of the three buttons; an external views button, an internal views button, and an options button. If the user selects the options button, they are brought to the options menu, where they can choose to download pre-existing company files of building views (so that they are accessible while offline), as well as re-watch the tutorial or log out. If the user selects external or internal views, they are brought to a menu where they can select the building/construction site that they wish to view, and have full access to the viewing of the building, as well as the implemented features, such as gaze interaction and x-ray visuals. A small settings or menu button will remain in the top right corner of the screen, where, if pressed by the user, opens up yet another menu. From this menu, the user is able to access the settings for the features included in the application (gaze interaction, x-ray visuals), including toggling the features on/off entirely. The menu also allows the user to return to the main menu at any time.

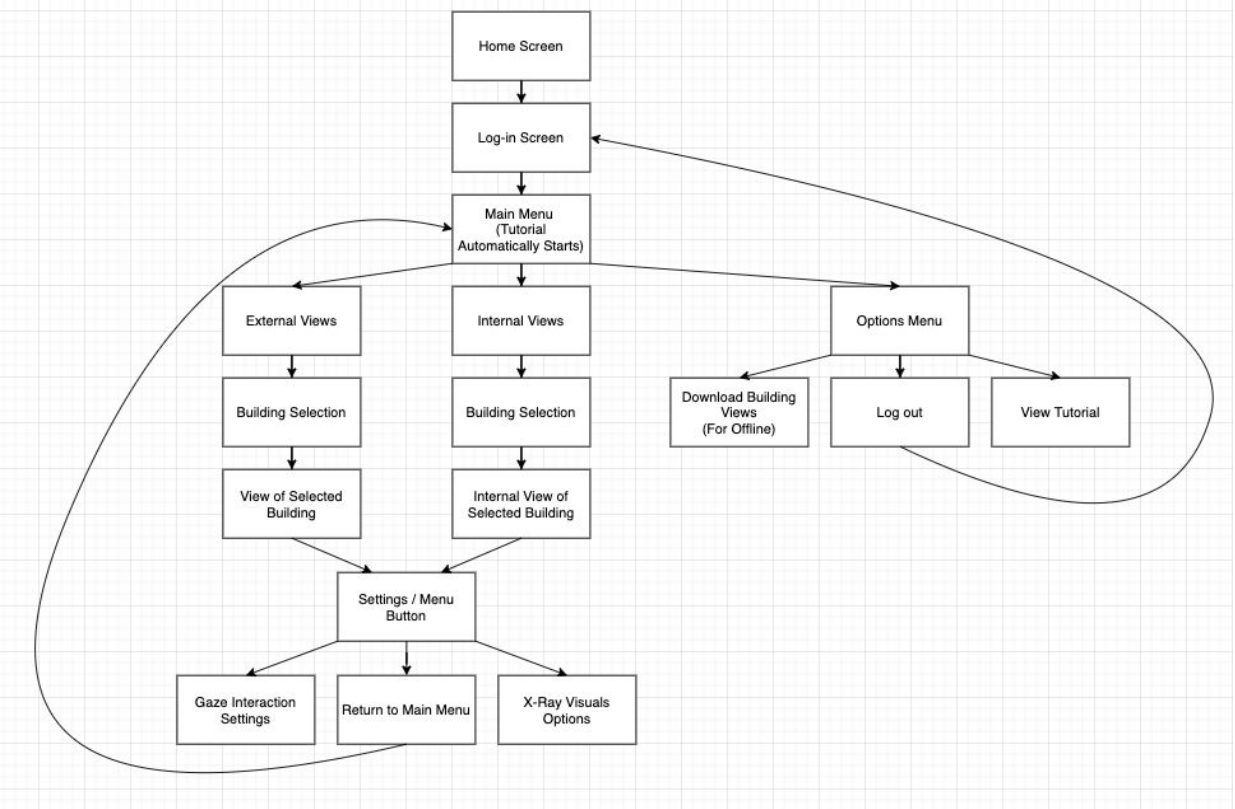

Figure 10. Flowchart for the navigation of application, based on subsystem 2

2.3.3 Subsystem 3

Similarly to global subsystem 2, subsystem 3 incorporates aspects from every member's conceptual design components to create an exceptional interface for upsurging user experience. Initially, the user is prompted to register a new user account within the application utilizing connections with other communication platforms including Google, Facebook, Microsoft, or personal/work email addresses or login if they already have an account. Afterwards, the language preferences from 2.2.1 were modified to incorporate more than the two national languages of Canada, English and French, including Spanish, German, Hindi, Tamil, Chinese, and many more. As a result of this modification, our application is broadened to a wider user audience and is accessible to a multitude of linguistic demographics.

After new user registration and language selection is completed, the user will be prompted to view the tutorial video (only in English & French) that section 2.2.3 detailed. Additionally, they will undergo a step-by-step tutorial that runs through each feature and allows the user to practice elements. This feature will have a skippable component that the user can utilize to skip through step-by-step or all at once to complete the welcome process at a quicker pace. New users will always go through this mandatory feature, to ensure they know to effectively use the app. This feature is primarily for beginner users, however, it may be accessed later in a pull down menu in settings for scenarios where the user requires a refresh on technical aspects. In detail, this aspect allows users to be able to understand all the features our application offers and to know how to use it to its full potential. Proceeding, the user will be able to begin a new project, open an existing file (if it was saved prior to the networking cloud), or to simply play around. In specific, the BIM requires the user to upload their particular files to the cloud. If the user is to

run into any additional issues there is a user help feature also implemented where they may access the F.A.Q (frequently asked questions) section and as well contact page to obtain technical support.

The user will then have access to their BIM file either from a previous design or one that was just created, then they will be prompted to be projected in a virtual reality with their BIM. The camera feature will be integrated in this aspect. Moreover, the user will be able to choose a specific location to project to (with the aid of mapping software i.e. Apple Maps, Google Maps, etc.), or to simply project it into a reality scheme of their desire. Once the user is integrated effectively into their virtual reality, they will have the tools to manipulate their surroundings. For instance, the user will be able to remain in either 3D/2D perspective to pinpoint precise details, enable/disable rotation, view multi-disciplines (electrical, mechanical, etc.), adjust lighting, and select floors.

In specific, the top right corner will contain a button users can click to open a menu that contains a sign-out feature, return to the main menu, help button, and review tutorial option. Another feature is clicking the tools button, that can aid in removing, inserting, and annotating elements within your BIM. In detail, insert will allow you to simply insert elements within a library of structures and minor components that the user has cultivated particularly for this project (i.e. bricks, doors, beams). During the insertion process, size of elements can be adjusted and as well as materials. Also safety is taken into consideration during the installation process to avoid going against the regulations of the designated location. The annotation element can be utilized to write additional notes for elements, also, hide (eye) and measurement (ruler) elements are enabled to be able to adjust those elements in more precision. In measurement, one can analyze tangential, normal, perpendicular factors as long as calculations concerning the BIM for certain 2D and 3D shapes. A critical element incorporated is the layering feature that allows one to view structural, mechanical, electrical, and architectural features the user can manipulate (an eye will be the symbol to hide one layer from the other).

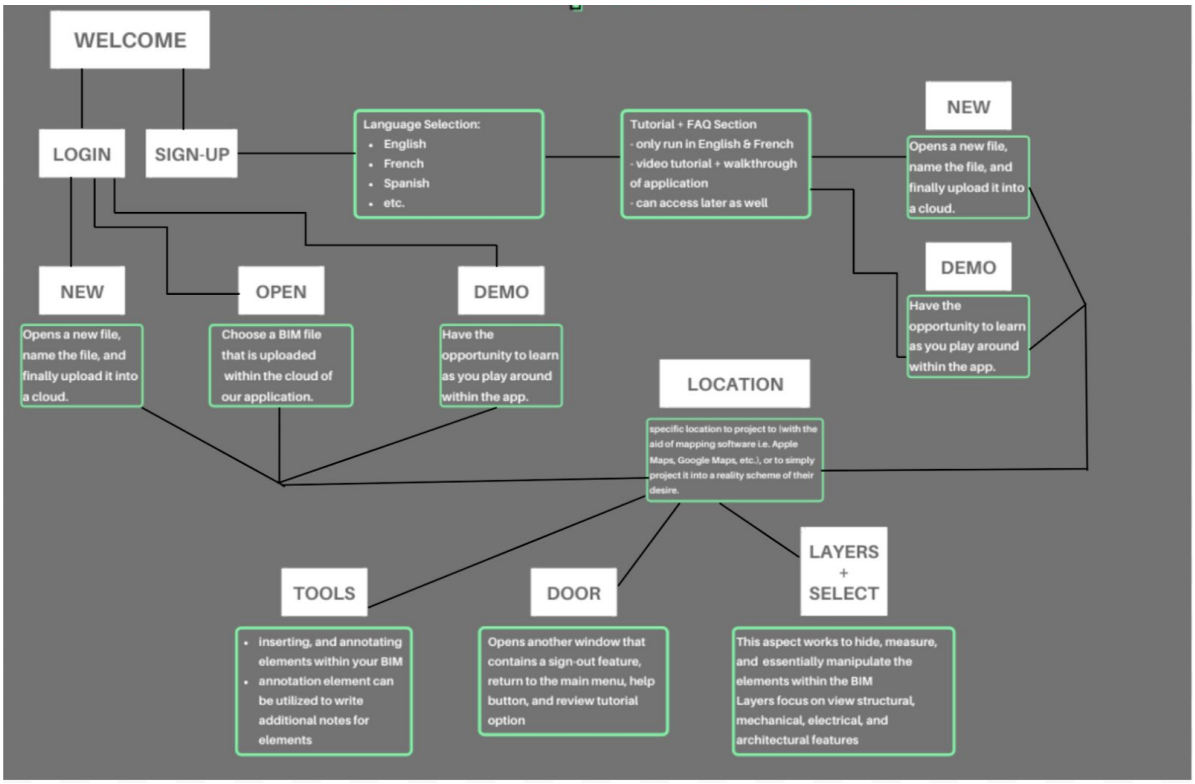

Figure 9. Flowchart for Global Concept 3

2.4 Benchmarking & Verdict

Table 1. Comparison of Global Concepts with Product Specifications - Benchmarking

Product Specification	**Importance (5 being the most important)**	**Units**	**Global Concept #1**	**Global Concept #2**	**Global Concept #3**
OS compatibility	5	1-5 (5 being compatible on all devices)	5	5	5
Usability	4	1-5 (5 being the easiest to use)	2	4	3
Cost	5	1-5 (5 being completely free)	5	5	5
User Engagement	4	1-5 (5 being the most engaging)	2	3	4
Phone-only functionality (For AR)	5	1-5 (5 being fully functional with a phone)	5	5	5
Tutorial + In-software Help	5	1-5 (5 having a fully functional tutorial and help system)	3	5	5
Aesthetics	3	1-5	2	3	3
Reliability	4	1-5	3	4	3
Offline Capability	4	1-5 (5 being fully functional offline)	4	4	4
TOTAL	**39**	**----------**	**31**	**38**	**37**

3.0 Conclusion

Application Name: Vision

In conclusion, our team first created a problem statement by identifying the most important needs for our product brought forward by EllisDon. Using our problem statement, each team member started the design process by brainstorming possible solutions to best solve the problem. Team members compartmentalized their ideas, and combined/eliminated them to create their take for a solution. After the brainstorming process, the team came to an agreement for the best course of action for the project, which was determined to be an augmented reality application running on Unity, that allows for the viewing of construction sites in 3D. The specifics of which have already been explained. In this deliverable, each team member brought forth their ideas for how their user interface could best be implemented, as well as any features that could be added into the application. Different combinations of these features and ideas were combined as subsystems, where they were compared to each other in the benchmarking process to determine the best subsystem to use as a template for our project moving forward. For the remainder of the project, it was determined that subsystem 2 would be the preferred subsystem, as it has the best combination of all desired components.