GNG1103 Report

Project Deliverable - D

Submitted by

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Abstract

This report develops a set of conceptual designs based on the previously identified and prioritized design criteria and product benchmarking. EllisDon Construction, represented by Patrick Lalonde, identified specific needs, a few of which he identified as essential to the final prototype. After refining these needs, benchmarking and identifying key aspects of the defined needs, the team came together and determined a conceptual design fulfilling the needs of the client. This development was initially started by producing new and/or modified concepts for each subsystem that address both the problem statement and all the design criteria. Based on these subsystem concepts, three fully realized and functional solutions were created by assembling the best combination of the aforementioned subsystem concepts. Functional concepts were then analyzed and compared to the original design criteria. From the analysis, the superior concepts were identified and further documented using diagrams and descriptions to outline the benefits, functionality and contingencies of each solution. Ultimately, from a combination of the superior subsystem ideas, three final solutions were identified and ranked, and a final one is chosen to pursue further prototype development.

Table of Contents

List of Tables

List of Figures

1   Introduction

This report details the generation of three unique solutions based on the identified design criteria based on interpreted client needs from the preliminary meeting on September 25th with Patrick Lalonde, the Director of Virtual Design and Construction (VDC) for Eastern Canada at EllisDon. Lalonde requires a cost effective, and user-friendly software platform that would eliminate the use of 2D drafts and carry 3D modelling straight through from Building Information Modelling (BIM) to construction, via a mobile device. Firstly, the overall software platform system was defined using a block diagram that outlined the software and user commands and further described the various subsystems requiring concept generation. In the concept generation phase, the team individually conceptualized new and/or modified concepts for each subsystem or subfunction that address the problem statement and design criteria. Following the creation of three generated solutions per subsystem, the ideas were compared, based on benchmarking and key aspects of the defined needs, to ultimately select most appropriate solution for each subsystem of the prototype. These ideal subsystem concepts were then grouped to produce three unique global solutions that were further analyzed according to their individually selected subsystems, and then streamlined into diagrams, figures and clearly worded explanations. These three conceptual designs were evaluated against one another, and the superior solution was determined to most accurately address the client's needs.

2   Conceptual Design

2.1   Definition of Subsystems

To begin, it is important to define the overall system as well as the main input and output variables, this is done in figure 2.1.1. The system will be composed of many subsystems which are further defined in figure 2.1.2.
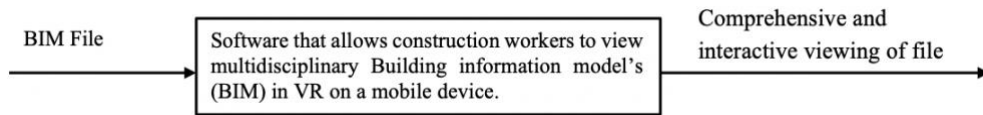
Figure 2.1.2 System Block Diagram

The main system is defined by the problem statement with an input variable of a BIM file and an output variable of a comprehensive and interactive viewing of the inputted file, to achieve this a combination of user and software commands is required. These commands are inputted into the defined subsystems with clear boundaries and functions, some subsystems require a combination of software and user commands while some require only a user command or software command. These commands and subsystems are summarized and defined in figure 2.1.2.

Figure 2.1.2 System Block Diagram with Subsystems

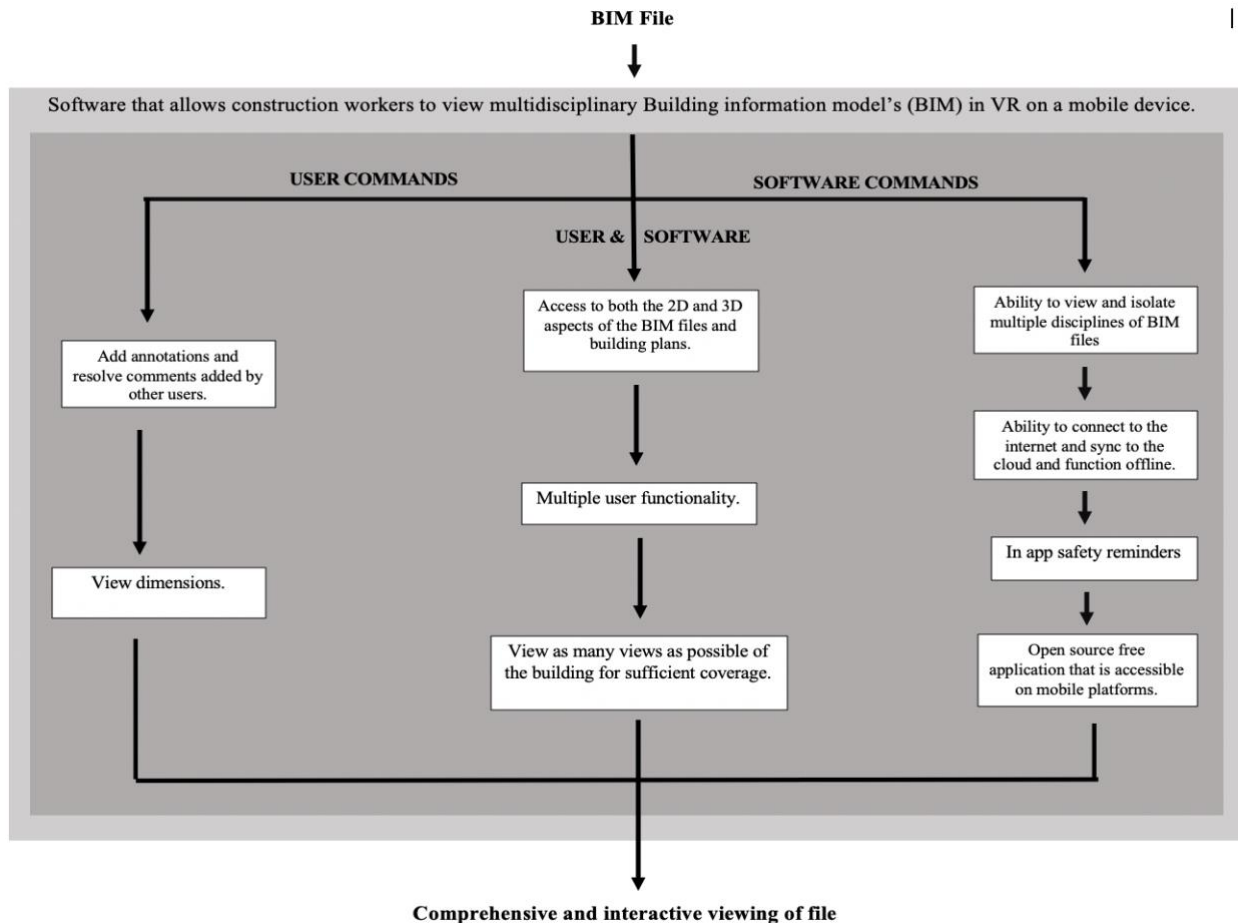**2.2 Concept Generation in Subsystems**

This section of the report further continues the process of conceptual design in subsystems defined in figure 2.1.2. Three unique solutions are generated to fulfill the functional requirement of each subsystem in table 2.2.1. Each generated solution has a respective creator, these creators are identified by their initial and defined in appendix I.

Table 2.2.1 Subsystems with Generated Solutions

Subsystem/Subfunctions	Generated Solution
Ability to view and isolate multiple disciplines of BIM files (mechanical, electrical, structural and architectural systems).	A button/switch for each respective discipline that enables them to be controlled. They can be turned "on" and "off" or have combined view (L.H)
	A sub menu that pops up allowing you to view each system of the BIM independently or overlayed. (V. J)
	Feature/button that allows user to access and isolate different disciplines of BIM files separately or combined. (M.W)
Ability to connect to the internet and sync to the cloud as well as function offline.	A notification that appears in the app asking if you would like to sync the system if there is internet available. (V. J)
	App automatically recognizes if it is in offline or online mode, when offline it will store changes which can be uploaded to the cloud once online. (B.V)
	App automatically recognizes when online, button appears to make sure user can sync to the cloud to function offline. (M.W)
In app safety reminders and warnings for any hazards on works site.	A window that appears reminding you of the safety requirements for the construction site as well as safety warning pertaining to the app. (V. J)
	A banner accompanied by a sound notification will alert the user of the site-specific safety requirements needed before allowing view (L.H).
	When someone is engaging in a task that may cause danger to others nearby, they can, with the press of a button, create a zone around them. Anyone entering this zone will be notified of the risk. (E.J)
Access to both the 2D and 3D aspects of the BIM files and building plans.	Ability to transform and view all 3D BIM files in 2D. (E.J)
	Ability to upload 2D and 3D aspects of the BIM and access them and view them separately. (V. J)

	Button that allows user to switch between 2D and 3D aspects of BIM files and building plans that also allows user to access them together. (M.W)
Add annotations and resolve comments added by other users.	Editing mode in which user will be able to add text comments for others to see. (B.V)
	Ability to place "sticky notes" on objects or sections of the design that are viewable by all users. (E.J)
	The ability to add comments in a "note-mode" that utilizes different coloured comments to indicate and differentiate comments/annotations added by other users (L.H)
View dimensions.	Ruler tool (draw a line between parts of the design to view the distance between them) (E.J)
	A button that allows the dimensions of objects to be turned "on" and "off" (L.H)
	The ability to click on an object and view its information, measurements etc. And when clicked off screen the window disappears. (V. J)
Multiple user functionality.	A connection to the cloud so multiple users can sync and view data real-time. (V. J)
	Changes are made to each user's file individually and users can push/pull changes when online. (E.J)
	Button that allows user to share files with other users, allowing for all to edit and view the data as it is changed. (M.W)
Open source free application that is accessible on common mobile platforms.	Executable (.exec) file that can be downloaded onto desktop as well as uploaded to internet to access on mobile. (B.V)
	Creating a free downloadable version of the code editable in any program capable of coding in C. (E.J)
	Using Unity and free unity applications that allow the software to be free. (V. J)
View as many views as possible of the building for sufficient coverage.	Tool bar with icons which allows views in 2D planes and 3D views to be chosen (B.V)
	Access to a "main page" that gives the various view options of the building site. This feature is always available so that the user can change views readily. (L.H)
	Navigator which allows users to freely move around construction site as if they were walking at any height. (B.V)

3   Refined Solutions

Based on the subsystem generated concepts three global system solutions are now defined and further detailed as complete solutions with figures in the following three subsections of this report.

3.1 Solution 1

For this solution as a team we have generated solutions for each subsystem/subfunction. For the user to be able to view and isolate multiple disciplines of BIM files we will create a button/switch for each respective discipline that enables control, this will also allow them to be turned "on" or "off" or have a combined view. For users to be able to access the files both online and offline a notification will show up on the app asking if they wish to sync the system when there is no internet available. A big important feature that will be added is safety reminders, a window will appear reminding the user of the different safety requirements for the construction site as well as safety warning pertaining to the app, as shown in Figure 3.1.1. Due to the importance of viewing the BIM files in both 2D and 3D we will create a button that allows users to switch between both the 2D and 3D aspects of the files and building plans, it will also function to allow both aspects to be viewed together. The app will have a toolbar with icons that allow for views in 2D planes and 3D views to be chosen. Multiple users will have access by the click of a button, see Figure 3.1.2, it will allow users to share the files and give them access to edit and view the data as it is changed. Because many users will have access to edit at the same time, we will add a function that lets one add comments in a "note-mode" that utilizes different coloured comments indicating who has added each comment. Our app will allow the user to click on an object and view its information,

measurements, etc. When they click off the window it will disappear. The app will use executable (.exec) files that can be downloaded onto desktop and uploaded online for easy mobile access.
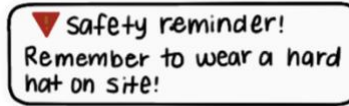

Figure 3.1.1 Example of the safety feature.

Figure 3.1.2 Example of the share feature

3.2 Solution 2

For our second solution we have gathered solutions for the subsystems/subfunctions. For the ability to view and isolate multiple disciplines we will create a sub menu that pops up allow users to view each system of the BIM independently or overlayed. It is important that the files can function both online and offline, the app will have a notification that appears asking if the user wishes to sync the system if there is internet available. When in the app it will remind the user of safety precautions and warnings for any hazards on work sites by a banner and a sound. The banner will alert the user of the site-specific safety requirements needed before allowing view. The app will allow users to transform and view all 3D BIM files in 2D. Users will have access to a "main page" giving various viewing options of the building site, the feature will always be available so they can change views readily, see Figure 3.2.1. In the app while editing users can add text comments for others to see. Dimensions will be shown with the function of a ruler tool. To use it one simply draws a line between parts of the design to view the distance between them. For multiple users to be able to access the files the app will have a button allowing for files to be shared, files

may be edited, and data will be able to be viewed as it is changed. The app will use Unity and free unity applications that allow the software to be free of charge and more accessible.

Figure 3.2.1 Example of the ruler tool function

3.3 Solution 3

For the final solution, we have again assembled many great solutions from the multiple subsystems of the design. To view the multiple disciplines, we would add a feature/button that allows users to access and isolate different disciplines of BIM files separately or together. With this control you can toggle the button repeatedly to switch between singular disciplines as well as many combinations of the layers in the BIM file. This would be much easier to program then free control over layers. This allows for us to expend more effort working on other subsystems. This app will be able to automatically recognize if it is in offline or online mode and when offline it will store changes which can be uploaded to the cloud once online. Risk management is also very well controlled. When someone is engaging in a task that may cause danger to others nearby, they can, with the press of a button, create a virtual zone around them. Anyone entering this zone will be notified of the risk on their device. To view the model in 2D or 3D the user can toggle on or off each view in a tool bar. Dimensioning is done with the help of a ruler tool. One selected the user can draw a line between objects to see the distance separating them. To avoid the confusion cause by many users interacting with the files at any given time all changes made are local and if you want to share them you can push the files and once connected to internet other users will be

able to upload your edited file. The code will be available to everyone in the form of an executable (.exec) file that can be viewed and edited by anyone. Lastly, there will be a joystick allowing the user to move around the model to view it from any direction or height without physically moving around the job site.
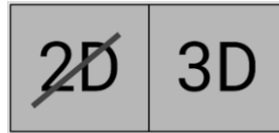

Figure 3.3.1 Example of the view tool

4   Solution Analysis

In order to ensure the chosen solution fulfills the client's needs, each solution will be analyzed against the design criteria that were formulated in previous deliverables based on the clients interpreted needs. This analysis follows in table 4.1.

Table 4.1 Solution Analysis Using Design Criteria

#	Design Criteria	Unit	Solution 1	Solution 2	Solution 3
1	Ability to view 3D Building Information Models (BIM) in Virtual Reality or Alternate Reality.	Y/N	Y	Y	Y
2	Compatible with common Mobile Devices (iOS or Android).	Y/N	Y	Y	Y
3	Viewing of BIM is available offline and cloud syncing available online.	Y/N	Y	Y	Y
4	Ability to view 3D internal systems in BIM's in VR or AR.	Y/N	Y	Y	Y
5	Navigation and interface must be user friendly.	Subjective Rating*	9	7	5

6	In app safety reminders and warnings for any hazards on works site.	Y/N	Y	Y	Y
7	Software application must be open source or free to use.	Y/N	Y	Y	Y
8	Training and implementation documentation must be provided.	Y/N	Y	Y	Y
9	Software application must be free to users.	$	0	0	0
10	At minimum be accessible in the form of a mobile application.	Y/N	Y	Y	Y

Based on the analysis in table 4.1, the three concepts will be rated on a scale of 10 based on how many criteria they fulfill, the one with the highest will be the solution we will pursue further development. This scoring is in table 4.2.

Table 4.2 Solution Scoring

Solution	Total Score
1	9.9
2	9.7
3	9.5

5   Conclusions and Recommendations for Future Work

Following the conceptual design process involving the definition of subsystems and potential solutions for these subsystems three unique global solutions that fulfilled all the defined criteria were developed and explained. Solution analysis lead to identifying that the only difference

between the solutions came down to the degree of ease of navigation and the interface experience for the user. Solution 1 was given a subjective rating of 9 in this category due to the use of toolbars and icons that will allow the user to seamlessly navigate through the application and execute whichever function they need to from a main menu. Therefore, moving forward prototyping plans and scheduling will be made using the solution defined in section 3.1.

APPENDICES

APPENDIX I – Creator Identification

       MW – Maya White

       EJ – Edwin Jazvac

       LH – Lauren Healy

       BV – Briar Vandenberg

       VJ – Victoria Jancowski