GNG 1103 – Engineering Design

Deliverable D – Conceptual Design

Team B1-05

Name	Student #
Fell, David	300186311
Galagedara, Niki	8728488
Hanna, Andro	300211677
Picard, Jacob	300207379

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Professor: Dr. Muslim Majeed

Faculty of Engineering
University of Ottawa

Abstract

A detailed report that analyzes and establishes a set of conceptual designs for the pre-determined problem statement. Previous user benchmarking, technical benchmarking, and a list of prioritized design criteria are all used to dissect and evaluate these concepts to develop an overall design that is most appropriate.

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1 Introduction

Since our meeting with clients Patrick and Kenny on September 25, 2020, we have worked meticulously to provide a design resolution to the problem at hand. They require a solution that will allow a construction team on site to easily view multidisciplinary Building Information Models in VR/AR on a mobile device. The software must be free, extremely user friendly, and easily compatible.

Through analyses of customer needs, development of prioritized design criteria, and evaluations in benchmarking, metrics, and target specifications, we have begun an effective process to develop a conceptual design.

Furthermore, with the compilation and analysis of our individual concepts, we have chosen a strong preliminary design concept that we believe to be very valuable. Additionally, we have provided a detailed description that we believe effectively justifies our selection for this critical conceptual design.

2 Summary of Completed Work Criteria

Table 1: Customer Needs

#	Need	Importance
1	Ability to view 3D Building Information Models (BIM) in VA Reality	5
2	Compatible with common Mobile Devices (IOS or Android)	5
3	Software application must be open source or free to use	5
4	Presented through VR or AR on a mobile device	5
5	Solution is based on existing free to use software or developed-in house	5
6	View insides of walls, see different electro-mechanical components	4
7	Be on forefront of technology	3
8	Navigation and interface must be user friendly	5
9	Training and implementation documentation must be provided	5
10	Easily operated by any individual regardless of technical skill level	5
11	Available online/offline	4
12	Use Google Cardboard or similar device	3
13	Display markups (dimensions, annotations, etc.)	3
14	Take obstructions into consideration	2
15	Ability to see site even when worker is not present (google maps)	2
Software Needs	**User Needs**	**Additional Needs**

Table 2: Design Criteria

Need #	Design Criteria
1	App/software interface to complete BIM
2	Compatible with IOS and Android
3	Cost-free
4	Compatible with IOS and Android
5	App/software
6	Clarity and usability of the interface
7	Compatible with IOS and Android, easy to use, free, available wherever the user is
8	Clarity and simplicity of the interface
9	User friendly, easy to use
10	Clarity and simplicity of interface
11	Available wherever the user is
12	Compatible with IOS and Android
13	Clarity of interface
14	Safety of users, app/software interface
15	Available wherever the user is

Table 3: Technical Benchmarking

Need #	Metric	Revizto	PlanGrid	FieldWire
2	Operating System	PC, IOS, Android	PC, IOS, Android	Web IOS, Android
4	Yes/No	Yes	Yes	No
7	Yes/No	Yes	Yes	Yes
10	Yes/No	Yes	Yes	Yes
11	Yes/No	Yes	Yes	Yes
13	Yes/No	No	No	No

Table 4: Advanced Benchmarking

Criteria	Revizto	PlanGrid	FieldWire
Cost	$395 / month per user	$182 / month	$137 / month per user
Clarity and simplicity of interface	-Easy to share -Synchronizing clashes -2D and 3D overlay	- Easy to share - Mark up - Sheet compares	-Easy-to-use mobile editing -Collaborate with owners and contractors easily
User friendly	- Clash detector and problem solver - Internal communication -Simplified logic search function -Object tracker	- Submittals logs - RFI - Access BIM models from everywhere -Supports all file types	-Location-based work -Real-time communication -Easy to use construction scheduling software -Offline editing
Safety of documents	-Issue Tracker function -Cloud sync and sharing	- Cloud saving - Mark up issues	-Cloud saving -Servers are held in undisclosed facilities with anti-intrusion systems
Total	11	6	9

Table 5: Target Specifications

Target Specification	Ideal and Acceptable x values
Cost	Free
Clarity and simplification	Very clear
User friendly	Extremely easy to use
Safety of documents	Completely safe
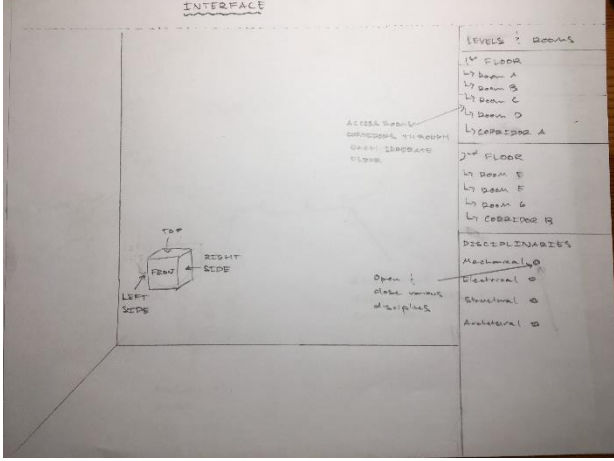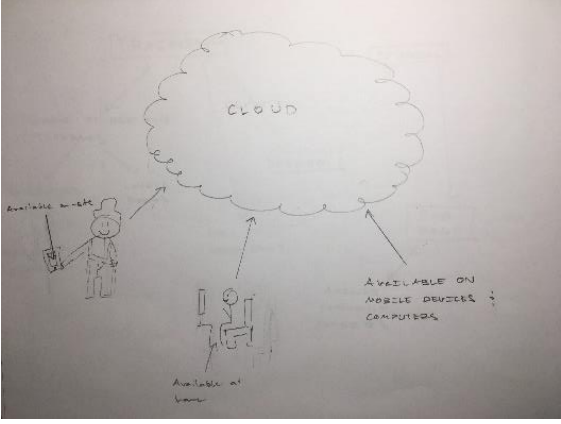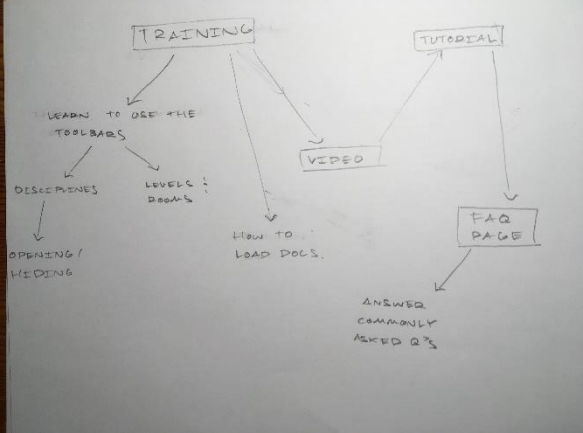
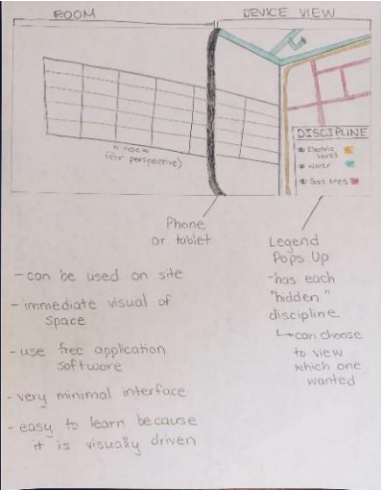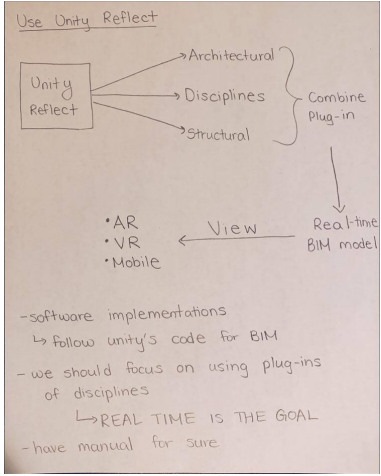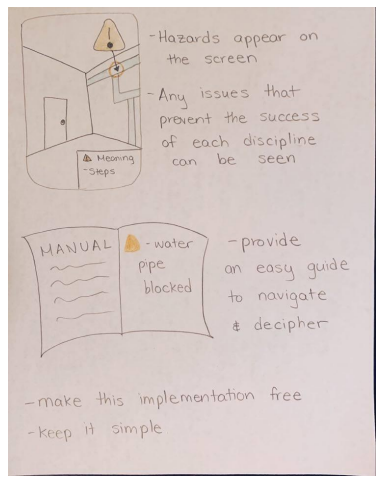| Design Specification	Relation	Value	Unit	Verification Method
Ability to view 3D Building Information Models (BIM) in Visual Augmented Reality	=	Yes	N/A	Test
Compatible with common Mobile Devices	=	Yes	N/A	Test/ Use IOS and/or Android
Software application must be open source or free to use	=	0	$	Estimate/ Final Check
Navigation and interface must be user friendly	=	Yes	N/A	Test/Evaluate User
Training and implementation documentation must be provided	=	Yes	N/A	Instructional Reports
Presented through VR or AR on a mobile device	=	Yes	N/A	Test/Evaluate Platform
Easily operated by any individual regardless of technical skill level	=	Yes	N/A	Test/Evaluate User

3 Product Concepts

3.1 Concepts by David

Table 7: Concepts by David

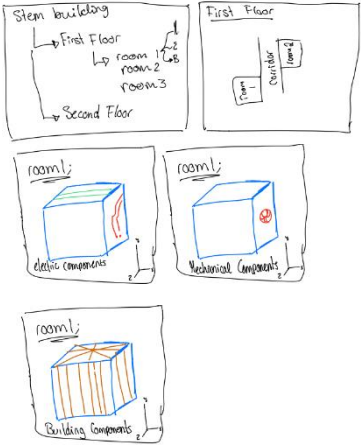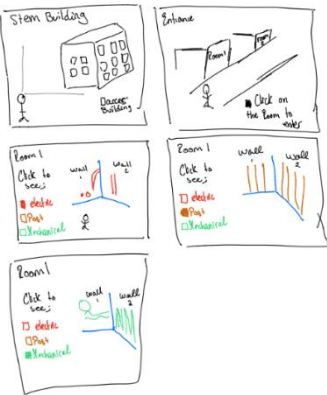|		
Concept 1	 *Figure 1: David's Concept 1*	My idea is a simple interface which is like OnShape. Here, each floor is divided into separate sections, where rooms and corridors are located. Each disciplinary can be viewed/hidden/combined.
Concept 2	 *Figure 2: David's Concept 2*	My second concept is a cloud which can be accessed by any worker; from home, on-site, etc. This would be done using an authenticator, to ensure that all documents are confidential.
Concept 3	 *Figure 3: David's Concept 3*	The last concept is a breakdown of the training section of our application. It includes a video, FAQ's page and a guided tour of an IBM design.

3.2 Concepts by Niki

Table 8: Concepts by Niki

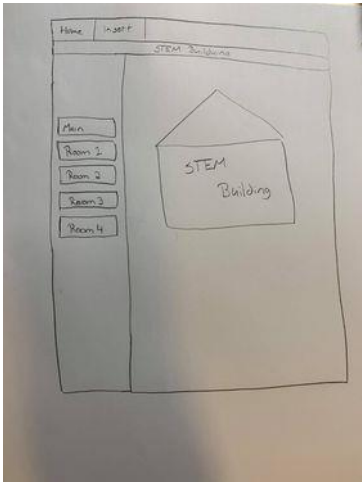|		
Concept 1	 *Figure 4: Niki's Concept 1*	My first concept is based on the actual interface that is viewed by the user on site. Provides an immediate visual, and the option to decide which disciplines are wanted to be seen. Concept is meant to be very minimal, and simple for a basis design.
Concept 2	 *Figure 5: Niki's Concept 2*	Using Unity's Reflect software, follow the general 3D software that views BIM. Coding for the software should be following this guideline to provide a simple path and solution in completing the final product.
Concept 3	 *Figure 6: Niki's Concept 3*	A concept based on the user friendliness of the software. Allows for a very simple, but straightforward manual to document and address any issues and bugs that a user may experience.
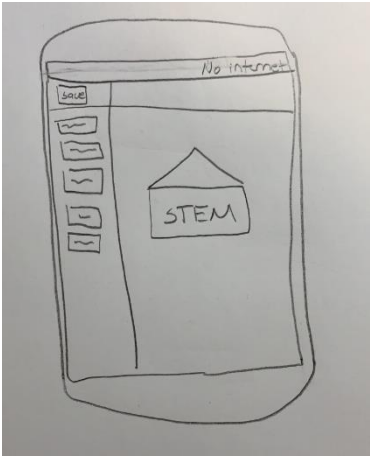
3.3 Concepts by Andro

Table 9: Concepts by Andro

Concept 1	*Figure 7: Andro's Concept 1*	In picture, we see the interface of the app which displays the different room of the building. When the user clicks on the room they wish to see, all the different disciplines will be shown at the same time and a 3D model of the room.
Concept 2	*Figure 8: Andro's Concept 2*	In this concept the person can choose the floor followed by the room and they can choose the discipline they wish to see.
Concept 3	*Figure 9: Andro's Concept 3*	In this concept, the user sees the building from the outside and click to enter the building. They can choose to navigate inside the building and choose the room they wisht to enter. After hey decide the room, they can select the discipline they want to see. They can also choose multiple disciplines at the same time.

3.2 Concepts by Jacob

Table 10: Concepts by Jacob

Concept 1	 *Figure 10: Jacob's Concept 1*	My first concept is the main home page of the software. The way I would want the home page to look is very similar to the OnShape home page. You can choose to see the whole building or separate rooms.
Concept 2	 *Figure 11: Jacob's Concept 2*	My second concept is the capability of annotating while viewing certain things. This will allow engineers to walk through a building and take notes on what works and what does not work. Also, you can attach the note to a certain thing. This allows others to know what the note is about.
Concept 3	 *Figure 12: Jacob's Concept 3*	My third concept is being able to use the app offline. I want the workers and engineers to be able to use the app while being on the job site and not having to worry about having internet connection.

4 Concept Evaluation

Table 11: Overall Decision Matrix

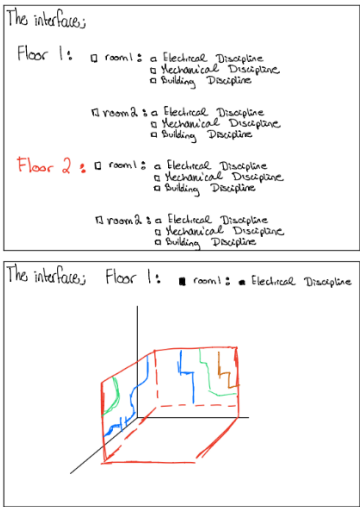| Criteria > (/5) Concepts ∨	Compatibility	Cost	Clarity & Simplicity	User Friendly	Document Safety	Total: (/25)
David - 1	3	5	5	3	N/A	16
David - 2	5	5	4	5	5	**24**
David - 3	5	5	4	5	N/A	19
Niki - 1	5	5	5	4	N/A	19
Niki - 2	5	4	1	1	N/A	11
Niki - 3	5	5	4	4	5	**23**
Andro - 1	5	5	1	2	5	18
Andro - 2	5	5	3	4	4	21
Andro - 3	5	5	4	5	4	**23**
Jacob - 1	5	5	5	5	N/A	20
Jacob - 2	5	5	3	5	N/A	18
Jacob - 3	5	5	5	5	N/A	20
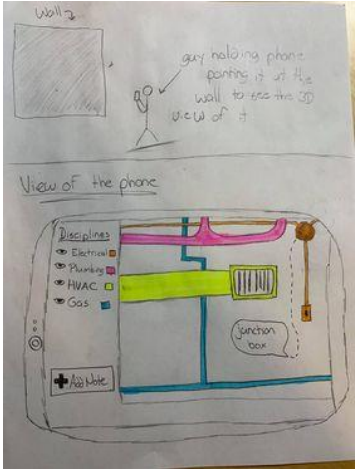
Table 12: Weighted Decision Matrix
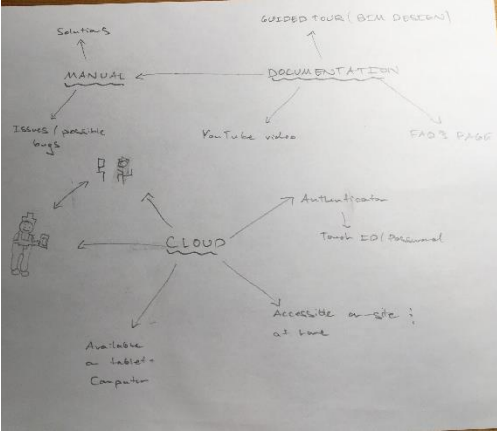
Criteria > (/100%) Concepts ∨	Compatibility (30%)	Cost (25%)	Clarity & Simplicity (15%)	User Friendly (20%)	Document Safety (10%)	Total: (/100%)
David - 1	18	25	15	12	0	70
David - 2	30	25	12	20	10	**97**
David - 3	30	25	12	20	0	87
Niki - 1	30	25	15	16	0	86
Niki - 2	30	20	3	4	0	57
Niki - 3	30	25	12	16	10	**93**
Andro - 1	30	25	3	8	10	76
Andro - 2	30	25	9	16	8	88
Andro - 3	30	25	12	20	8	**95**
Jacob - 1	30	25	15	20	0	90
Jacob - 3	30	25	9	20	0	84
Jacob - 3	30	25	15	20	0	90

5 Secondary Concepts

After analyzing each concept provided by our team, we have chosen 3 of the best performing concepts to further analyze. From Table 11 David's concept 2, Niki's concept 3 and Andro's concept 3 were ranked the highest. In Table 12, all values were considered with the appropriate criteria weights factored in. From this table, the same 3 concepts also scored the highest. Upon reviewing all ideas as a team, a decision was made that the secondary concepts will be a combination of these 3 top scoring concepts, along with some elements from the other medium scores of Tables 11 and 12.

Table 13: Secondary Concepts

Secondary Concept 1	 *Figure 13: Secondary Concept 1*	"The Interface" OnShape inspired, each floor is divided into separate sections, where rooms and corridors are located. Each disciplinary can be viewed/hidden/combined. Step by step: person can choose the floor followed by the room and they can choose the discipline they wish to see. You can choose to see the whole building or separate rooms in real time. Follow the general 3D software that views BIM – Unity.
Secondary Concept 2	 *Figure 14: Secondary Concept 2*	"The Access & Use" Capability of annotating while viewing. Allows engineers to walk through a building and take notes on what works and does not. Concept is meant to be very minimal, and simple for a basis design.

Secondary Concept 3	 *Figure 15: Secondary Concept 3*	"The Documentation" Tutorial includes a video, FAQ's page, and a guided tour of an BIM design. Provide a cloud which can be accessed by any worker. This would be done using an authenticator, to ensure that all documents are confidential. Manual to document and address any issues and bugs that a user may experience.

5.1 Secondary Concept Evaluation

Table 14: Secondary Overall Decision Matrix

Criteria > (/5) Concepts ∨	Compatibility	Cost	Clarity & Simplicity	User Friendly	Document Safety	Total: (/25)
1	5	5	4	3	N/A	**17/20**
2	5	5	5	4	N/A	**19/20**
3	5	5	5	5	5	**25**

Table 15: Secondary Weighted Decision Matrix

Criteria > (/100%) Concepts ∨	Compatibility (30%)	Cost (25%)	Clarity & Simplicity (15%)	User Friendly (20%)	Document Safety (10%)	Total: (/100%)
1	30	25	12	12	N/A	**79/90**
2	30	25	15	16	N/A	**86/90**
3	30	25	15	20	10	**100**

As our project is not a "physical product" we unanimously decided to make our secondary concepts

focused on the 3 certain areas we believe encompasses the entire project.

Table 16: Secondary Advantages & Disadvantages

Secondary Concept 1	
Advantages	**Disadvantages**
• Building around an "OnShape look" guarantees a compatible interface (for all mobile devices) • Software will be designed in Unity so will be free • Step by step process provides incredible ease of use • Allows easy visibility of all disciplines	• Even though it is step by step, there are many measures that come with each, so it can be challenging • This concept does not have a manual provided, it is just focused on the interface • Can only see room by room, in case multiple rooms are needed to be viewed
Secondary Concept 2	
Advantages	**Disadvantages**
• Capability of annotating while viewing • Allows engineers to walk through a building and take notes on what works and does not • Very minimal, and simple for a basis design • Allows you to concentrate on a certain discipline or view all disciplines at once • Uses colours to clearly distinguish the different disciplines	• Our concept does not allow user to use the app anywhere else then on the job site • The amount of information displayed on the page could be overwhelming to new users
Secondary Concept 3	
Advantages	**Disadvantages**
• Video would help the client navigate through the application • FAQ's page would be easily accessible, simple and would remove the need for a customer service system • BIM design exemplar would be especially useful for visual learners and would make a great reference point • Cloud would save all data, even if outside servers crash/ are hacked • Maintain client confidentiality • Manual is time effective for the client	• Creating a cloud can be very challenging • Using a cloud subscription can be costly

6 Group Design Concept

Following the analysis of our three secondary concepts, we have come up with one final preliminary concept incorporating all our key ideas. For the interface we based ourselves off OnShape. The user can decide to view the building as a whole or chose to view a certain room. They can also choose which disciplines they wish to see and made them so they may be viewed in real time. The use of the software is concentrated on being as practical as possible. We made it possible for the user to add a note on anything, which can then be linked to a concern. In the documentation aspect, we have implemented tools to help the user fully understand how to use the software and use it to its full potential. Furthermore, the plans will be uploaded to a cloud which can be accessed by anyone on the job site. As for security, the cloud will have an authenticator to prevent outside parties from accessing the files. We also intend to provide a troubleshooting guide to aid the user in working through problems and/or bugs that could happen.
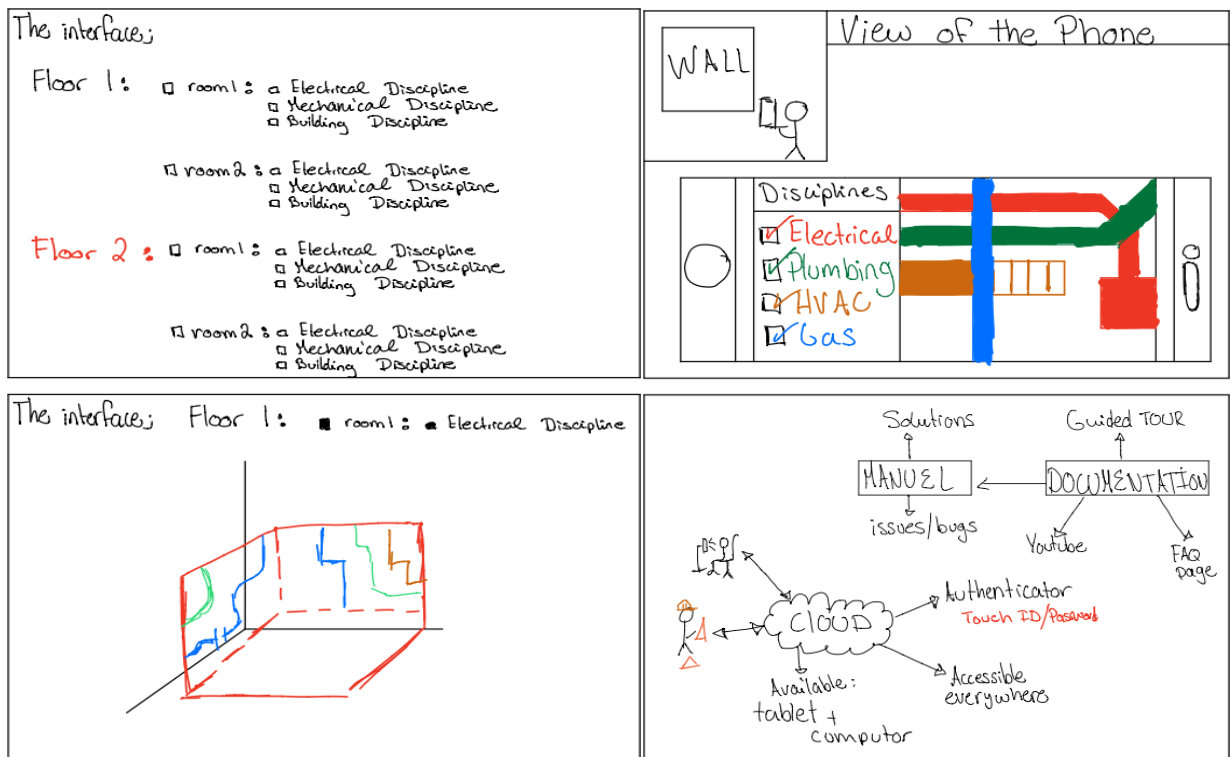

Figure 16: Conceptual Design

Table 17: Conceptual Design Advantages & Disadvantages

Design Concept	
Advantages	**Disadvantages**
- A compatible interface - Software will be free - Step by step process - Allows easy visibility of all disciplines (individually or multiple at once) - Annotate while viewing - Allows walking through a building and taking notes - Minimal, simple, distinguishable colours - Media that is easy to use to learn the software - Quick access FAQ pages and BIM design exemplars - Cloud saves all data - Manual is time effective	- Still has many steps (even if they are explained), bodes a challenge - Real-time elements cannot be accessed outside site (only files that have already been previously saved)

We have further critiqued our advantages and disadvantages pertaining to our final design concept. Each aspect of justifying our choices has been drawn from the main target specification identified. Compatibility, cost, clarity, user ease, and documentation were the main design criteria we needed to address and believe we have effectively done so.

7 Conclusion

Through our complete debriefing, analyses, and discussion found in this report, we believe we have provided a valuable design resolution for our clients Patrick and Kenny. Once established that they require a solution that allows a construction team on site to easily view multidisciplinary Building Information Models in VR/AR on a mobile device. The software must also be free, extremely user friendly, and easily compatible.

Beginning with 12 individual concepts, we were able to successfully analyse and evaluate the benefits and drawbacks of each idea to narrow down the aspects we felt would be most effective. This was done using decision matrices, advantages vs. disadvantages tables, and a constant recall to our benchmarking, target specifications, needs, and design criteria. As a group, we determined that our secondary concepts should each be a "facet of the project" to fully scrutinize each element to be used in a final design.

From there, we further examined our ideas and built a model that inhibits all the weighed alterations to determine a strong conceptual design. We continued to analyze this design to ensure that we were satisfied with it and allow ourselves to use it as a great basis, and firmly believe that we can successfully go forward with building our project.
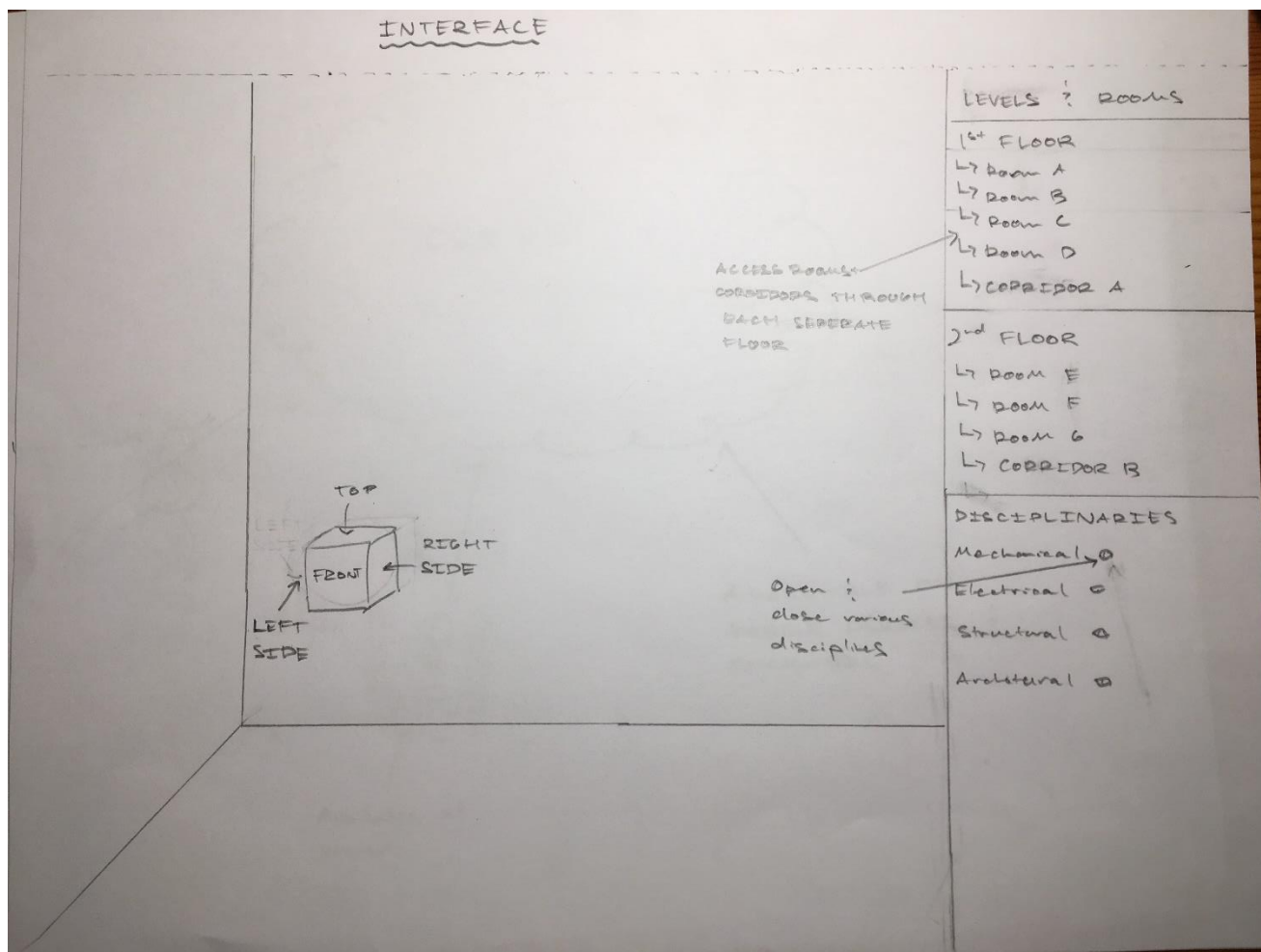
8 Appendix

INTERFACE

LEVELS ? ROOMS

1st FLOOR
- Room A
- Room B
- Room C
- Room D
- CORRIDOR A

2nd FLOOR
- ROOM E
- ROOM F
- ROOM G
- CORRIDOR B

DISCIPLINARIES

Mechanical
Electrical
Structural
Architectural

ACCESS ROOMS + CORRIDORS THROUGH EACH SEPERATE FLOOR

TOP
LEFT SIDE
FRONT
RIGHT SIDE
LEFT SIDE

Open ; close various disciplines

Figure 17: Closeup of David's Concept 1

Figure 18: Closeup of David's Concept 2
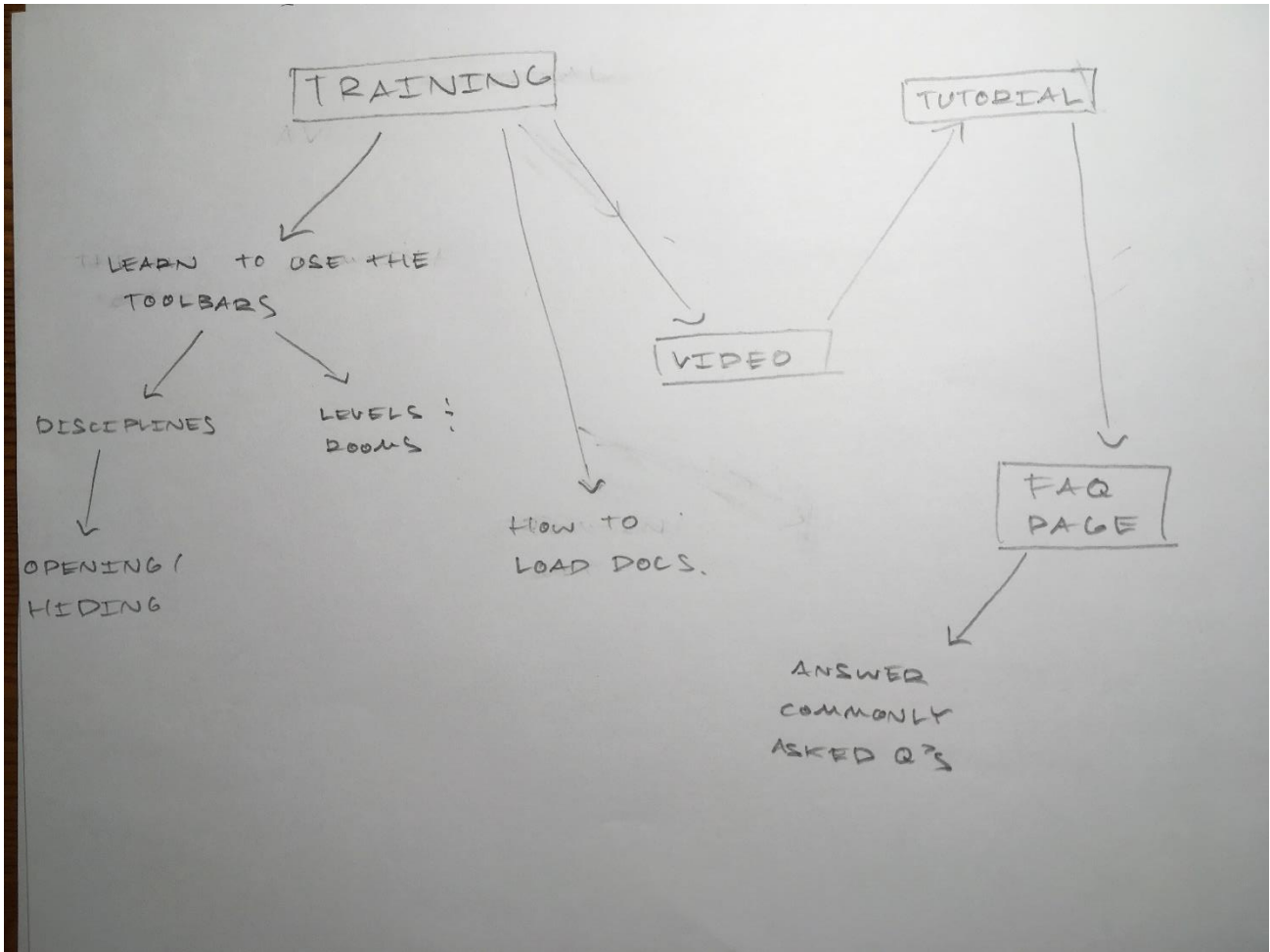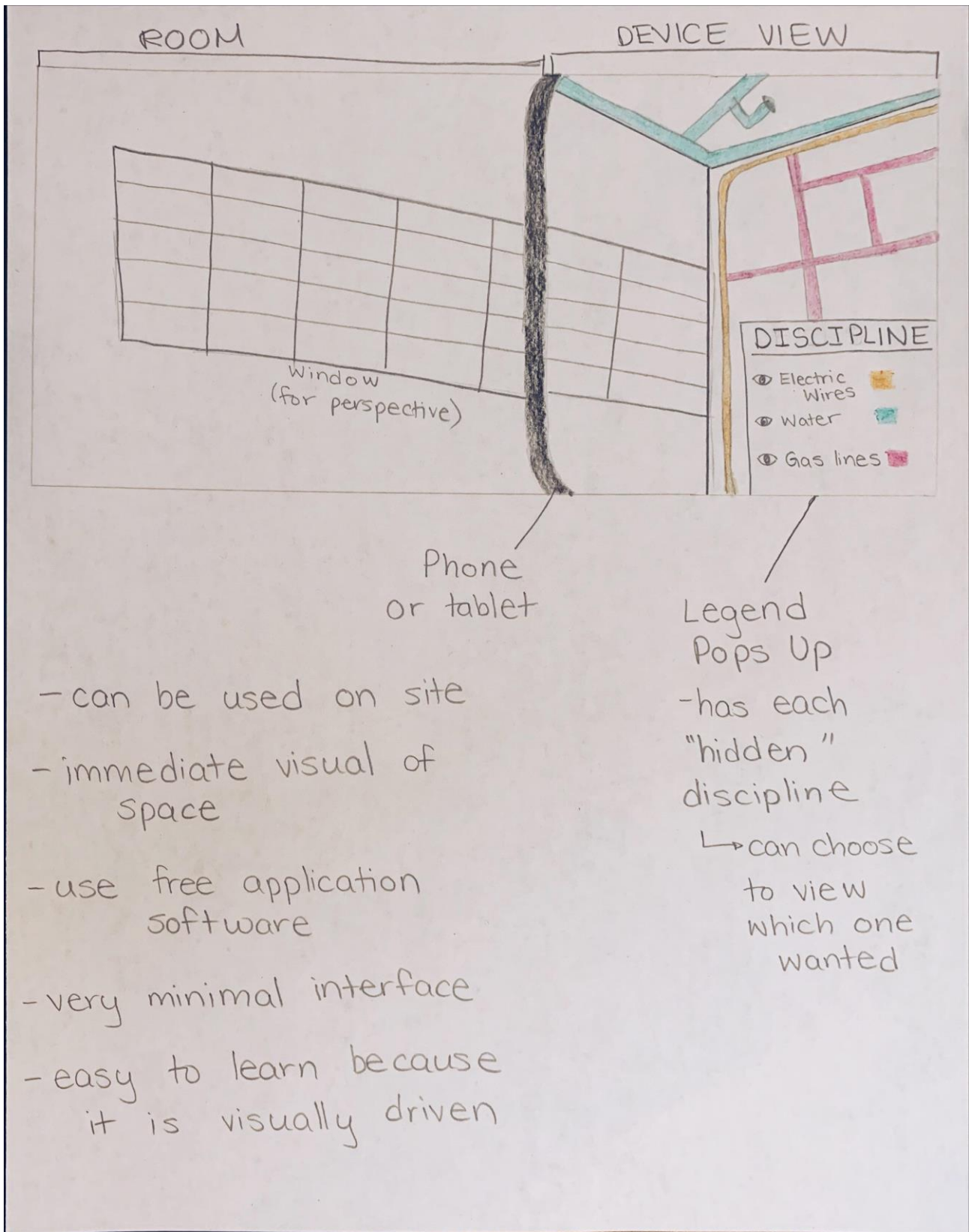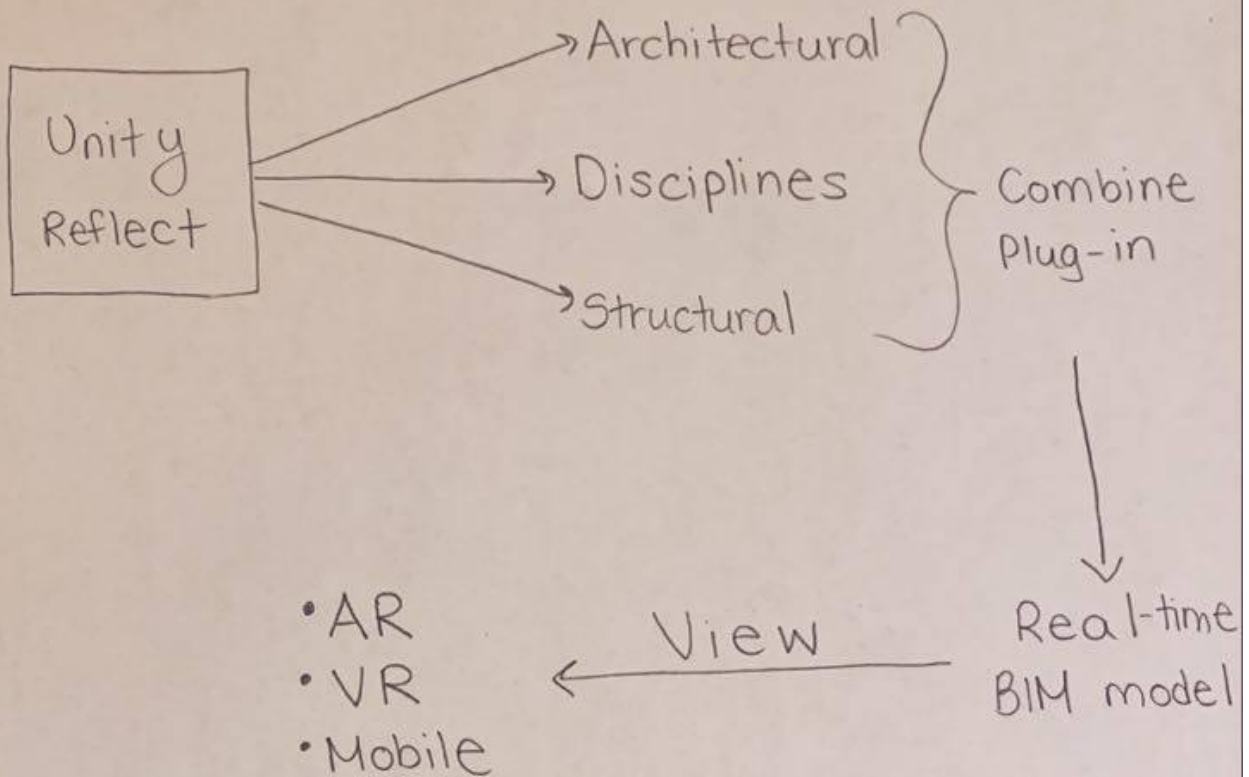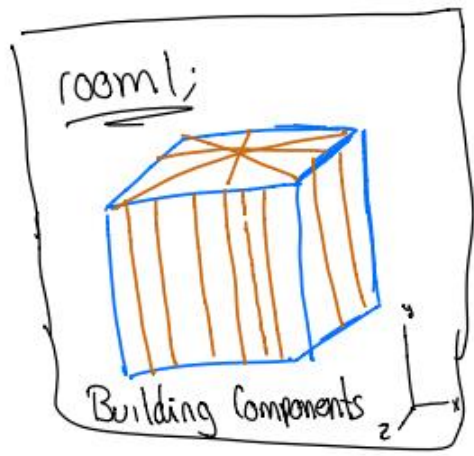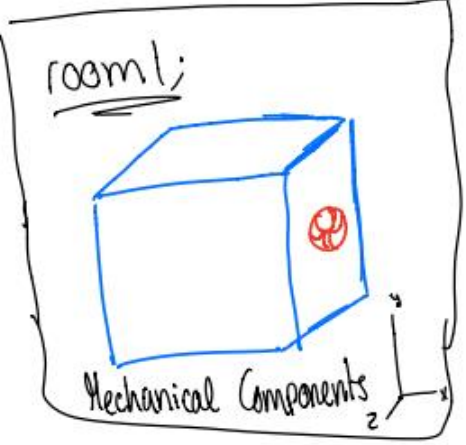
Figure 19: Closeup of David's Concept 3

ROOM   DEVICE VIEW

Window
(for perspective)

DISCIPLINE

👁 Electric
    Wires
👁 Water
👁 Gas lines

Phone
or tablet

Legend
Pops Up

– can be used on site

– immediate visual of
    space

– use free application
    software

– very minimal interface

– easy to learn because
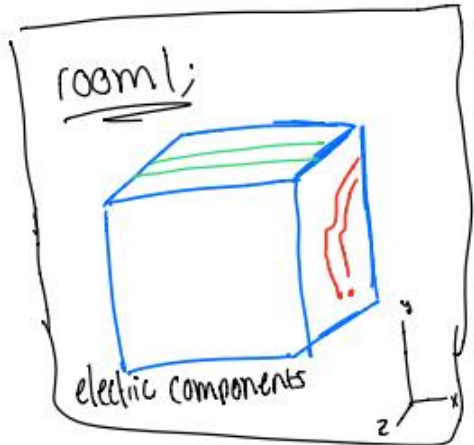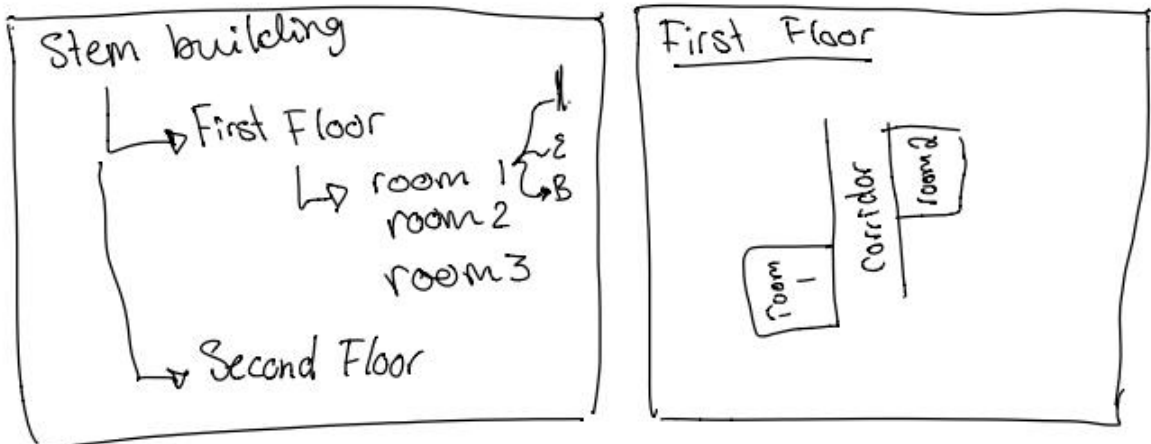   it is visually driven

-has each
"hidden"
discipline
↳ can choose
    to view
    which one
    wanted

Figure 20: Closeup of Niki's Concept 1

Use Unity Reflect

Unity Reflect → Architectural
→ Disciplines   } Combine Plug-in
→ Structural

Combine Plug-in ↓ Real-time BIM model

•AR
•VR   ← View ← Real-time BIM model
•Mobile

- software implementations
  ↳ follow unity's code for BIM

- we should focus on using plug-ins of disciplines
        ↳ REAL TIME IS THE GOAL

- have manual for sure

Figure 21: Closeup of Niki's Concept 2

- Hazards appear on the screen

- Any issues that prevent the success of each discipline can be seen

⚠ Meaning
- Steps

MANUAL
- water pipe blocked
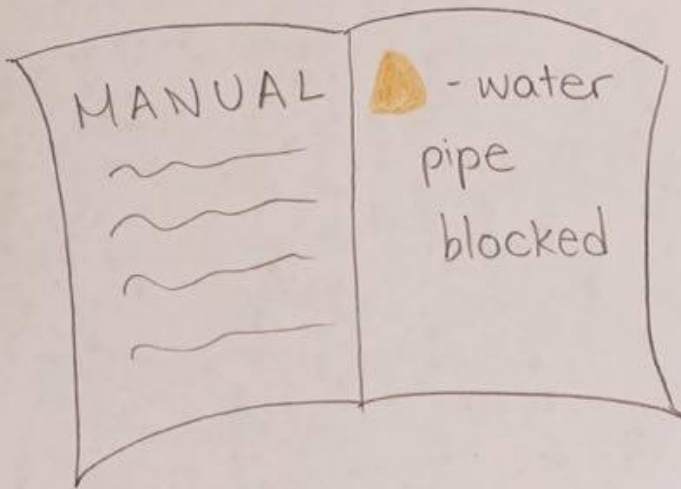
- provide an easy guide to navigate & decipher

- make this implementation free
- keep it simple.

Figure 22: Closeup of Niki's Concept 3

stem buliding

room x   roomy   room z

room (room 2   room 3

room x   🔴 wires
                              🟩 HVAC
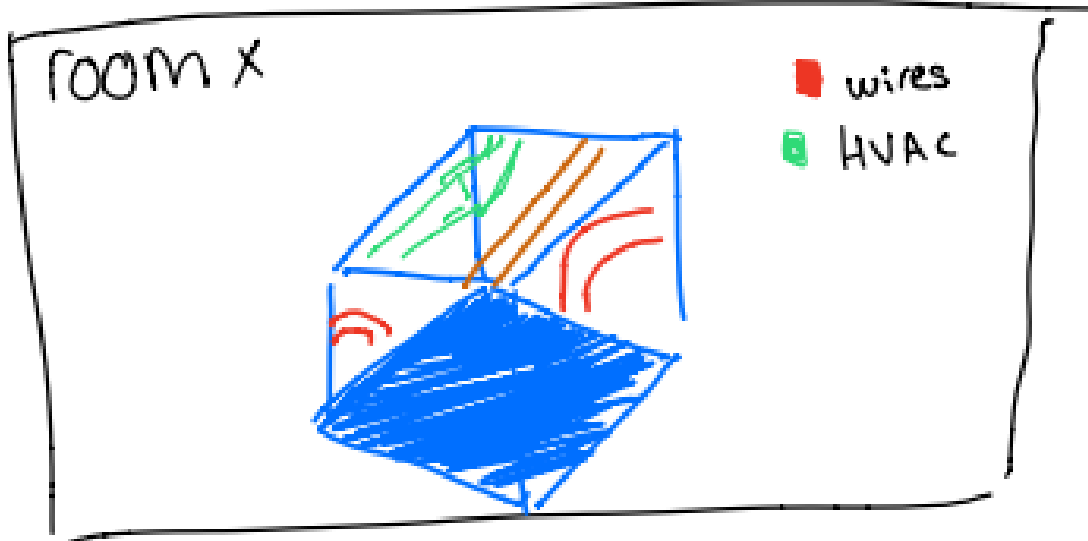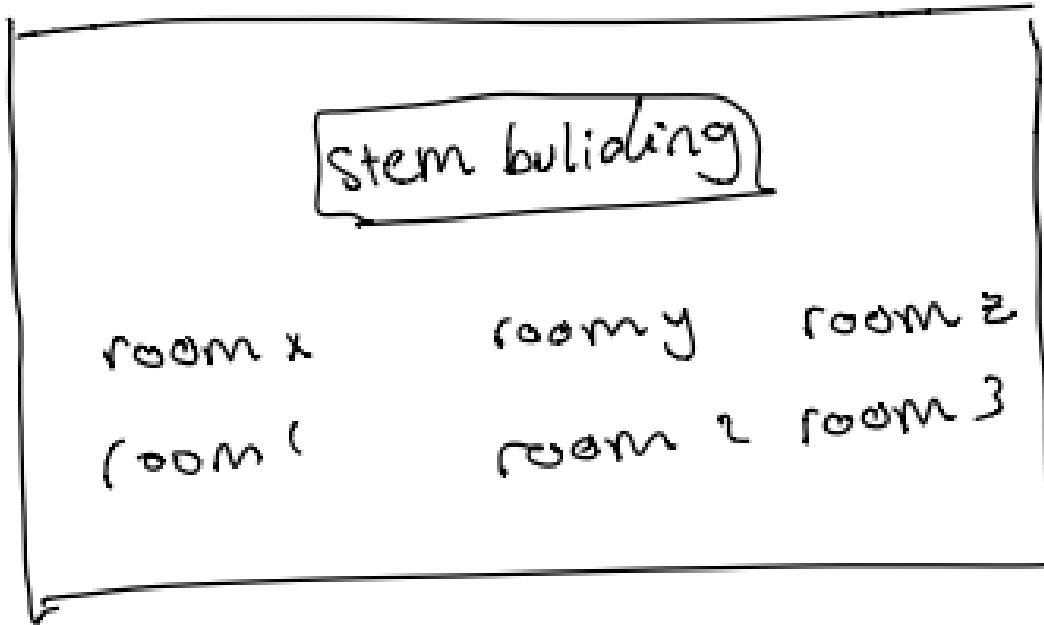
Figure 23: Closeup of Andro's Concept 1

Figure 24: Closeup of Andro's Concept 2
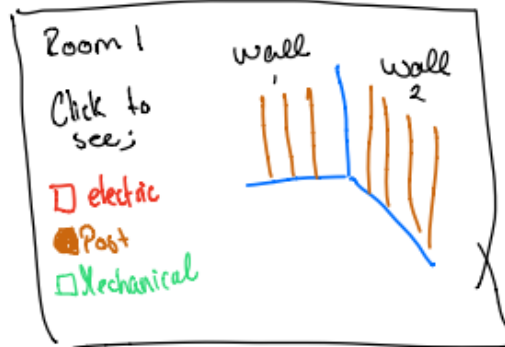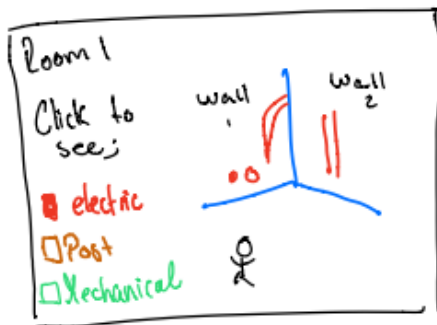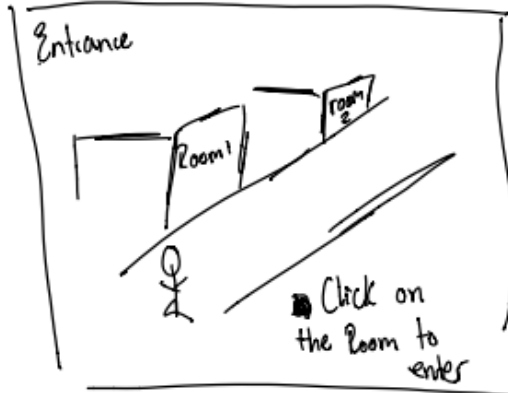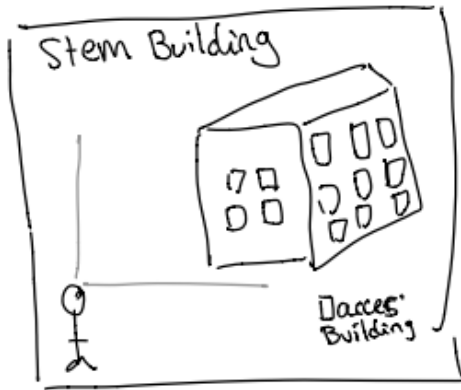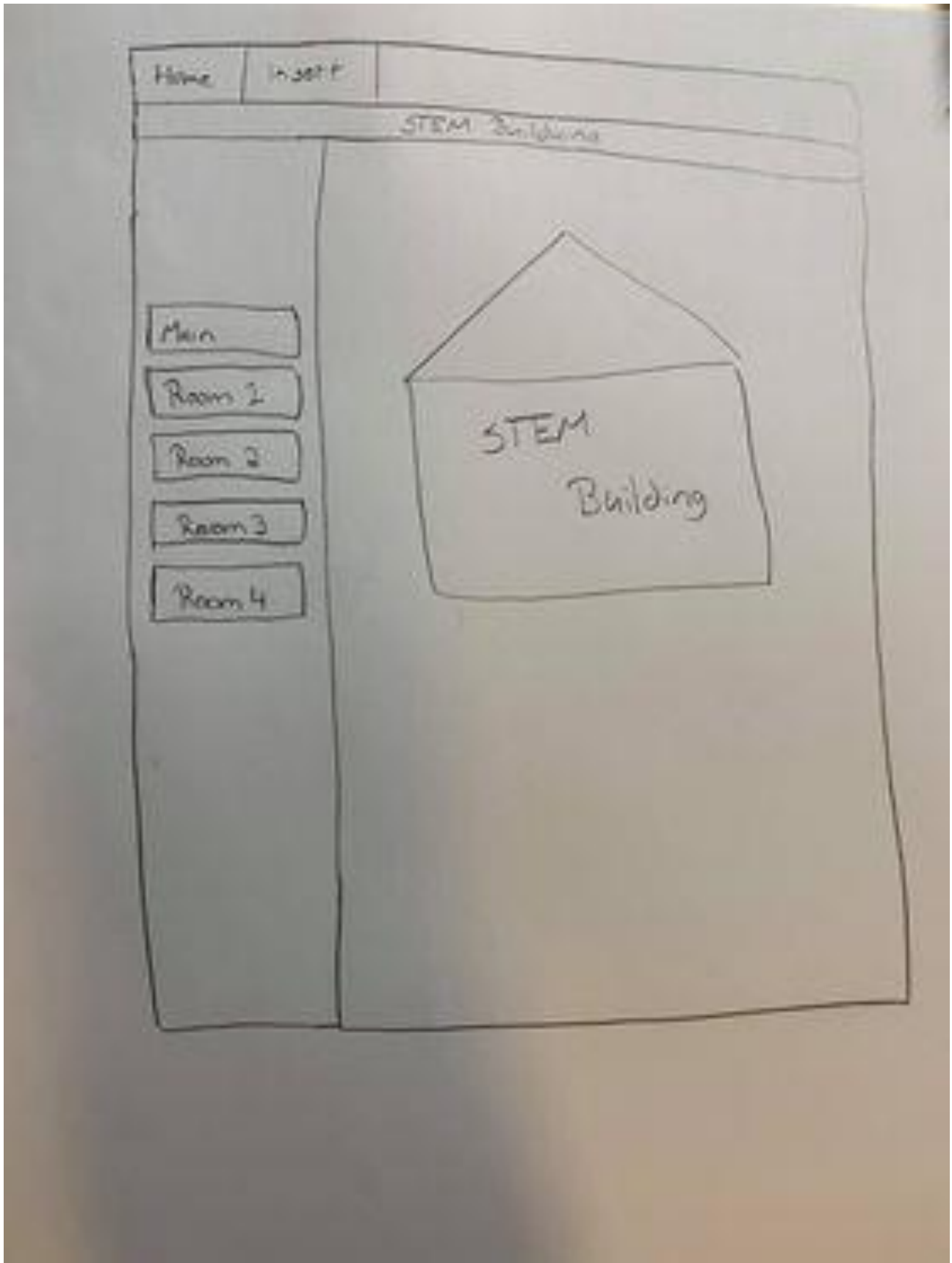
Figure 25: Closeup of Andro's Concept 3

Figure 26: Closeup of Jacob's Concept 1
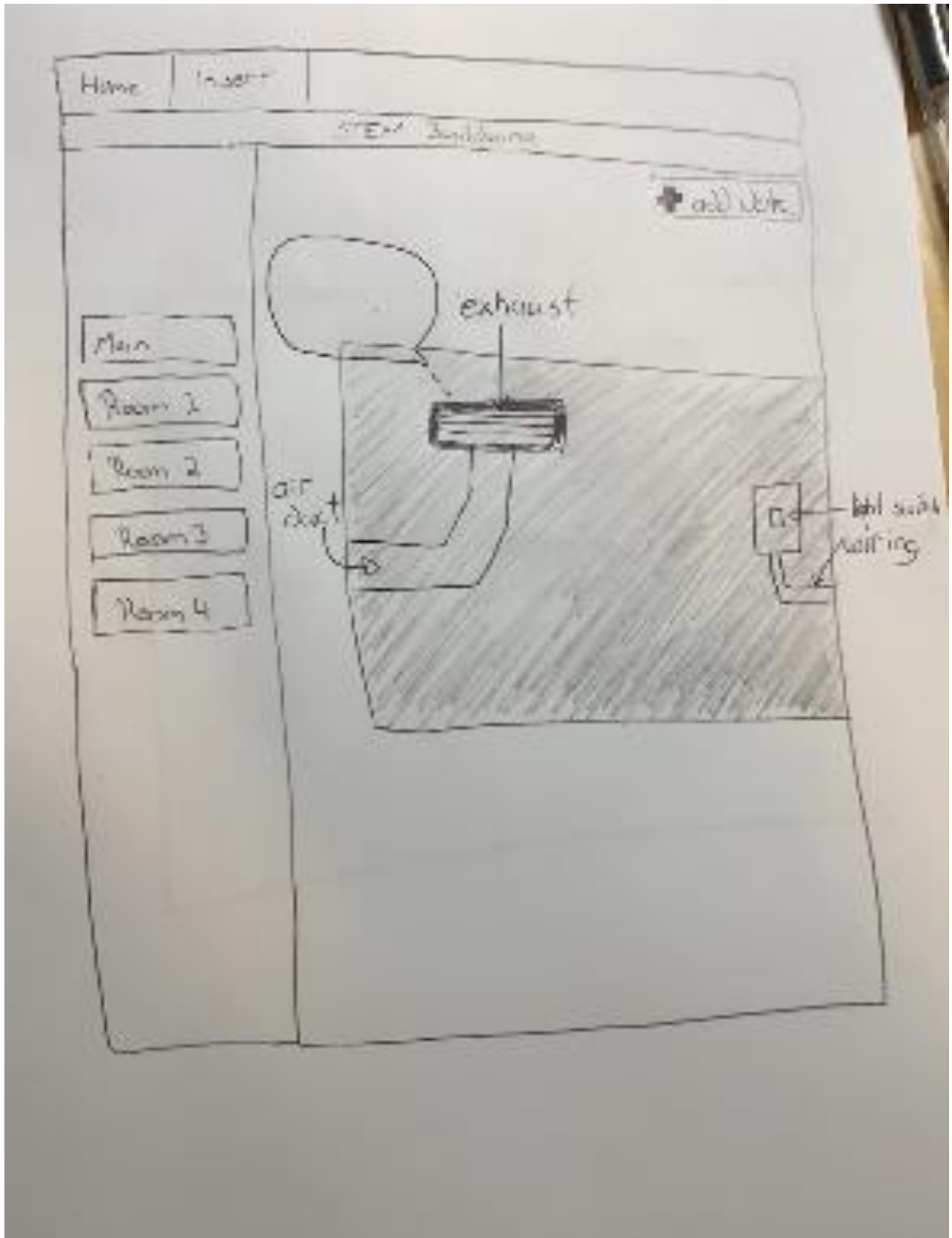
Figure 27: Closeup of Jacob's Concept 2

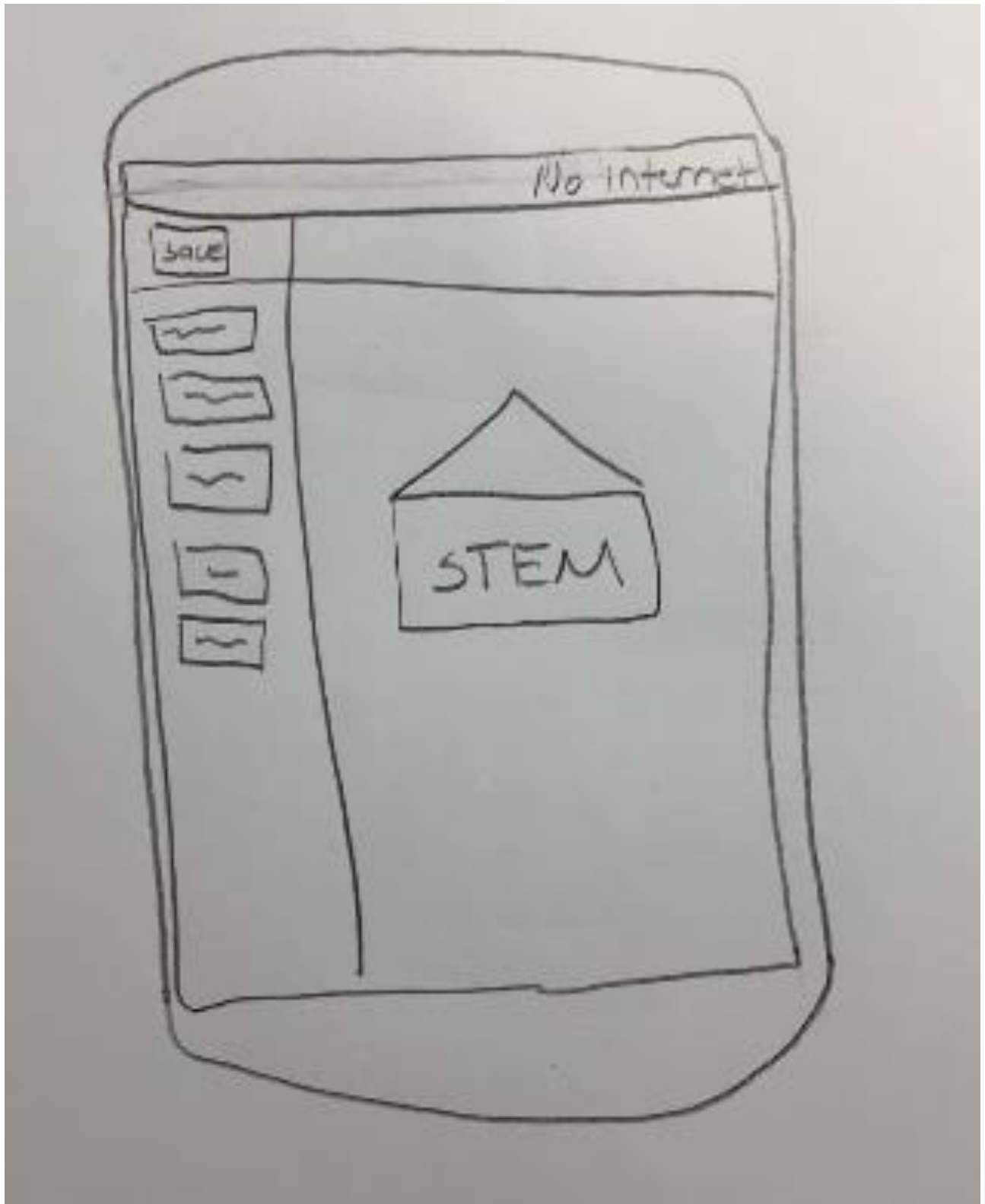*Figure 28: Closeup of Jacob's Concept 3*

The interface;

Floor 1:   □ room1:   □ Electrical Discipline
                       □ Mechanical Discipline
                       □ Building Discipline

            □ room2:   □ Electrical Discipline
                       □ Mechanical Discipline
                       □ Building Discipline

Floor 2:   □ room1:   □ Electrical Discipline
                       □ Mechanical Discipline
                       □ Building Discipline

            □ room2:   □ Electrical Discipline
                       □ Mechanical Discipline
                       □ Building Discipline
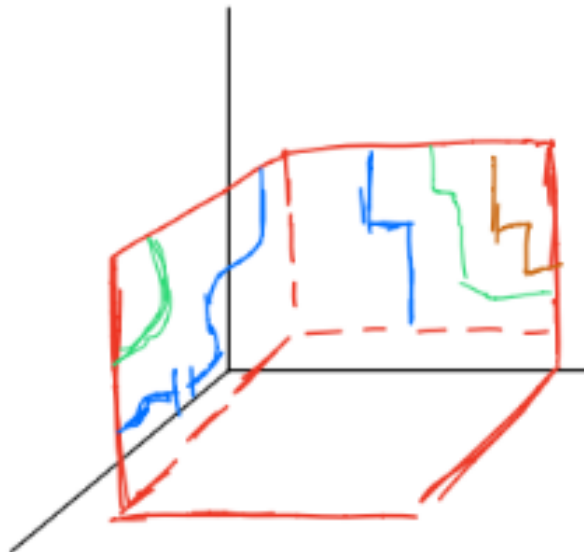
The interface;   Floor 1:   ■ room1: ■ Electrical Discipline
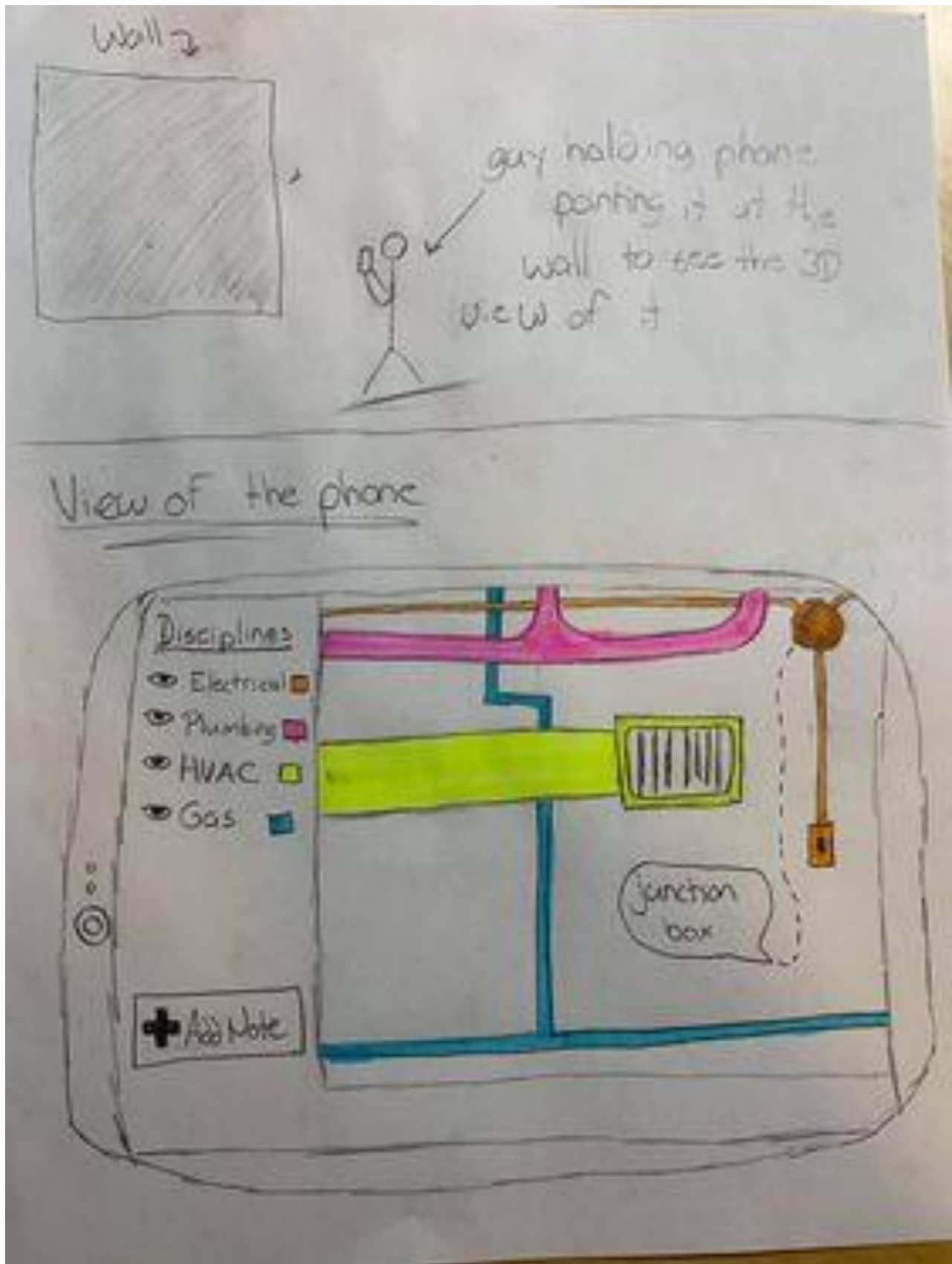

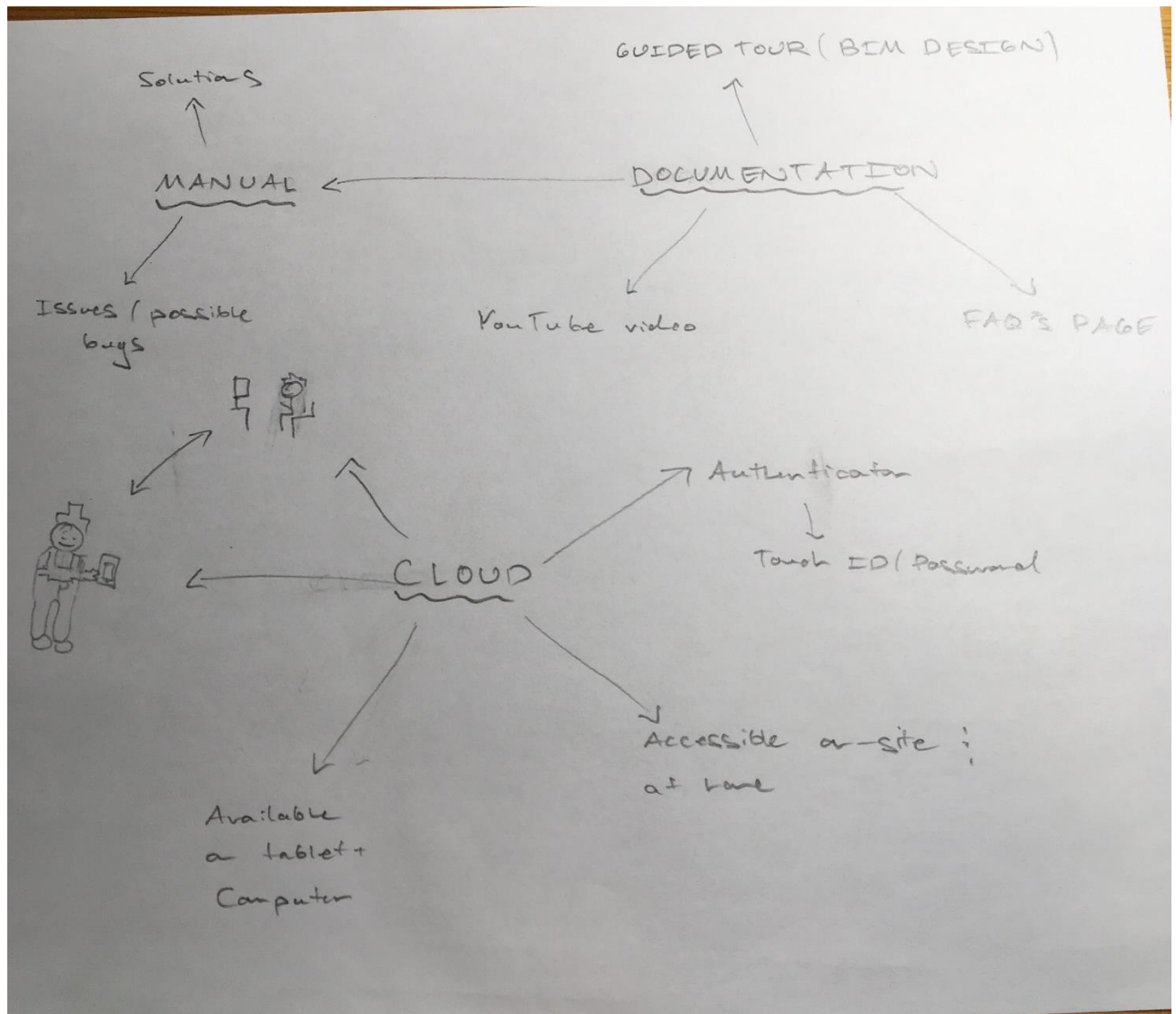*Figure 29: Closeup of Secondary Concept 1*

Figure 30: Closeup of Secondary Concept 2

Figure 31: Closeup of Secondary Concept 3