GNG2101 Report Template

Project Deliverable C: Conceptual Design, Project Plan, and Feasibility Study

Submitted by

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Abstract

This report develops a set of fifteen conceptual designs, based on the previously identified and prioritized design criteria, and product benchmarking which are furth refined into a final solution. After identifying design criteria generated from the needs of Roy and Anthony, the team came together and realized multiple conceptual designs, fulfilling the needs of the clients. This development was initially started by ideating concepts for subsystems that address both the problem statement and design criteria. Based on these subsystem concepts and the ideas of each team member, three solutions were created. These solutions were analyzed and compared to the original design criteria, and further broken-down using diagrams and descriptions to outline their benefits, functionalities, and contingencies. Ultimately, these three final solutions were identified, debated, and ranked. From this, a final solution was chosen to pursue further prototype development.

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List of Acronyms

Acronym	Definition
UML	Unified Modelling Language
AI	Artificial Intelligence
EEG	Electroencephalogram
LED	Light Emitting Diode

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 January 18th, with Anthony and Roy. They expressed the need for a cost effective, and user-friendly software platform that would allow people with disabilities the ability to communicate in with caretakers, and others using a text-to-speech option, and a smart home interaction. This is important as there are few devices that have these function, and the ones that exist are expensive. Anthony and Roy expressed that independence for people with disabilities, and even the option just to say, “thank you,” can vastly improve someone life and freedom. 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 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 address the client’s needs most accurately.

2 Conceptual Design

2.1 Definition of Subsystems

It is important to define the overall system, as well as the function of the software for this conceptual design. This is done in figure 2.1 and figure 2.2. The system will be composed of many subsystems which are broken down into the Caretaker UML and End User UML. From these diagrams, subsystem concepts were generated.

Figure 2.1.1- End User UML

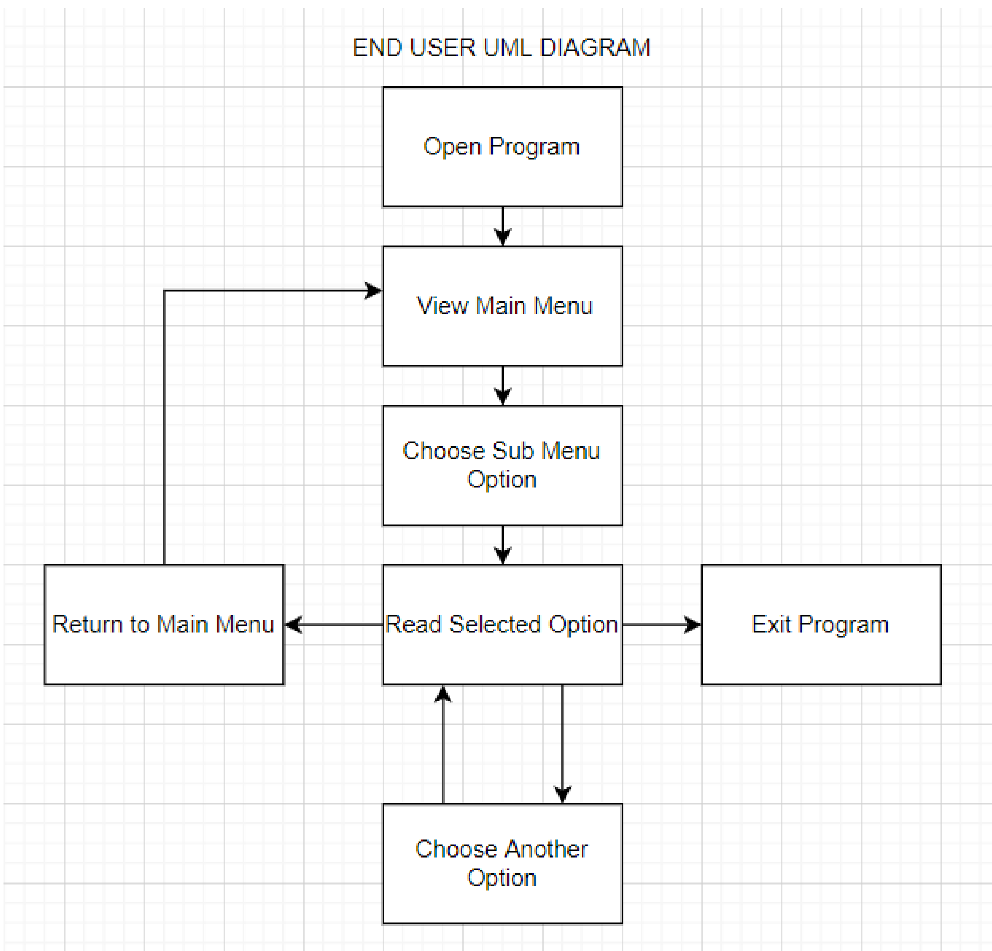
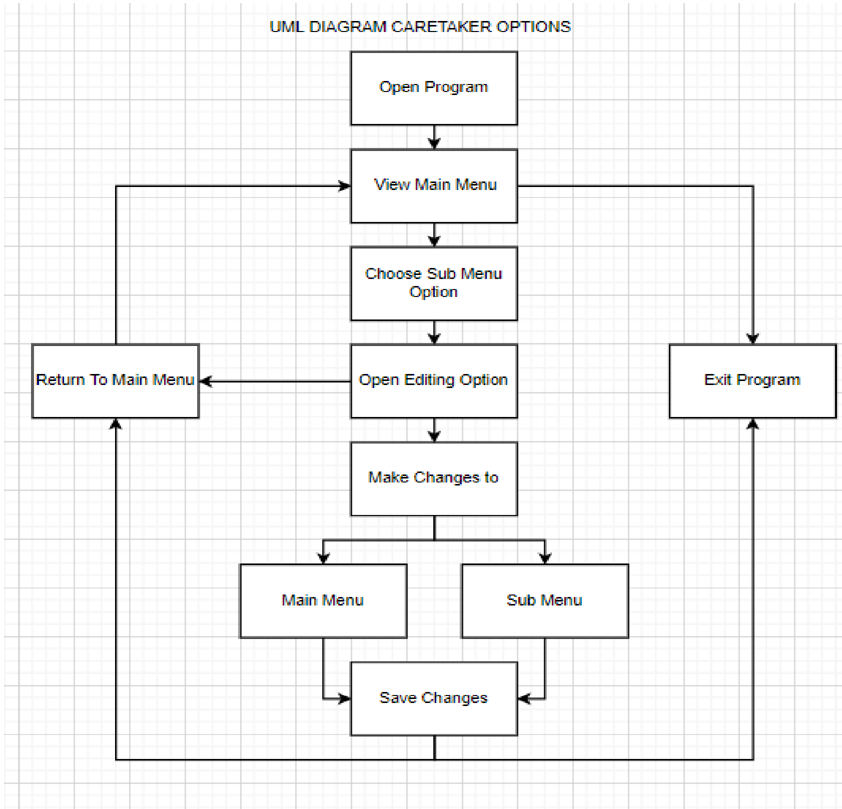


Figure 2.1.2- Caretaker UML



2.2 Team Concept Generation

2.2.1 Kaiyi Solutions

1. Eye Tracking and Receiving Method

Allow the access to user's camera to catch the movement of the angle of the user eyeballs, then predict the spot they are looking on the screen to work as an indicator, set a specific spot on the screen as the confirmation area where if they stare at it for a few second it confirms the process. Then users can proceed to the words input using a regular style keyboard on the screen.

2. Finger Moment Amplification

Design a device that detects and captures the user's hand muscle movement, predicts the desired direction where their finger tends to move towards, so a single finger can work as a mouse on the screen; then add a button on the side as a confirmation input device.

3. Replaced by AI

Monitor the user's body condition at all time, then apply AI system to express their needs when the certain threshold is triggered.

2.2.2 Michael Solutions

1. Portable EEG

An electroencephalograph, EEG in short can scan electrical impulses of the brain. This device can constantly scan for the user's brain activity. Using electrodes attached to the users head it is possible to activate the device when user thinks of speaking. When the device is activated it would cycle through potential phrases and when the device reached the desired phrase the user can think of saying it, sending another electrical signal to the device and allowing the device to speak the phrase.

2. Implanted EEG

It is possible to implant electrodes into a brain to measure localized brain activity. Using this device, the user can produce words just by thinking of them. Many localized electrodes connected to the speech region of the brain would convert electrical signals into letters the user wants to speak. Once a word is obtained it would be spoken by the device.

3. Single button

A single button coupled with a display. As the user presses the button the phrases scroll, till the desired phrase is reached and the phrase is spoken by the device.

2.2.3 Chuanzhi Solutions

1. Solution 1

a. One button for the end user to control the whole system.

b. Binary-type phase storage. Use 4 to 6 binary digit, (can store 16 to 64 phases corresponding to digit number) sort the phase. For example: 0000 is for “thank you”.

c. Dot (click) for 0. Dash (hold for a short time) for 1. hold for more than 3 seconds to reset the digit.

d. Device will shake after every instruction be read successfully. (dot, shake, dot, shake, Dash, shake, Dash, shake, “play 0011”, long shake)

e. help end user get feedback from device (consider there are different kind of users, disabled on vision or listening, physical sense will be the good sense)

f. Another button for the family of the user (or the health-care provider) to input the phrase. (press input button, input the digital number, begin to record).

g. Some tip for remembering the phase, while the family recording, minimize the first or second digit, like (the 0 is for greeting,1 is for using the voice system of google)

h. Easy to build, cheap, completely offline, can be used by most of the disable communities. Need time to mastering. About 10 sec for search each phase.

2. Solution 2

a. A phone application

b. Convert text to voice. Input the sentence that user wants to be spoken.

c. A txt file that exists in this app as phrase library, select the sentence to speak.

d. Connect to the browser or other app, can speak the sentence user select on anywhere of the phone.

3. Solution 3

a. Phone application.

b. Convert the voice control system into button control.

c. When the user wants to speak with the other, hand over the phone, they choose to input text or voice. Convert what they want to express to voice text or voice. That is settled can be modify by other than users.

d. One user button presses to change mode: voice system mode or commutation mode.

e. Any arbitrary button (haven't decided yet) for people that user want to communicate with. (choose their input type, or type to impute what they want to say) convert input to the way of commutating that user can understand.

2.2.4 Victoria's Solutions

Figure 2.2.1 - Victoria's Solutions

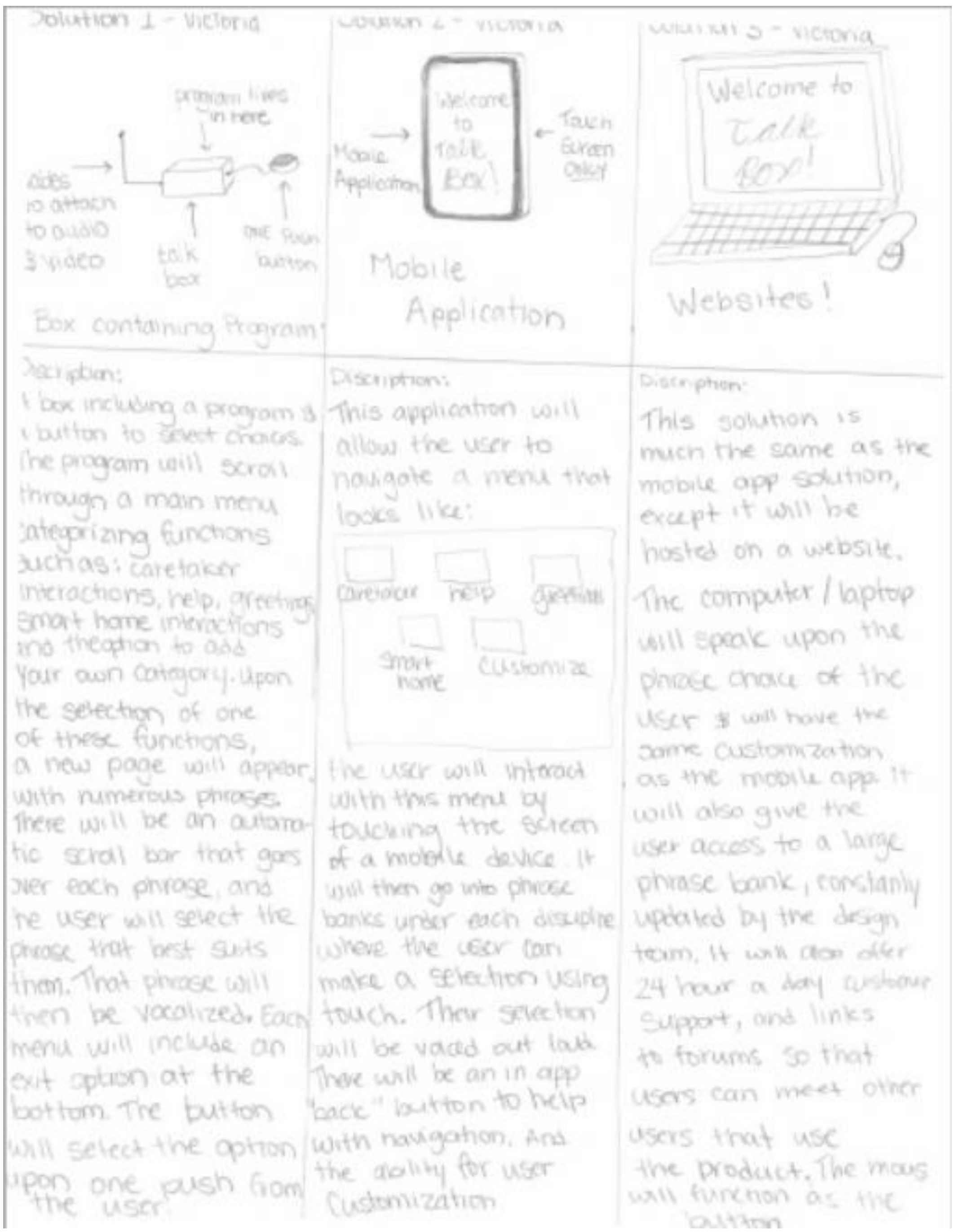


Table 2.2.1 – Subsystem Concepts

Sub-System	Team Member Generated Ideas
A way to select the on-screen options.	The options will be selected by a one bush button when the cursor is hovering over the desired option. One push will signify a selection. (Michael)
	5 digital number, using bits to visualize what the options will be. (Chuanzhi)
	Using a joystick that can push, pull and press to navigate the onscreen options. (Kaiyi)
Simple user display.	The screen will have minimal items on it. It will have pictograms for each category that the user can interact with. It will use a menu scrolling option. (Victoria)
	Brain vibe detector and translator. (Chuanzhi)
	For blind user, we design a certain beep with different frequency that indicates different phrases. (Kaiyi)
Voice interaction with smart devices	When the phrase/request is read out by the talk box, the smart home device will listen and allow user interactions. (Victoria)
	The smart devices connect directly to the app. (Chuanzhi)
	The phrases are run through google translate to enable text to speech for smart devices to hear them. (Michael)
Text to speech ability	The user selects the phrase from a sub menu; the phrase is read out from the talk box. (Victoria)
	Outsource talking abilities to google (Chuanzhi)
	Adding word banks and pronunciations from online dictionaries. (Michael)
Portability of device.	Wheelchair mounting device. A black box containing the Arduino is mounted using Velcro straps to move where the user needs it. (Victoria)
	Belt that straps onto the wheelchair. (Chuanzhi)
	Install the talk box app on the phone or iPad etc. Which we assume user would be carrying around. (Kaiyi)
Provides user visual cues.	Eye tracking and receiving method that confirms the selection by staring at it for a few seconds. (Kaiyi)
	Vibration of the phone to let the user know the decisions. (Chuanzhi)
	The user will have pictograms on the screen denoting which menu or sub menu they are entering. The scroll bar will methodically scroll through each option so that the user can select which one they will interact with. (Victoria)
A way to navigate on screen options.	Amplify and predict user's finger muscle movement direction to make the finger work like a mouse. (Kaiyi)
	Using the joystick, push and pull will allow user to go between choices and pressing the stick will confirm user's selection. (Michael)

	The user will navigate the on-screen options using a one push button, and a scroll menu. To select, the user pushes a button, to scroll the program automatically scrolls for the user, and to exit or return to a previous menu, there will be an option on every menu and sub menu. (Victoria)

3 Refined Solutions

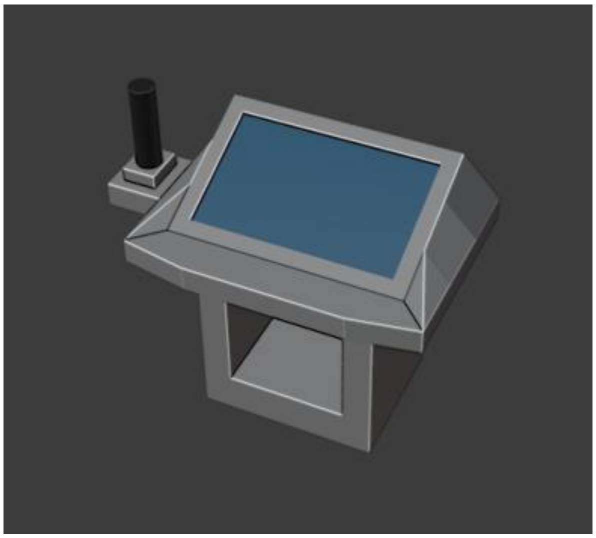
Based on the subsystem concepts, three global solutions are defined and further detailed as complete solutions and figures in the following section of this report.

3.1 Solution One

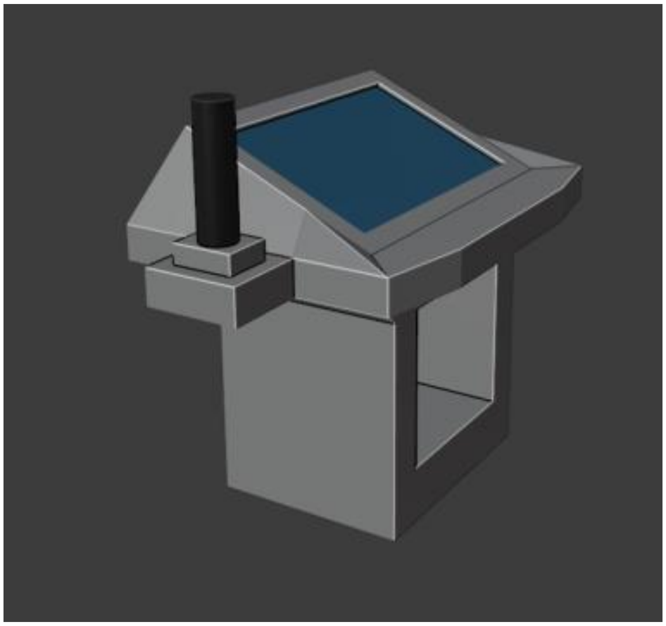
The first solution will include an Arduino inside a 3D printed enclosure, that contains the program. This box will be able to be attached to the wheelchair using a Velcro belt. The device will use a modular button that can be changed out, depending on what works for the user (Joystick, large button, switches). The program upon opening will show the main menu. The main menu will include categories for smart home interactions, caretaker interactions, shopping interactions, etc, and will be personalize upon the user's modifications. Each of these categories will lead to a sub menu, containing phrases. Upon selection of a phrase, the phrase will be voiced using text to speech. The navigation will be though , and a s automatic scroll menus election using the modular buttons. There will be an option to exit included in the scroll menus, which will take the user to the previous menu. There will be an option for users to modify the phrase bank, through a phone application. This will include adding categories to the main menu as well. The phrases will be displayed on an LED screen, attached to the Arduino.

3.1.1Solution 1 Diagram

3.1.2 Solution 1 - Front View



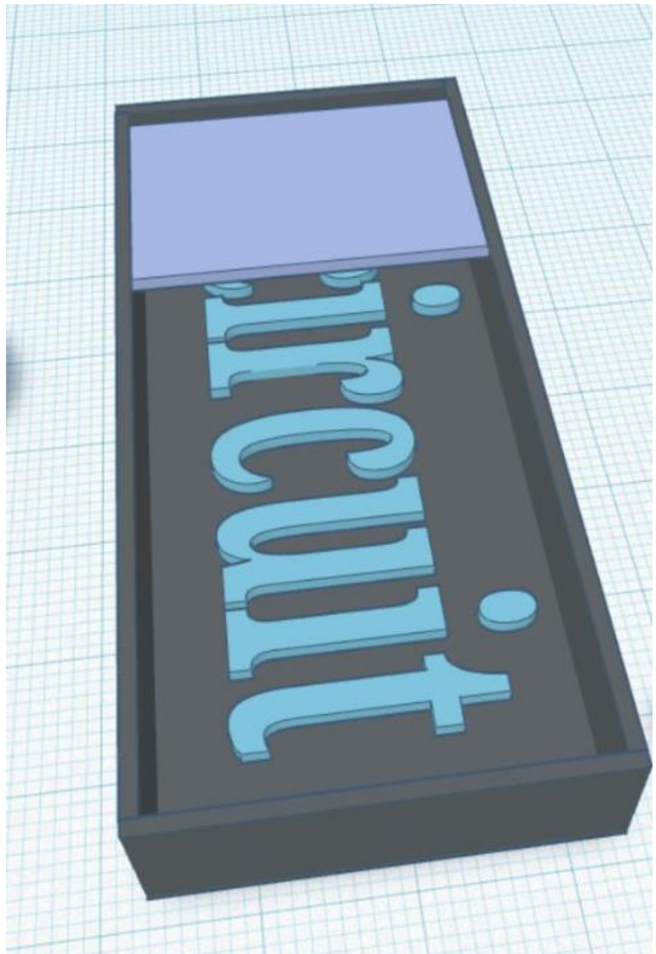
3.1.3 - Solution 1 Side View



3.2 Solution Two

The second solution will be another Arduino inside a 3D printed enclosure. The Arduino will function similarly to the first solution and will also come with a modular attachment point for an input device. The major difference between solution one and solution two is the feedback to the user. In solution two the user will receive auditory feedback or “beeps”, instead of visual feedback. Each phrase will have its own number of “beeps” associated with it and once user hears the correct amount of “beeps” the input button can be pressed, and the device will speak the phrase.

3.2.1- Design for Solution 2



3.3 Solution Three

The third solution consists of an application that can be attached to the user's wheelchair using a mount, (phone, iPad, tablets, ect.) The product will also contain a button that can be connected to the phone and to the application. The application upon opening will show the main menu which will include categories for smart home interactions, caretaker interactions, shopping interactions, etc. and will be personalized upon the user's modifications. The main menu will include both pictograms and text for each selection to ensure simple navigation. Each of these categories will lead to a sub menu, containing phrases related to the previous choice they made. Upon the selection of a phrase, the phrase will be voiced using text to speech through the speaker of the phone. The navigation will be though automatic scroll menus, and a selection, using the modular button. There will be an option to exit the sub menu at the very end of the scroll menu. The app will also provide caretakers with a simple user interface to add, adapt, change phrases, menus, and sub menus. The interface would be created using unity.

4 Analysis of Solutions and Feasibility Report

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

4.1 Analysis

Table 4.1.1 Solution Analysis

#	Design Criteria	Unit	Solution 1	Solution 2	Solution 3	Imp.
1	Requires a simple switch or a button.	Y	Y	Y	Y	5
2	Adaptable User Functionality	Y	Y	N	Y	3
3	Simple User Interface	Y	Y	N	Y	4
4	Text – To – Speech	Y	Y	Y	Y	5
5	Device posesses large, diverse phrase bank.	#	10	4-	10	4
6	Device is durable and eco-friendly.	Y	Y	Y	N	3
7	Device cost	$	65	65	600-	3

8	Device functions offline.	Y	Y	Y	Y	5
9	Voice Interaction with Smart Devices	Y	Y	Y	Y	5
10	Software can be modified by users.	Y	N	N	Y	4
11	Reset function.	Y	Y	Y	Y	1
12	Device will charge through wheelchair.	Y	Y	Y	Y	1
13	Device will provide user with pictograms or onscreen text.	Y	Y	N	Y	3
14	Device is portable through mount to wheelchair.	Y	Y	Y	Y	4

Solution 1: 138

Solution 2: 114

Solution 3: 138

Green is equal to 3, Yellow is equal to 2, Red is equal to 1. The solution scores were calculated using the color ranking of the design criteria of each individual solution multiplied by the importance of the design criteria. Note that there is a tie between two ideas.

4.2 Feasibility Report

The solution 3 would be the easiest one to accomplish due to it being the programming of an application on Unity, but it assumes that users would have a device that can run the app; for that reason, the device costs much more than the budget.

Solution 2 is easier to execute compared with solution 1, where we will have to compute with a small LED screen, versus being constrained to having no device for the programmers, or the users to see.

4.3 Solution Scoring and Final Solution

Table 4.3.1 - Solution Scoring

Solution	Total Score
1	138
2	114
3	138

5 Conclusion and Recommendations for Future Work

In the solution generating process, we have learned to generate ideas in both vertical and lateral directions, and solved problems with different approaches and techniques. The brainstorming was successful, and in the first stages no ideas were left out. Upon further refinement, more solutions were eliminated. Despite the absence of a team member, generated three solutions and narrowed it down to one upon further analysis. According to the information we gathered from the client interview, the matrix created based on the demands and the requirements of clients, including the function of our product from user's perspective.

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 led to identifying that the only difference between the solutions came down to cost and what was more tailored to the request of the client. Solution 1 was given a subjective rating of 138. Therefore, moving forward, prototyping and scheduling will be made using the solution defined in section 4 of this report.