

Project Deliverable D

-Detailed Design, Prototype 1, and BOM-

Group A3

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Client feedback summary

The following table set shows the solutions decided on in Deliverable B that were presented to the client as well as the feedback the client shared after the meeting.

Presentation of solutions

Three solutions were presented to the client, Madi, in the second client meeting. Solution 1 (UI system with voice command) was the primary solution chosen by the team in Deliverable C. The team also wanted to give Madi a selection of different approaches, so Solution 2 (custom external keyboard) and Solution 3 (ergonomic pen) were also selected as diverse choices in order to prompt additional feedback that might not have been said in the first client meeting. The following tables outline the pros and cons of each solution, as presented to the client, and the feedback received during the meeting. Visual representations of Solution 1 from Deliverable C were also presented to the client, and can be found in Appendix A.

Table 1: Solution 1 - UI with voice command		
Pros	Cons	Client feedback
<ul style="list-style-type: none">• Minimal cost• Highly customisable• Simple to set up and use• Easily integrated into workflow• Easy for team collaboration; faster development time• Easy to use with a tablet, without interrupting motion	<ul style="list-style-type: none">• Will become outdated if Photoshop keyboard shortcuts change• Not tactile• Would not be of assistance on a low-vision day• Voice command systems are new to all team members	<ul style="list-style-type: none">• Interested in the voice activation software• Would like a smoother interface, better colour picker, and a better brush selector

Table 2: **Solution 2** - Custom external keyboard for selecting Photoshop tools

Pros	Cons	Client feedback
<ul style="list-style-type: none"> • Tactile • Big buttons are very visible • Easy to remember where actions are 	<ul style="list-style-type: none"> • Difficult to collaborate; longer development time • Not customisable • Not necessarily with voice (could be discussed) • Added motions in workflow needed to transition between tablet and keyboard 	<ul style="list-style-type: none"> • Very interested in tactile keyboard, having own physical toolbar • Make sure keyboard isn't heavy (>10 lbs) • Normal keyboard key size is okay • Larger icons on keyboard, but not so large that they can't be distinguished from each other

Table 3: **Solution 3** - Ergonomic pen for Wacom tablet

Pros	Cons	Client feedback
<ul style="list-style-type: none"> • Already a tool used in workflow • Fixes complaint of tired hands 	<ul style="list-style-type: none"> • May accidentally press buttons on pen • Difficult to make • Difficult to collaborate; longer development time • No voice command (could be discussed) 	<ul style="list-style-type: none"> • Little to no interest • If using the pen was too difficult, they probably wouldn't try to make art that day

Discussion questions

After the presentation of the pros and cons of the 3 solutions, the group conducted an open discussion of the solution with Madi. A summary of the team's questions and client's answers is as follows:

Should voice command always be on (listening), or be able to be toggled at wish?

Having voice command on while the program is in use would be best. If desired, it should be easy to turn it off.

The team was advised against using fast popups or flashing animations for clients with conditions similar to yours. Would you consider a dropdown menu with options to be a fast popup?

Fast pop-ups are usually not too much of an issue; the color red is a much worse trigger. However, it would be preferable to have smooth graphics and animations.

When redesigning the color picker, is there a specific grid size or other features that would help you distinguish between colors?

It would be best if the color picker had a border between each color to tell them apart.

If we were to add some kind of visual feedback such as lights to the keyboard or on-screen notifications, would that be useful for you?

It would be useful to have some feedback when a key is pressed. The best colors would be off-white or a soft blue/green.

In our last meeting, you talked to us about how you use your art for art therapy. Are you hoping to use our solution with your clients, or will it be strictly for you? And if it's with your clients in mind, do we need to make any considerations for their needs?

The art therapy is usually for people with mental illness rather than physical disabilities. However, the program will be for personal use only.

Updated and detailed design of concept

The solution feedback and discussion in the client meeting indicated that the client was interested in a solution that integrated a custom keyboard for Photoshop tools. This was different from the solution that the team outlined in Deliverable C, and so some modifications needed to be made.

The updated product concept needs to be a combination of a custom keyboard and voice command system which could both be used to control Photoshop, depending on the user's preference. There will still be a software component to the product, which provides on-screen feedback and further tool options (such as brush selection and the color picker), but it will no longer be the main focus. Functionality in relation to Photoshop will remain the same; the product will still allow the user to interact with Photoshop tools to create digital art, record recently used commands for reuse, allow the user to smoothen their drawn lines, and provide a new color picker and brush selector.

Concept breakdown

The product functionality relies heavily on mapping input to keyboard shortcuts to allow the user to manipulate Photoshop tools and navigation. The team has created a glossary of commands (see Appendix B) that the client will be using to create their art; these will be implemented in the system.

The new product concept can be broken down into three main components; the voice command system, the custom keyboard, and an on-screen interface (UI). The functionality and implementation of these components can be further broken down as follows.

Voice command system

The voice command system will be used to provide voice input to the system. This input will be interpreted by the system and mapped to various Photoshop commands. These commands will then be executed in Photoshop using keyboard shortcuts. The priority for voice commands will be tool selection (e.g. "Paintbrush", "Lasso select"), and menu navigation (e.g. "New file", "Save file").

During research in Deliverables B and C, the team discovered the program GAVPI which is free to use and has a public GitHub repository. The team (Callum) has done some preliminary testing with GAVPI and found it easy to integrate with Photoshop keyboard shortcuts. This is a promising solution for the voice command component.

Some further research and experimentation does need to be done for this solution. It remains to be seen whether GAVPI can be easily used along with the other components and other options, such as Google's Web Speech API will still be considered during the prototyping process. For GAVPI, the team needs to look into its license for reuse, the programming languages it runs on, and whether it has a friendly API for integration with the system.

Keyboard

The keyboard harnesses the same functionality as the voice command system, taking advantage of the pre-existing keyboard shortcuts that exist in Photoshop. Due to the online nature of this year, the keyboard solution wasn't the first choice for the team as collaboration on a hardware project would be difficult. However, the client absolutely loved the idea of tactile mapping; meaning physically pressing a button to switch between specific tools. In order to meet this specific client need, the keyboard solution has been reintegrated into the project.

To prototype and build this component, it's important to determine the amount of keys the client would like, which functions these keys should each have, and their respective layouts. Because this is a crucial decision and because the team doesn't want to shoot low and create a useless piece of hardware or aim too high and create a complicated mess of keys, feedback from the client is important before continuing much further.

Once the final layout is decided and parts are ordered, a keyboard specialist on our team (Austin) will wire up the board, load on the firmware, and ensure that everything is working properly.

Interface/Visual feedback

The use of keyboard shortcuts only solves one of the accessibility issues that the client faces. Even with added buttons and voice capability, Photoshop is still cluttered and confusing. Creating a cleaner visual interface that shows when tools are in use, when the voice command system is listening, and simplifies the brush selection menu and color picker will help to make Photoshop more usable for the client.

The client also expressed an explicit need to avoid the colour red. This is to avoid triggering seizures. While avoiding red when building the software's interface is simple, it also raises an interesting problem. Photoshop, and almost any other digital art programs, starts all of their colour selectors at a harsh red. Both because of this and the client's difficulty separating colours when they are presented in a colour cloud, the newly designed UI will have to feature a completely redesigned colour picking system.

Integrating this into Photoshop will require some experimentation, but since much of Photoshop is accessible through keyboard shortcuts and the rest of the parts of this prototype focus around them, there is no reason the user interface (UI) can't take advantage of this as well. Newer editions of Photoshop allow users to set their own shortcuts. Combining this feature with the fact that any colour can be represented in code through a hex code, RGB values, or HSV values, fully integrating the new UI so that it makes Photoshop a friendlier experience shouldn't be too difficult.

The final product of all of these parts is a fully integrated single software overlay with an external keyboard that contains all the functionality listed above and opens with Photoshop when the client accesses the app. This software should take no extra effort to use but provide the client with all of the accessibility they desire.

Product assumptions

Product assumptions lay out the bias or opinions on the product they are creating. In this case, many of the product assumptions are related to the client's disability. This product hopes to decrease the hurdle of the disability by providing many alternative solutions to the same problem. For example, if the client can't talk well on a particular day, the keyboard and UI will both contain keyboard shortcuts that can access tools without using the voice commands. The client did express though that on a particularly bad day where they couldn't move their hand or couldn't see, they would not be making any art, digital or otherwise. With all of that said, the following is a list of product assumptions:

- The product acts as an overlay for Photoshop
- The overlay can communicate with Photoshop through keyboard shortcuts
- The overlay can be used to enable and disable voice controls
- The user has enough hand mobility to be able to press some keys
- The user is able to talk loud enough for voice control
- The user has a microphone to allow audio input into their computer
- The user uses a windows computer to create their art
- The user knows the names of the tools that they want to use, and is able to call upon them
- The product allows the user to create digital art under many circumstances that prevented them from completing projects before

First prototype

Discussion

Much of the explanation of the product can be found above in the detailed design breakdown. In summary, the final product will be a three-part solution containing an external keyboard, voice-command capabilities, and a simplified UI that all work together to make Photoshop a more accessible and enjoyable experience.

The prototypes in this deliverable are low-fidelity. For this project, that means that three parts have been divided and worked on separately. The keyboard has had a quick visualization of possible shapes and numbers of functions available that will be sent off for the client to pick from. The software and overlay prototype is focused on a higher level visualisation of the entire system, as it acts as the central "hub" that intercepts information from the input sources. The voice control has been a focused prototype and has almost been completely built. It is now being tested through dogfooding, where the creation team uses their own product in house (i.e. this team using it to create diagrams). As the final prototype approaches, these three parts will be joined together to create one final product. Since this is the first prototype as well, everything

has been kept low cost. No budget has been spent creating designs, programming the voice control, or in building keyboard designs.

Documentation and explanation

The following two diagrams show a broad overview of the final project. Two input sources, from a microphone or a keyboard, will be linked to a software overlay that will interpret the input and use it to manipulate photoshop. This overlay also acts as an output, showing which tools are selected much clearer than in photoshop.

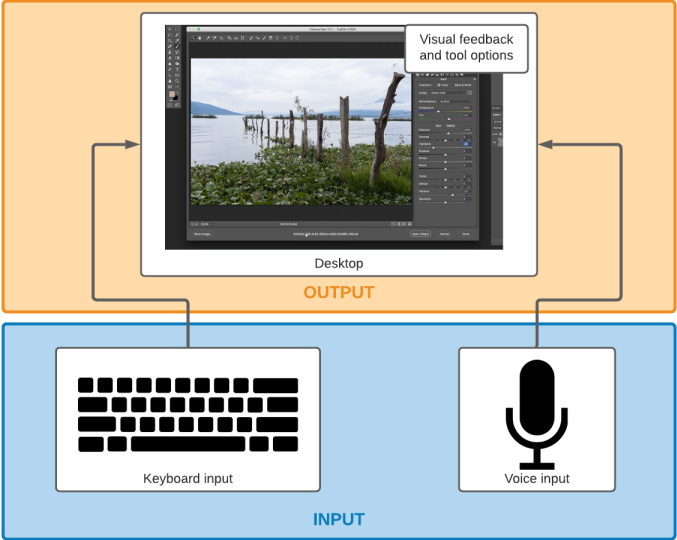


Figure 1: High-level mockup of product design, showing inputs and outputs of system

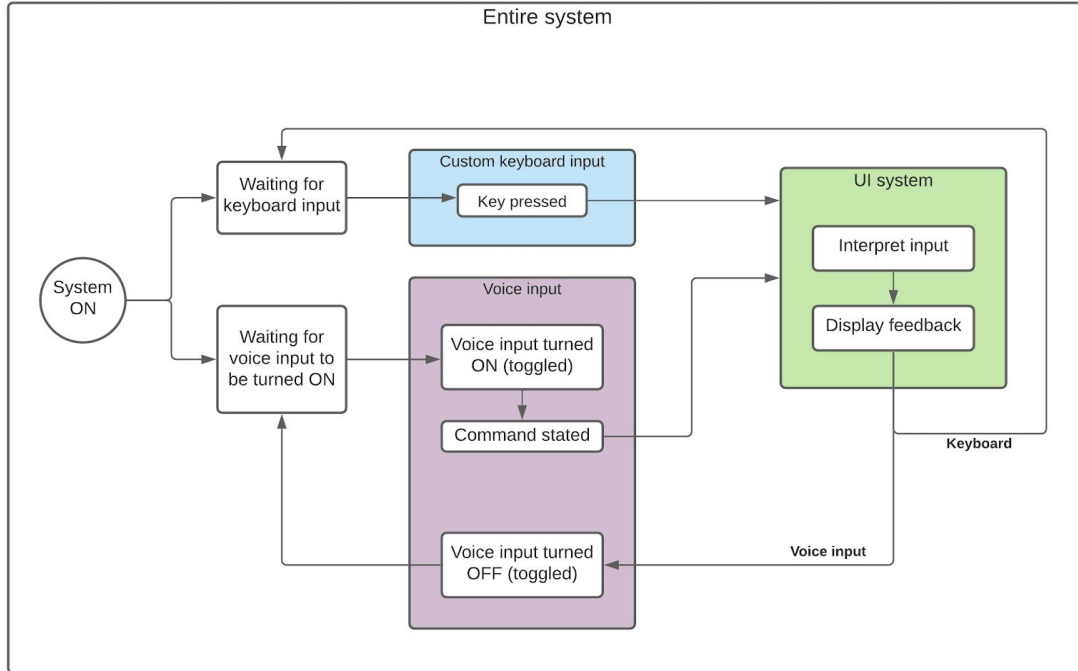


Figure 2: System flowchart, showing the lower-level interactions between components

Custom keyboard

This is an initial render for the custom keyboard. The team will be closely collaborating with the client in order to determine the optimal key layout for their needs. The final keyboard design and render may differ from the current render. It will be designed with Fusion 360 and rendered with an on board rendering engine.

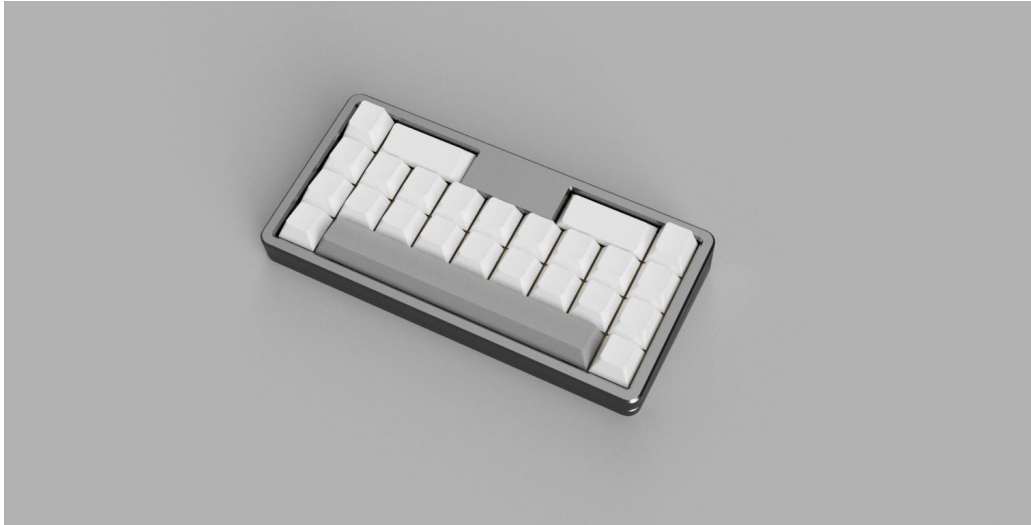


Figure 3: Render of sample keyboard

Potential layouts

These following options, along with a list of possible photoshop tools for each key, will be presented to Madii so that they can pick which design they would most appreciate and where they would like each tool's key. If none of them fit their needs, a new design can be brainstormed.

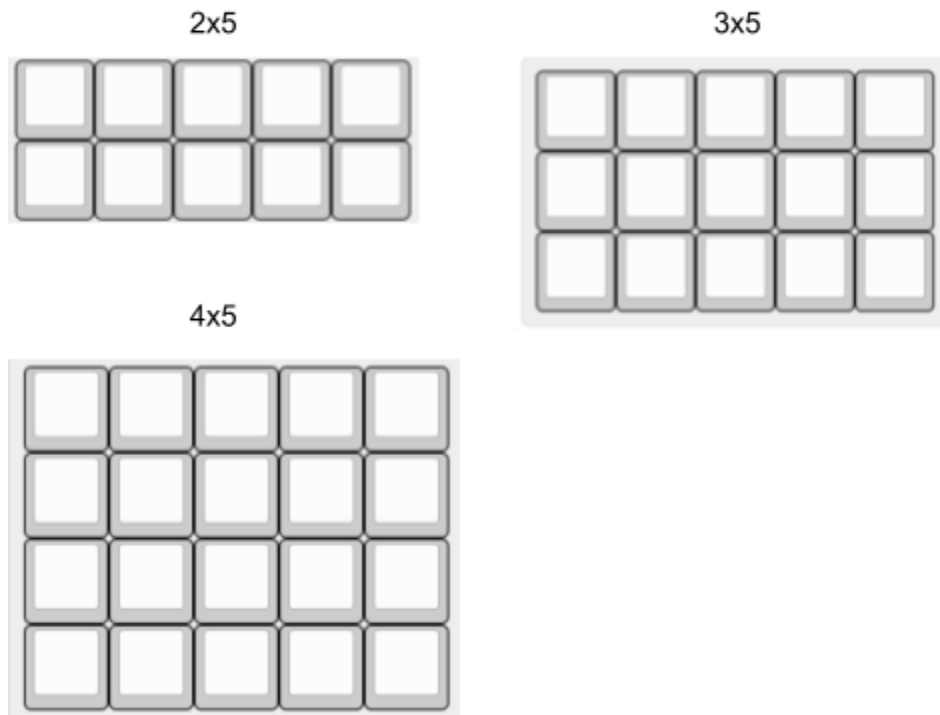


Figure 4: Examples of possible keyboard layouts

Voice command system

This voice command system uses the GAVPI software to map voice commands to keyboard commands and even entire keyboard shortcuts. Currently there are 140 different possible voice commands recorded in the software, though this number might increase. Of these 140 different voice commands though, only 16 use “unique” voice paths. Part of these voice paths is a confirmation from the computer that the action has been completed. This is done through an automated voice and audio feedback.

For some examples of pathways, see Table 4 below. Included is the desired effect in Photoshop, the voice commands one would have to say for that effect, and then embedded keyboard shortcuts that GAVPI runs through. In the final product, a user manual will be provided with an all encompassing library of possible commands.

<i>Table 4: Examples of common Photoshop pathways</i>		
Photoshop Feature	Voice Commands	Keyboard Shortcut Pathway
Open New File	“New File”	CTRL+n
Increase Paint Brush Size	“Brush”, “Increase Size”	b,]
Duplicate Layer	“Access Layer”, “Go Down”, “Enter”	Alt, right x4, down, down, enter
Write a common word (like “Cat”)	“Text”, “Left Click”, “Type Capital C”, “Type a”, “Type t”, “Enter”	t, left click, Shift down, c, Shift up, a, t, enter
Zoom to full screen canvas	“Toggle toolbars”, “fit to screen”	Alt, CTRL+0

Desktop UI

The desktop user interface (UI) intercepts keyboard and voice input and outputs relevant information to the user. A flowchart describing its functionality is shown below (Figure 5). Low-fidelity prototypes of the components have been created for the UI output, and their exact aesthetics and layout will be refined in future client meetings and prototype iterations.

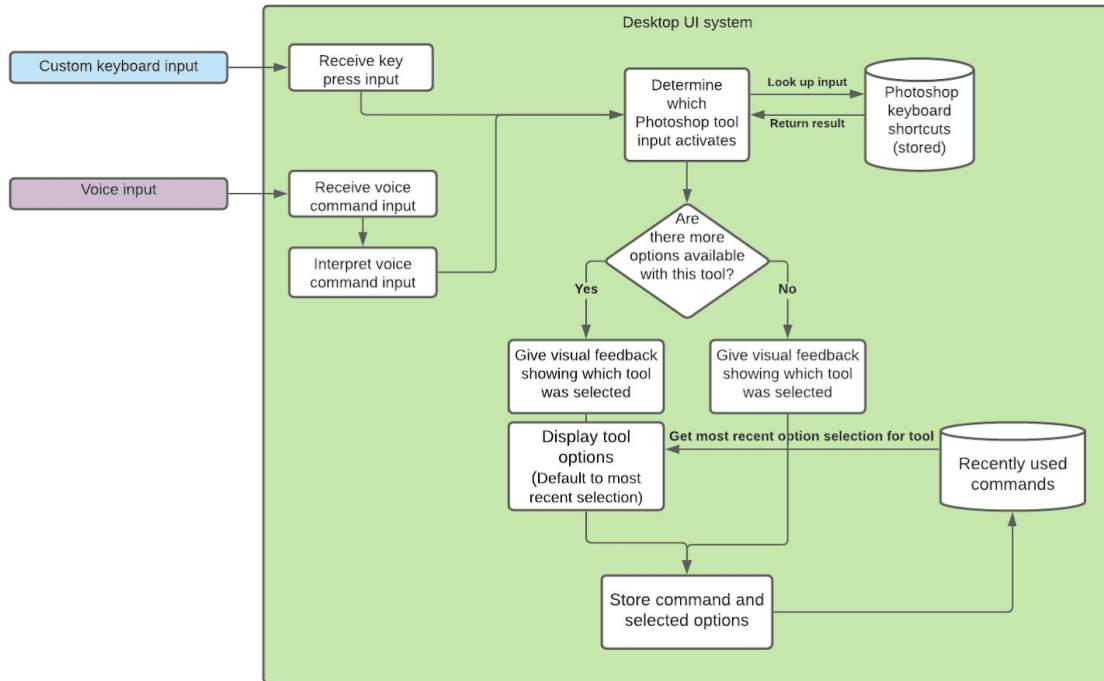


Figure 5: Desktop UI flowchart

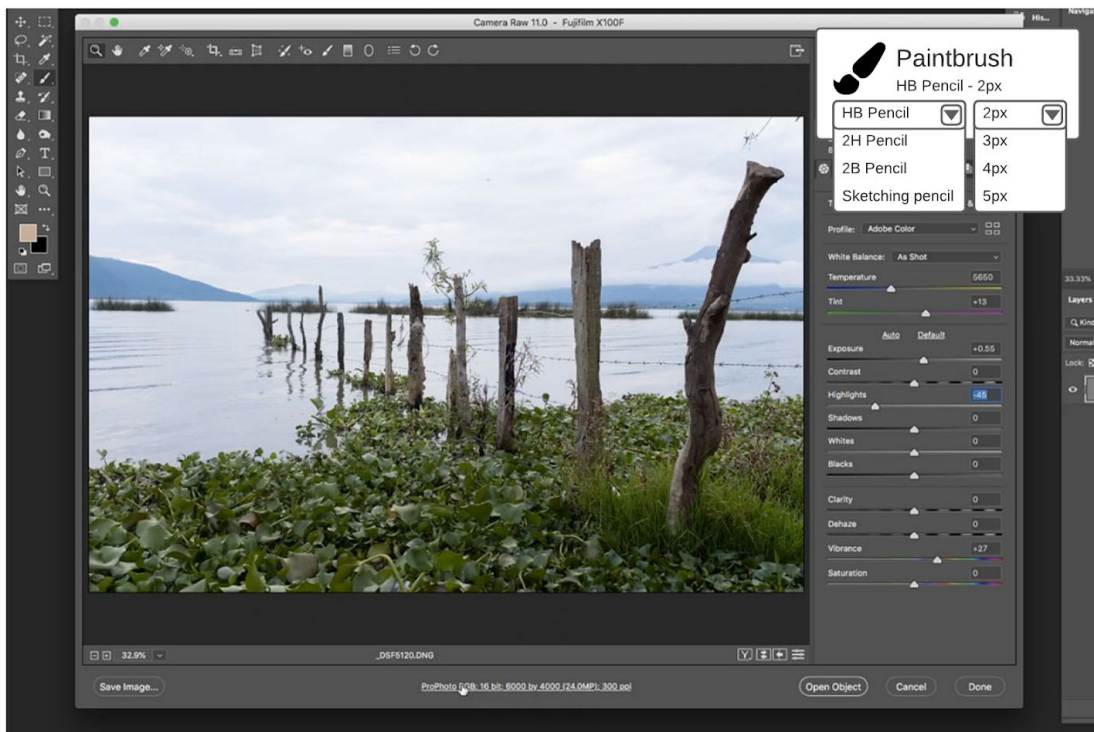


Figure 6: An example demonstrating relative size and location of the UI overlay

Color picker

A newly designed colour picker is shown below. It features an option to pick from predetermined colour palettes, a project palette that shows common colours that have been used in the project so far, separations between neighbouring colours, and an RGB colour selector. Instead of sliders, these values can be adjusted using button inputs to avoid accidentally creating a sudden red. The entire design is focused around avoiding red and avoiding having the colours arranged in a “cloud” so that Madii knows precisely which colour they are using.

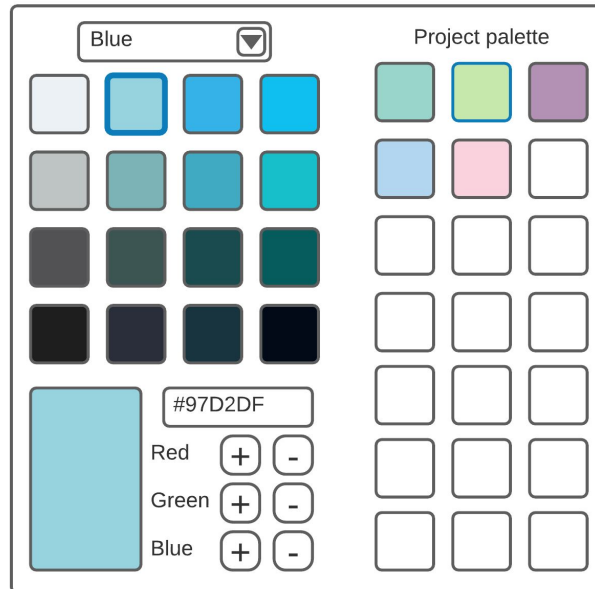


Figure 7: Example colour picker

Brush and tool options

Following are two examples of visual feedback for further tool option selection. These would change as different paint brushes or fonts are selected.

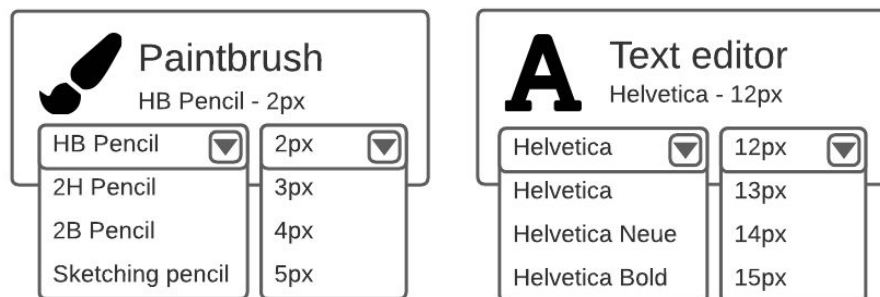


Figure 8: Mockups of visual feedback for tool selection

Testing

In the testing section of this document, how each of the parts of the overall prototype work to meet the design criteria established in Deliverable B as well as their respective testing methods are explored. Because product assumptions were decided based on the design criteria and the client interviews, it seems fair to compare them to the metrics established in previous deliverables. Immediately below is a table with the target specifications and ideal values from Deliverable B.

<i>Table 5: Target specifications from Deliverable B</i>				
	Metric	Units	Ideal	Acceptable
1	UX as empathetic with client	Personal ranking	5	4-5
2	Number of repeatable functions	Positive integer (count)	100	20-100
3	Icon size	px or cm (on-screen)	50px/2.5cm	35-100px/ 1.4-3.0cm
4	Customizability	Personal ranking	5	3-5
5	Number of commands recorded	Positive integer (count)	100	50-100
6	Assistive features	Personal ranking	5	5
7	Prevalence of red	% on startup	0%	<10%
8	Presence of fast pop-ups	Yes/No	No	No
9	Hardware Integrability	Personal Ranking	5	5

Using the above target specifications, the ideal values for each of the prototype parts have been listed in a table below. Because this project has broken into three parts, it is important to see how each individual part helps to reach the final project target specifications. Table 6 shows a breakdown of how each individual part will be tested for each metric.

Table 6: Partitioned prototypes and their ideal target specifications

Metric	Custom keyboard	Voice command system	Desktop UI
1	5	5	5
2	100	100	Maximum of value for keyboard and voice command
3	1.4cm	50px	5cm x 3cm
4	5	5	4
5	0	0	10
6	4	5	3
7	0%	0%	<10%
8	No	No	No
9	5	4	5

Custom keyboard

Since this is a low-fidelity prototype and the keyboard components can only be purchased once, it is important to decide on a final design before beginning construction. Because of this, testing focuses on client empathy, ensuring that they feel comfortable with the keyboard and options they would receive.

Table 7: Keyboard prototype and how it will be tested

Metric	Testing performed
1	UX as empathetic with client
2	Number of repeatable functions
3	Icon size

Offering between three choices. At the time of writing, the client has not decided on which they would prefer, but the test will conclude once they decide on a shape.

Either 10, 15, or 20 based on client choice

Standard keyboard size (14mm), extra spacing between

4	Customizability	Based on client choice.
5	Number of commands recorded	N/A
6	Assistive features	
7	Prevalence of red	Keyboard will remain monochromatic (black or white)
8	Presence of fast pop-ups	No
9	Hardware Integrability	Simple connection to the PC through USB.

Voice command system

The voice command system works by using keyboard shortcuts already built into photoshop. Because each voice-command is mapped to a keyboard pathway, they can be tested using an online “keyboard press detector” to ensure the input is going through the right keys. Additionally, the system can be continually tested throughout the project as photoshop is used to create artwork and displays for other deliverables.

Table 8: Voice command prototype and how it will be tested		
Metric		Testing performed
1	UX as empathetic with client	The UX to program is not the friendliest, but it is simple once the initial programming is done. Will be tested with the Client. Dogfooded as well
2	Number of repeatable functions	Testing will be done to see if the number is too overwhelming.
3	Icon size	N/A
4	Customizability	Agile style testing to ensure the client is happy with the final result
5	Number of commands recorded	Testing will be done with the client and through dogfooding.
6	Assistive features	Continued testing to see if the voice input is at an acceptable quality for aid.
7	Prevalence of red	N/A
8	Presence of fast pop-ups	N/A

9	Hardware Integrability	Test with clients specific microphone and shortcuts
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Desktop UI

The desktop UI is tested using an agile design system, where constant feedback between the client and the development team ensures that the final product is functional and polished.

Table 9: Desktop UI and how it will be tested		
Metric		Testing performed
1	UX as empathetic with client	Looking at the size, shape, and feel of the UI component mockups that have been created
2	Number of repeatable functions	N/A
3	Icon size	Measured based on UI mockups
4	Customizability	Measured based on UI mockups
5	Number of commands recorded	Estimated for the moment; will start at 10 but depends on the method of storage chosen in upcoming prototypes (e.g. Array, text file, json, database)
6	Assistive features	For the UI alone, there are very few accessible features other than large icons and font size. This is not the accessibility-focused component of the overall design.
7	Prevalence of red	Due to the color picker, it is impossible to completely eliminate red from the design.
8	Presence of fast pop-ups	The animation speed for dropdown menus will be controlled to a slow animated slide.
9	Hardware Integrability	The primary goal of the UI system is to integrate the keyboard and voice input systems and can be controlled using the Wacom tablet as a mouse.

Plan for presentation and next client meeting

In the presentation, the group hopes to show off a combination of each of the parts of the prototype. Since the keyboard and UI remain very conceptual prototypes, they can be demonstrated in the presentation and client meeting through diagrams. However, since the

presentation is ten minutes long, if there is time the voice control functionality can be demonstrated to show just how effective the prototype is.

Bill of Materials (BOM)

Since this project does include hardware, a keyboard, it will need a complete Bill of Materials (BOM). However, since the final price is still undetermined (due to the need for client input on design), the BOM remains a rough estimate. Since the keyboard options presented show a minimum of 10 keys and a maximum of 20, these values are used to give a rough quoted price range. This quoted price range does not include the price of parts that cannot yet be determined or the price of shipping, but seeing the current number, keeping the project within budget seems more than possible. Most of the materials for the BOM are for a custom circuit board, the electronic components and other various components required to make the keyboard.

Table 10: Comprehensive Bill of materials (BOM) for the keyboard prototype			
Component	Description	Quantity	Price (\$)
ATMEGA32A-PU	Microchip	1	4.67
1-2199299-5	DIP Socket	1	1.15
512-1N4148TR	Semiconductor	Number of switches	0.07*Quantity
TZX3V6A-TR	Semiconductor	2	0.27
MF-R050	Circuit protector	1	0.46
603-CFR-12JR-52-75 R	Carbon-Film resistor	2	0.14
MFR-12FTF52-1K5	Resistor	2	0.19
MFR-12FTF52-10K	Resistor	1	0.19
UMT1H4R7MDD	Capacitor	1	0.28
RD71H104K0M1H03A	Capacitor	2	0.41
RCE5C2A220J0A2H03B	Capacitor	2	0.64

ABL-16.000MHz-B4Y	Timing crystal	1	0.45
MJTP1230A	Tactile switch	2	0.26
LTL-4222	LED light	1	0.16
68602-406HLF	Wire housing	1	0.39
USB4085-GF-A	USB receptacle	1	1.3
PCB	Keyboard Shell	1	Undetermined as of right now
Standoffs & Screws	Screws	1 set	5
Switches	Switches	Number of switches	0.4-0.7 * Quantity
Keycaps	Keycaps	Number of switches	Undetermined as of right now
TOTAL:			~\$22.57-\$27.27

Project Plan Update

A copy of the updated project plan can be seen below. Due to sickness, Austin was less available for this deliverable, and due to midterms and other requirements, both Callum and Ellie will be less available for Deliverable E. With this in mind, tasks have been grouped up, and we have all pitched in to give extra help to complete these deliverables. Attached with this deliverable is a PDF copy of the project plan in higher resolution.

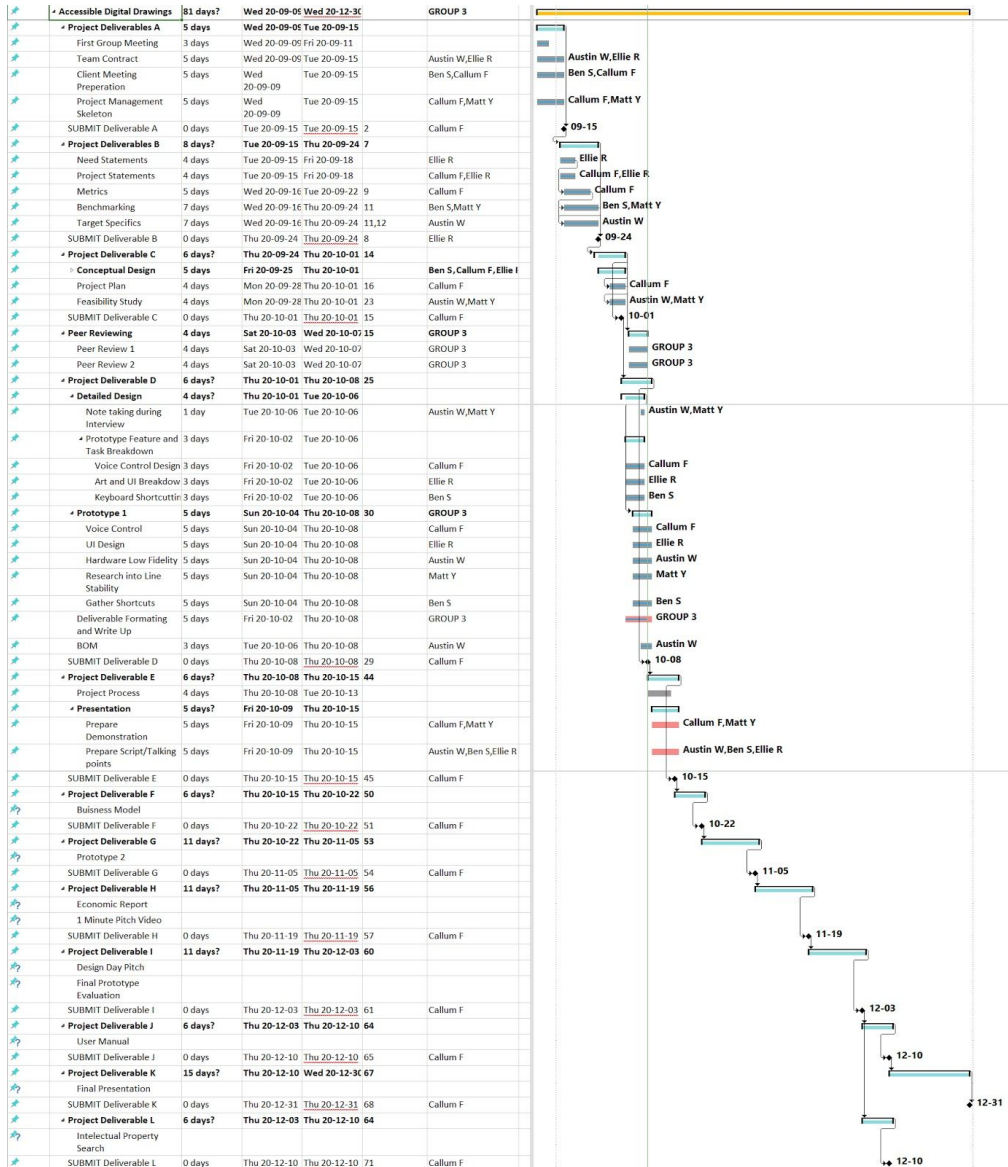


Figure 9: Updated project plan for Accessible Digital Drawings group A03

Appendix

A. Visual representations of Solution 1, as presented to the client in meeting 2.

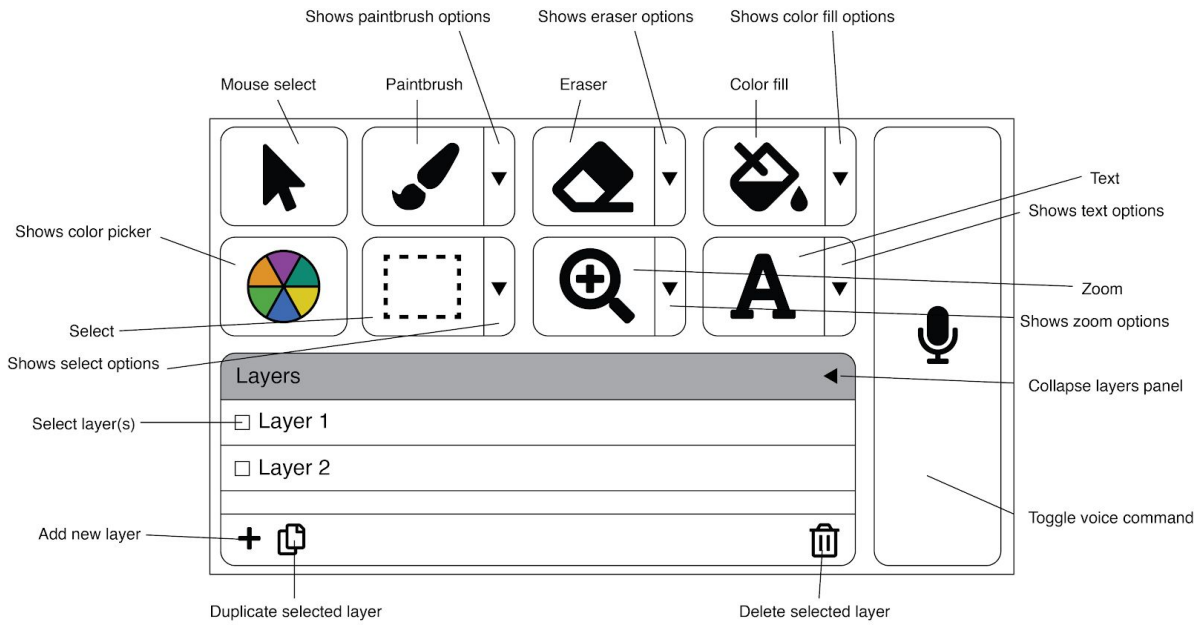


Figure 10: Potential UI design

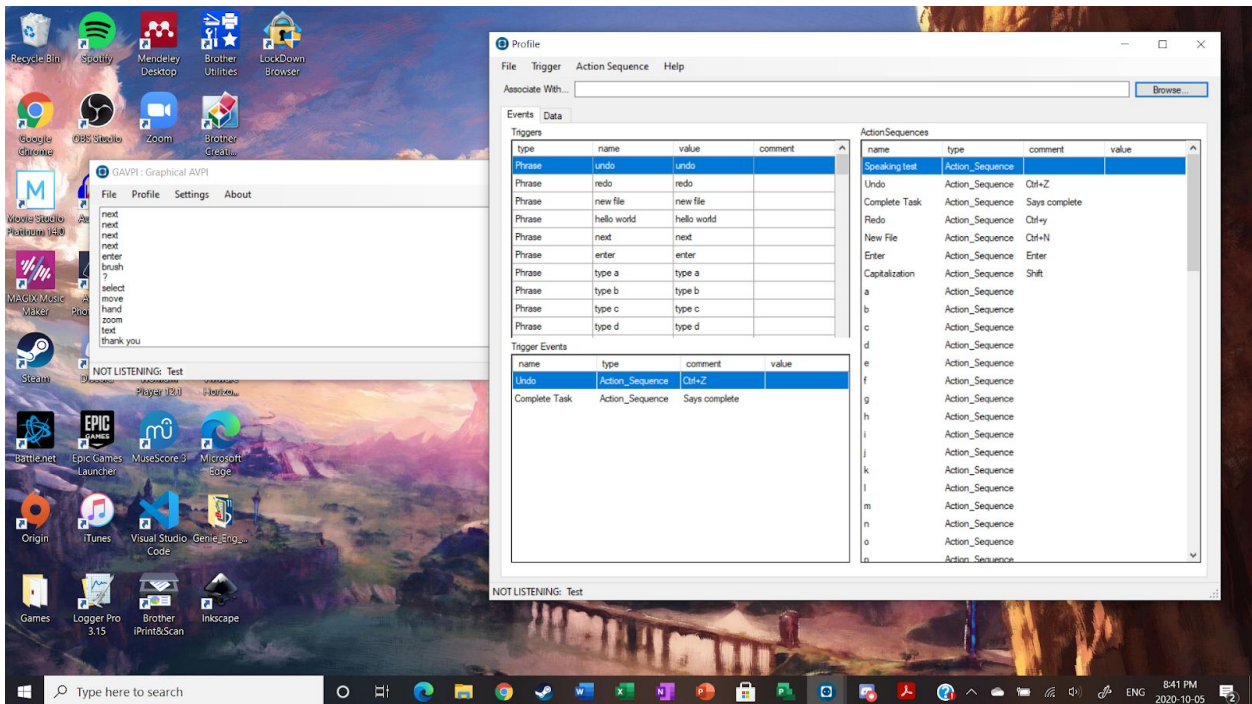


Figure 11: GAVPI voice command system

B.

Table 11: Glossary of frequently used Photoshop commands and their keyboard shortcuts			
Frequently used		Less commonly used	
Function	Shortcut	Function	Shortcut
New	Ctrl+N	Close All	Alt+Ctrl+W
Open	Ctrl+O	Revert	F12
Close	Ctrl+W	File Info	Alt+Shift+Ctrl+I
Save	Ctrl+S	Print One Copy	Alt+Shift+Ctrl+P
Save As	Shift+Ctrl+S or Alt+Ctrl+S	Fade	Shift+Ctrl+F
Print	Ctrl+P	Paste Special > > Paste in Place > Paste Into	Shift+Ctrl+V Alt+Shift+Ctrl+V
Exit	Ctrl+Q	Layer via Copy Layer via Cut	Ctrl+J Shift+Ctrl+J
Undo	Ctrl+Z	Refine Edge	Alt+Ctrl+R
Forward	Shift+Ctrl+Z	Extras	Ctrl+H
Cut	Ctrl+X or F2		
Copy	Ctrl+C or F3		
Paste	Ctrl+V or F4		
Free Transform	Ctrl+T		
Transform > Again	Shift+Ctrl+T		
Color Settings	Shift+Ctrl+K		
Modify Keyboard Shortcuts	Alt+Shift+Ctrl+K		
Menus	Alt+Shift+Ctrl+M		
Preferences > > General	Ctrl+K		

New Layer	Shift+Ctrl+N		
Select > > All > Deselect > Reselect > All Layers	Ctrl+A Ctrl+D Shift+Ctrl+D Alt+Ctrl+A		
Group Layers Ungroup Layers	Ctrl+G Shift+Ctrl+G		
Arrange > > Bring to Front > Bring Forward > Send Backward > Send to Back	Shift+Ctrl+] Ctrl+J Ctrl+[Shift+Ctrl+[
Merge Layers Merge Visible	Ctrl+E Shift+Ctrl+E		
Zoom In Zoom Out Fit on Screen 100%	Ctrl+= Ctrl+ Ctrl+0 Ctrl+1 or Alt+Ctrl+0		
Show > > Target Path > Grid > Guides	Shift+Ctrl+H Ctrl+' Ctrl+;		
Rulers	Ctrl+R		
Snap	Shift+Ctrl+;		
Lock Guides	Alt+Ctrl+;		
Actions > > Brush > Color > Info > Layers	Alt+F9 or F9 F5 F6 F8 F7		
TOOL SELECTION			
Move Tool	V	Color Replacement Tool	B
Rectangular Marquee	M	Gradient Tool	G

Tool Lasso Tool Magic Wand Tool	L W		
Eyedropper Tool Color Sampler Tool Ruler Tool Note Tool Count Tool	I I I I I	Burn Tool Sponge Tool	O O
Crop Tool Slice Tool Slice Select Tool Spot	C C C	Foreground/ Background Colors	D
Healing Brush Tool Patch Tool	J J	Switch Foreground/ Background Colors	X
Brush Tool Pencil Tool Mixer Brush Tool	B B B		
Clone Stamp Tool Pattern Stamp Tool	S S		
History Brush Tool	Y		
Eraser Tool Background Eraser Tool Magic Eraser Tool.	E E E		
Paint Bucket Tool	G		
Pen Tool	P		
Horizontal Type Tool Vertical Type Tool	T T		
Path Selection Tool	A		
Rectangle Tool Line Tool Custom Shape Tool	U U U		
Hand Tool	H		
Rotate View Tool	R		
Zoom Tool	Z		

Toggle Preserve Transparency	/		
Decrease Brush Size Increase Brush Size	[]		
Decrease Brush Hardness Increase Brush Hardness	{ }		
Previous Brush Next Brush First Brush Last Brush	, . < >		