University of Ottawa
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Deliverable D: Detailed Design, Prototype 1, BOM, Peer Feedback and Team Dynamics
Lab Section A04 Team_18
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Introduction and Client Feedback

Our client (Kim) was generally pleased with our first prototype and current design. We were able to design a prototype that included the vast majority of the client needs that we had documented. In our second client meeting, Kim gave us further feedback with regards to exactly how our product would function for her and what materials she feels would be appropriate for our product. This included possible surface area restrictions on each door panel as she was unsure whether full braille words would fit comfortably. In the case that they did not, she liked our suggestion of raised symbols she could feel, provided we accompany the device with a sort of legend/translator so she knows what each symbol represents. She was also happy with the questions we had to help us understand what her experience is like. From her tone of voice and her responses, we felt she was satisfied in the meeting, and felt as if she was being heard. Below are some important notes that summarize the feedback that our client had for us as we continue developing our design and prototypes:

- Materials are important (for texture and comfort when locating correct door panel)
- Locator dots could be confused with the door handle (we emphasized the door handle would be raised with respect to the braille however)
- Audio tutorial or physical manual legend for what each symbol means (this is in the case we do not have enough room on each door panel for full braille words of the stove function beneath)
    - Shape symbols or some other simple symbols would be preferable
- Different doors themselves may be different textures to help differentiate between the button beneath
- Sound system was well received however we need to check if the stove already makes sounds upon button activation because then our sound system would be redundant

Updated Design

Sound subsystem

(Azan and Kyle)

- **Note: We are exploring this area and creating separate prototypes to test its feasibility in the final product. It is possible this subsystem may not appear on the final product but exploring the area is important since the client did show interest in it being a safety feature.**
- Buzzer sound for doors relating to turning on and off the stove (Critical Functions)
- It is redundant to have every door result in a buzzing sound to indicate if critical functions (like turning on or off any heating pad) will be activated by this door.
- The doors of the grid have 2 potentially different designs.
    - The preferred and likely design will close the circuit when the door is open by using a sliding ribbon which will connect 2 metal contacts when the ribbon is pulled by the door.

    - The 2nd but more durable and easier design closes the circuit when the door is closed by having metal contacts on the edge of the door and frame.
- The circuit will be a series circuit with a resistor (calculations have yet to be determined) (resistor is in to avoid damage to the battery in a short circuit) and a potentiometer (for volume control) with the buzzer and battery.
    - If the circuit is closed when doors are closed, the doors will be in parallel to the buzzer
    - If the circuit is closed when doors are open, the doors will be in series as well as an additional capacitor in parallel to the battery.

Grid Subsystem

(Muiz, Lauren and Patrick)

- Locator symbols will be part and parcel with the door of each button. This will be achieved by 3D printing each door and including the symbols in the design of the door so the entire component is one unit. This negates the client's previous issue of having locator dots fall off at inopportune moments.
- Door panels may be a different material than the main grid based on what the client says in regards to the feel of the braille dots and what we as a team feel is appropriate given the conditions of operation around a kitchen (water/food spills, heat from the stove).
- The grid itself will be made out of sheet metal. We are considering having an outer textile covering (other possible materials include rubber, plastic etc) so in the event steam rising from things cooking makes the metal hot, the user will not burn themselves if they brush the grid.
- Hinges will be bought to size for each door panel and screwed into the grid sides.
- On each door panel, a small hook (eye hook?) will be screwed into the door to allow the user to open it. As mentioned previously, this hook will be notably "taller" by means of depth in relation to the locator dots so the user can effectively feel the correct words.
- NO SPRINGS: we have discarded the idea of springs to automatically close the door once the user has pressed the desired button beneath. The user can close the door manually.
- Attaching the device to the stove control panel on the backboard.
    - Long adjustable straps attached to the back of the grid that then goes behind the stove and hooks/wedges onto the bottom of the stove (wedge will be malleable and adjustable for the height of the stove and to fit into the cavity beneath the stove).
    - Velcro/magnets (depending if the stove blackboard is magnetic) will be stuck to the stove and to the device to prevent lateral movement.

Critical Product Assumptions

Below, we have outlined several assumptions we have made as we developed our proof of concept and further ironed out the details of our design. Some are assumptions that all users

will be generally similar to our client (ex/ can read braille) and some are related to the production of our product (access to the machine shops).

- Client has a working sense of touch (and is relatively sensitive to closely packed groups of locator dots)
- Client is able to understand symbols/braille by feeling with their fingers
- Client is able to accurately open small doors (such like those in pill boxes)
- The product would not be submerged in a liquid or food for long periods of time
- We assume we will have access to a 3D printer
- We assume we will have access to sheet metal and have the ability to deform sheet metal
- The stove backboard is magnetic
- The stove does not make its own sounds and thus, our sound system is helpful for the safety and efficient operation of the device for the user

Prototype 1

Purpose: This prototype is a proof of concept. It is for visualizing what our device will look like on a high level and ensuring there are no major problems we have overlooked.

Type of prototype: This prototype will be low-fidelity and focused on the door hinge subsystem. However the hinge mechanism in our final design will be smaller and more concealed than the hinge mechanism in the prototype figures below. This prototype is for communication between our group and the client as well as testing the positioning on the stove.

- Cardboard grid
    - This will not be full size however it will show the button boxes, placement and positioning of the hooks, braille and hinges.
- Attaching subsystem (straps)
    - These are made of string with pool noodle attached to the bottom to simulate a wedge to help secure the line underneath the stove.

With our door subsystem, we have brainstormed some questions and metrics that will need to be evaluated by measuring the actual stove in question (to be done the weekend of Oct. 8). Below are things we will be looking for:

- When looking at the stove:
    - Numbers of buttons
    - Surface area of each button (dimensions of the heat pad)
    - Dimensions of the overall control panel
    - Dimensions of the overall backboard
    - Distance from the top of the backboard to the bottom of the stove (for length of the straps/magnets)
    - Hinge dimensions (related to the size of each button function)
    - Is the stove magnetic? (backboard, element surface… etc)

Below, we have documented our first prototype with several pictures and explanations.

Figure 1: Frontal view of the device positioning

From the above picture, the placement of the grid on the stove panel can be seen. This stove is controlled by a touch screen and so the burner adjusters are separate however the general idea is clear. On the stove presented by the client, all functions are grouped on one panel and can be covered efficiently by the grid.

Figure 2: Depth positioning of the device on the stove

The above picture shows the thickness of the grid relative to the control backboard of the stove. This prototype is about 2 cm thick and we will finalize this dimension for our final product based on testing and once we get measurements for the actual stove.

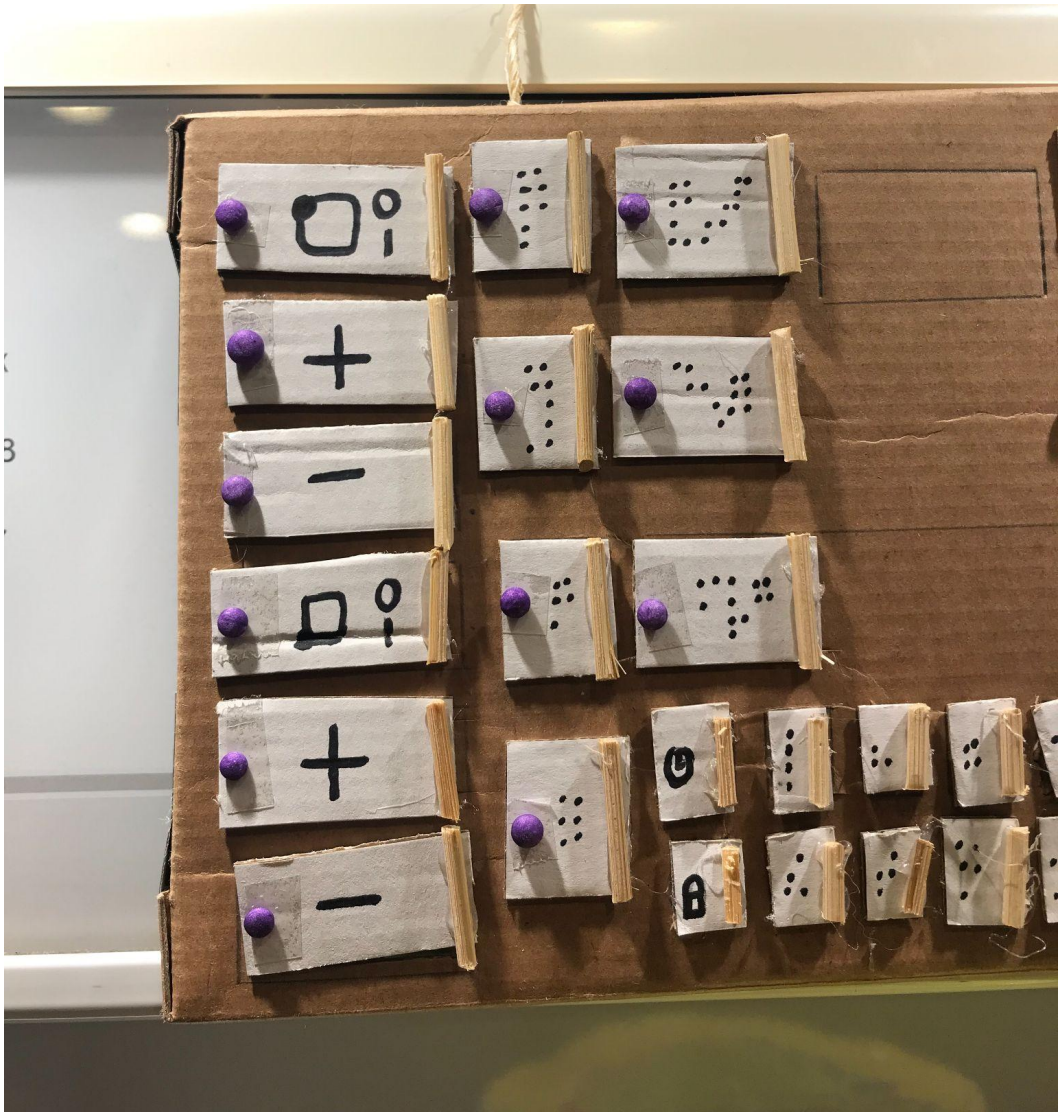

Figure 3: Close-up showing door placement, hinges, braille locators and hooks

The above picture shows an oversimplified version of what our final product will look like. Each door will have a hinge on the right hand side for opening and closing (represented above by a wooden stick). The left hand side will have a hook (represented above by a purple ball) which the client can grab and pull to open the panel. Each panel will have braille words or symbols (represented by raised dots) which allow the client to read what the function of each button is underneath. We are still discussing whether symbols or braille words will be used and this is why a combination of both have been used to represent the button functions.

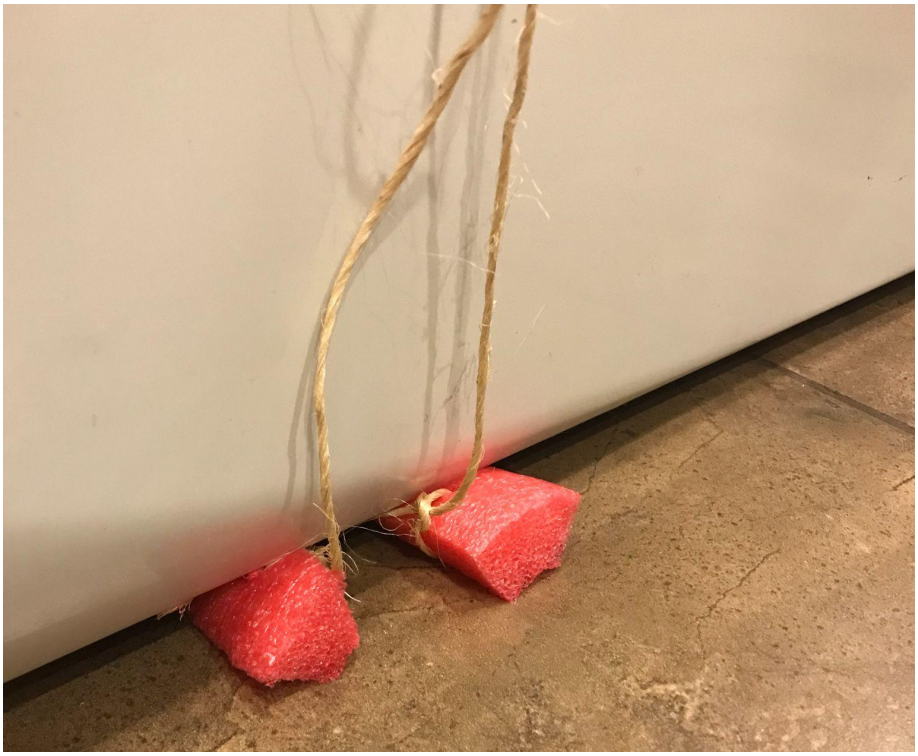

Figure 4: The stops trail the back of the stove to lock it vertically.

The above picture shows the stops which will ideally be adjustable on the ends of the retaining straps. These are passed over the backboard of the stove and are jammed underneath to prevent up and down movement of the device once it is in place on the stove control panel. Lateral movement of the grid will be stabilized by velcro stuck on the face of the backboard (or magnets however this will also be decided once we view the real stove in question).

Figure 5: The underside of the grid

The above picture shows the underside of the grid and how each door panel will open to its own compartment. In this way, the user is prevented from touching other buttons when attempting to activate the one in question. The grid once again will be to the dimensions of the stove in question.

Prototype 2

In this following section, we give a brief overview of our second prototype. These ideas may be subject to change as we continue our research and testing however.

Purpose:

- How hot will the grid become?
- Are the hooks and braille easily differentiable?

- Are the grid dimensions done properly in accordance to the actual stove (test by going back to the store and testing device placement)

Type of prototype: This prototype will be a high fidelity prototype with respect to the grid. Actual dimensions will be observed along with functioning door panels and hinges. It will still be low-fidelity in regards to the material because although we will test material heat resistance, this will be separate from our prototype which will be constructed from plastic. It will also be comprehensive in the sense that we will show our first formal iteration of the sound subsystem. Further details on the latter below.

Sound subsystem: Proof of concept:

- 3D print an actual dimensioned product
- First iteration of the sound system
    - Purpose
        - Do the benefits of the sound system outweigh the consequences of using the sound system
        - How loud would the sounds be
        - Does the volume control appropriately control the volume of the buzzer?
        - Is there any risks of a short circuit when enclosed inside the dimensioned product
        - How often will the battery need to be replaced?
        - Is it easy to replace the battery?
    - Type of prototype
        - This subsystem prototype will be a comprehensive, high fidelity prototype with respect to the sound system. This prototype will test how well the sound system integrates with the grid. The prototype is based on one of 2 designs (selected on which “open-door detection” method we choose) using the electrical parts that will be used in the final product. We will also be checking how this system may negatively affect the function of the grid, or potential problems in everyday use.

Testing Plan and Results

The purpose of this prototype is to visualize the product and make sure the functional decomposition we specified will be satisfied by our design. To do this a small cardboard focused prototype with locator functionality will be tested for the following criteria.

1) Allows user to identify a stove function (efficiently)
2) Allow user to position the grid effectively on the stove control panel
3) Allows user to comfortably feel their hand across the grid panel
4) Allows user to easily strap it to front of stove

These criteria will be tested by a team member who didn’t participate in the building of this prototype, or family member. They will attempt to locate a specific button blindfolded. Their time and ease of feeling the panels will be recorded. This test is slightly inaccurate as none of

us have connections to people who are able to read braille and so it is likely the times will be higher than what they would be for our target audience. Each person was asked to perform the task twice and they were asked to provide feedback, comments and concerns at the end. Another thing to note is these tests were performed on an induction stove with manual buttons spread out along the entire backboard of the appliance (as seen in the proof of concept pictures). Therefore, the positioning and location of buttons is not the same as the actual stove we are designing for.

The strap subsystem will also be tested by fastening the cardboard grid to a stove using our design and seeing if the grid remains in place. As well, the time to set up will be recorded. The same individual who performed the test blindfolded will now attempt the set up without aid again with the time being recorded to evaluate if the design is easy to use for a blind person (a need of the client was independence of use and when setting it up).

The design criteria being tested with this prototype are the same as those from deliverable B. For future testing, as a team we are brainstorming ways to test from the perspective of a blind person as right now, some of our future design criteria will be difficult to pinpoint without a strategy (whether symbols or full braille words are better assuming the surface area of the door panel constraint is satisfied).

Results

Table 1: Results from the testing of the proof of concept

Design Criteria	Task Measured	Test Volunteer 1		Test Volunteer 2		Comments
		Attempt 1	**Attempt 2**	**Attempt 1**	**Attempt 2**	
Usability D: Time for first time set up (no visual component s) or set up time	Time for installation of grid on the stove	6.5 mins.	5 mins.	7.75 mins.	5 mins.	-strings were awkward to deal with when attempting to position the grid -pool noodle wedge worked well as a stopper to hold the grid in position vertically
Usability A: Time to locate an element of the interface	Locating a stove function	5.25 mins.	4.75 mins.	4 mins.	4.5 mins.	-generally not a useful test for a sighted person with a blindfold
Comfort	Hand feel as it is slid across the grid panels	N/A	N/A	N/A	N/A	-uniform aspect of grid (hinges, hooks, etc) on panels always in the same place makes it helpful and consistent -not the actual device material but the cardboard was not uncomfortabl e

Potential Problems with our Design

Below, we have outlined some potential problems we may encounter in the construction of our design. Some of these were exposed during our second client meeting on October 5, 2021.

1. If a sighted person were to use this device, they may struggle to efficiently push the correct buttons because each touch button will be covered by a door inlaid with braille that the person may not be able to understand.
2. If we include the sound subsystem, washing the device may become an issue as electronic components may become damaged
3. If the body of the device is made of sheet metal and we provide a textile covering in the situation where the user brushes the potentially hot surface, this covering may become loose or ruined in the washing process.

Bill of Materials (BOM)

In order to determine amounts of each material, we will need to know the dimensions of the stove as well as the number of buttons. Our plan is to go physically look at the stove on the weekend of October 8, 2021 and from that point, we will have a better idea of how much of each material is needed. Some price slots are not applicable as of right now as we have no idea the amount we will need or the type to buy. Below is our bill of materials. It is an elementary first draft of what we expect to need in the coming weeks, however it may be subject to change once we do more research.

Table 2: Bill of materials

Material	**Amount**	**Price**	**Location**	**Purpose**
Door panels	~40	Depends on cost of 3D printer material	MakerLab	To cover each heat-sensitive button and provide flat surface area for braille.
Hooks	Dependent on number of doors	$0.81 / hook	Home Depot	Place to grab and open the door.
Hinges	40	$6.06	Etsy	Opening mechanisms.
Covering for outer surfaces of the grid box (rubber/plastic - textiles?)	Dependent on the sizing of the stove and our heat testing results.	N/A	Fabricland	Outer grid covering to prevent the sheet metal from heating up.

Main grid base - sheet metal (aluminum)	TBD	TBD	Makerlab?	Main base-plate of the device.
Retaining straps	2	TBD	Amazon	Secure the device on top of the stove control panel via wedges between the stove and the floor.
Velcro (command strips)	2	$8.51 for 4 pairs	Amazon	Stuck to the stove backboard and the device to prevent lateral motion.
Resistors	1 resistor in final 120 for testing	1 dollar for pack	(Already owned)	Buzzer Circuit
Potentiometer 10k	1	$1.50	(Already owned)	Buzzer Circuit volume control
piezoelectric passive buzzer	1	50 cents	(Already owned)	Buzzer circuit sound
Ceramic capacitor 10uf	1 (2 for testing)	50 cents	(Already owned)	Buzzer circuit
1 slot plastic battery case for AA battery	1	12 dollars for 8 pack including cases that can hold multiple batteries in case specifications change	Amazon	Buzzer circuit power delivery
AA Battery	1	$9 for pack of 4	(Already Owned)	Buzzer circuit power delivery
electrical wire	TBD	Between $1-5 per metre	TBD	Buzzer circuit

Conclusion

After our second client meeting on Tuesday, October 5, 2021, we gained some important insight into potential directions to take with our design and also things that could be problems such as use by a sighted person. The client liked our design as was evident in the tone of her voice and her many questions for us. We had a good discussion about each functionality and how it would all come together.

For our first prototype, we developed a proof of concept from cardboard, tape, string, foam and pool noodles to represent our grid system. This can be seen in **Figures 1-5.** It was low fidelity and was for testing the strap mechanism for holding the grid vertically on the backboard of the stove. It was also for testing the feel of sliding the user's hand across the panels and the placement of the door panel elements including the hinge, hook and braille locator dots. The testing was elementary and concise as the actual functionality of our prototype was limited. We didn't want to advance too far without the actual dimensions and features of the stove presented by the client. **Table 1** outlines results. For future testing, we will be developing a better system to produce testing similar to how a blind person would use the device. Our lack of knowledge about braille is the current obstacle. **Table 2** shows our bill of materials. As of right now, we are unsure as to the quantity of many components and in some cases (ex/ the covering for the grid) the type as well. Therefore, it was difficult to specify these two properties respectively.