Enhanced Interface for GE 1.6 Cu. Ft. Countertop Microwave Oven JES1656SJ*†

Human-Computer Interaction

Athens University of Economics and Business
Department of Informatics

Georgios Syros, Anastasios Toumazatos, Fotios Bistas
p{3190193, 3190198, 3190135}@aueb.gr

June 2023

*Demo: https://youtu.be/B6Jepy5Hvfo
†Project source code: https://github.com/gsiros/CookMate

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1 Introduction

1.1 Project Overview

This project explores the design, development, and evaluation of an *enhanced*, interactive user interface for the *GE 1.6 Cu. Ft. Countertop Microwave Oven JES1656SJ*, aiming to improve usability and accessibility for a diverse range of users. The emphasis of this project is on the iterative design process and user-centered design methodologies, with the end goal of creating an intuitive and user-friendly product.

1.2 Aim and Objectives

The principal aim of this research is to undertake a comprehensive analysis of the interface from the perspective of various user categories. The objectives include understanding user needs, identifying potential usability issues, and enhancing the interface based on the gathered insights. A significant focus is on employing diverse methodologies to ensure a comprehensive evaluation and capture multi-dimensional perspectives on usability.

1.3 Overview of the Report

This report comprehensively outlines the research process, methodologies, and results of the study. It begins with the process of user category selection, followed by a detailed explanation of the iterative spiral model used for prototyping. The report provides extensive information on each development cycle, including the issues identified, the derived mock-ups, the resulting modifications, and the evaluation methodologies employed.

Throughout this process, multiple evaluation techniques are employed, including questionnaires, interviews, think-aloud sessions, and cognitive walkthroughs. Subsequent sections discuss the incorporation of advanced features like natural language processing and computer vision in improving the usability and accessibility of the interface.

In conclusion, the report provides a summary of findings and reflections on the project, demonstrating the significance of a user-centered approach in designing and refining an intuitive and accessible interface.

2 User Category Selection

Judging by the complexity of the interface and the features offered, the microwave tries to appeal to a plethora of user groups. The microwave is allegedly targeted towards the average consumer. However, its complexity and wide variety of features complicate its usage. A microwave is one of the most common appliances in a household, and thus, if targeted to the average consumer, should primarily focus on features that promote simplicity and swiftness.

In conclusion, the user categories should be narrowed down to the following groups: young, middle-aged and elderly people, with an inclusion of people with limited mobility and/or Visual impairments.

3 Spiral Model Cycle 1: Initial Prototyping

3.1 Identified Needs of Selected User Categories

Different types of people usually have different needs and patterns of usage. Based on common demographics and usage trends, the following are some key needs for each selected user group:

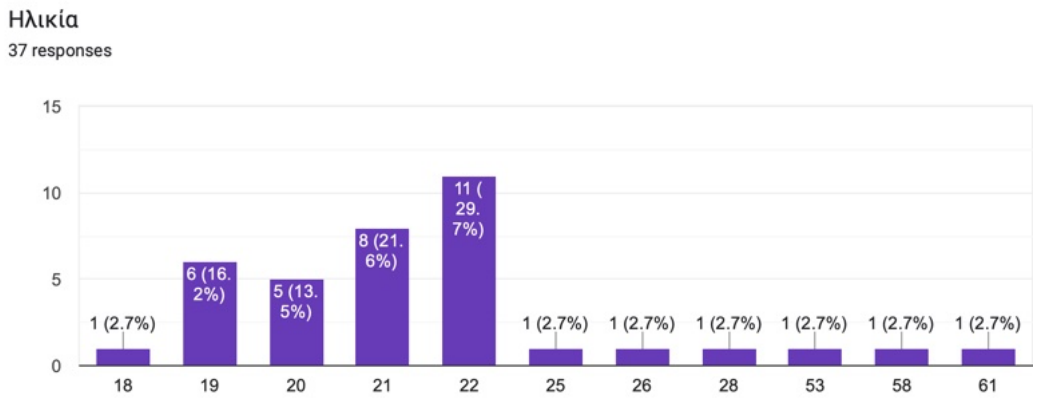

Figure 1: Questionnaire Demographics.

- **Young People** (e.g. adolescents, young adults): This group often uses microwaves for convenience foods, and may appreciate quick-cook buttons and energy-saving features. They may also be more open to modern interfaces, such as smartphone integration or touch screens.
- **Middle-Aged People**: This group is generally comfortable with technology, but it may prefer simpler interfaces without unnecessary complications. Straightforward functionality like simple time and power adjustments would be essential.
- **Elderly People**: This group may have difficulty reading small text or manipulating small buttons. They might also be less comfortable with overly complicated interfaces.
- **Users with Limited Mobility and/or Visual Impairments**: These users need easy-to-reach controls and possibly larger buttons or voice commands to operate the microwave. This user group requires auditory cues or tactile feedback for proper usage. Text-to-speech and voice control could assist this group.

3.2 Selection of Interface Features

To elicit the key features that should be kept, added or removed questionnaires were handed out to our target groups. We managed to get approximately 40 responses, out of which a wide range of ages was covered. The majority of the responses was collected from young people, who were more eager to answer as can be observed in figure 1.

In our quest to enhance the interface's usability and functionality, we must take into consideration the preferences and habits of the average user. Our ultimate goal is to deliver an interface that is not just intuitive, but also rid of unnecessary clutter that may deter ease of use.

Referencing figure 2, we can discern that the most commonly utilized modes among the users are the reheat and defrost functions.Unquestionably, the reheat function forms the backbone of a conventional microwave oven, fulfilling an essential requirement for reheating meals swiftly and efficiently. This functionality is universally used, making it indispensable to the design of our microwave interface, and thus, we must retain it without any reservations.

To further strengthen our decision to concentrate on the defrost function, we delve into the data depicted in figure 3. This visualization reveals that a noteworthy 50% of the survey respondents regularly utilize the defrost function. Such a significant proportion of users engaging with this feature implies its importance in the daily routine of a large subset of our target audience.These modes are integral to the

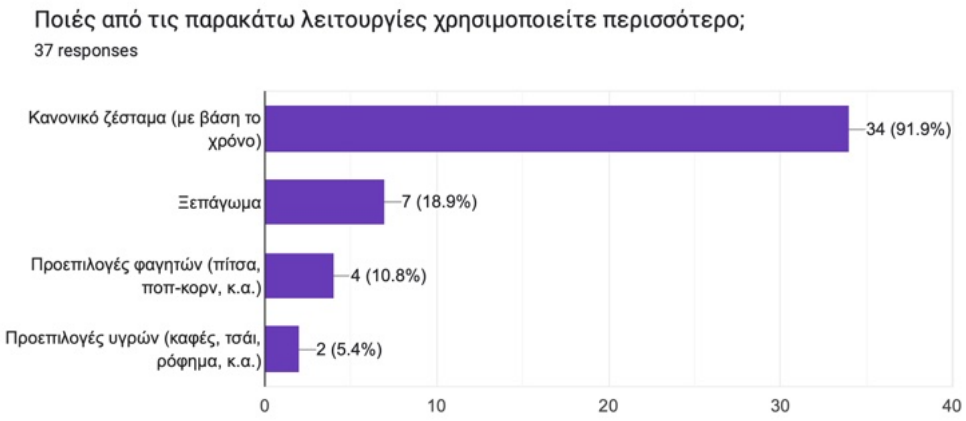

Figure 2: Preference of most frequently used feature.

daily culinary practices of the average consumer, enabling them to reheat leftovers or defrost food items with efficiency and convenience.

On the contrary, we observed that the usage of specialized modes, specifically those designed for certain food and beverage presets, was significantly lower. Such features, while being handy in certain scenarios, do not cater to the broader user base and often end up being disregarded or even misunderstood, creating a sense of complexity in the minds of the users.

Hence, driven by the data collected and keeping in mind our dedication to a simplified yet powerful user interface, we have decided to concentrate on refining the user experience around the reheat and defrost modes. This decision also aligns with our overarching goal of tailoring the microwave interface to meet the most frequent needs of our users, thereby making it more efficient and user-friendly.

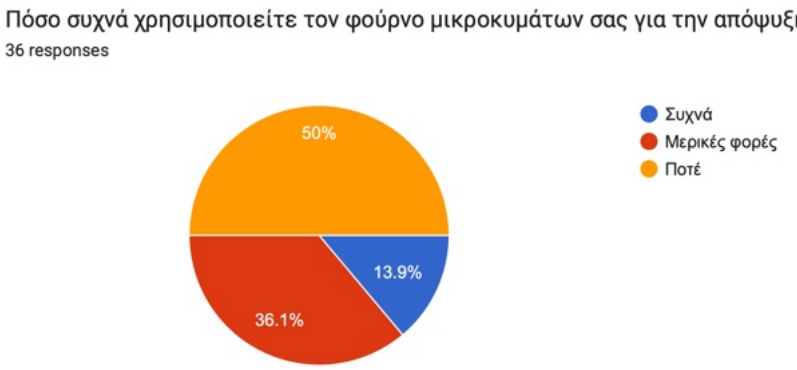

Figure 3: Frequency of Defrosting; frequently (blue), occasionally (red) and never (yellow).

Considering the data at hand, we make an informed decision, leaning towards the preferences expressed by our user base. Figure 4 reveals that the time-based approach to defrosting holds a clear advantage, being the more popular choice amongst our respondents. In contrast, the weight-based method only finds favor with a relatively small fraction of users.

This trend provides a clear direction for our design decision. We recognize the importance of maintaining usability and familiarity within our interface. Therefore, in alignment with the more popular usage patterns, we opt to design the defrost function around a time-based system. This decision not only aligns with user preference but also maintains the intuitive nature of our interface, without compromising on

functionality.

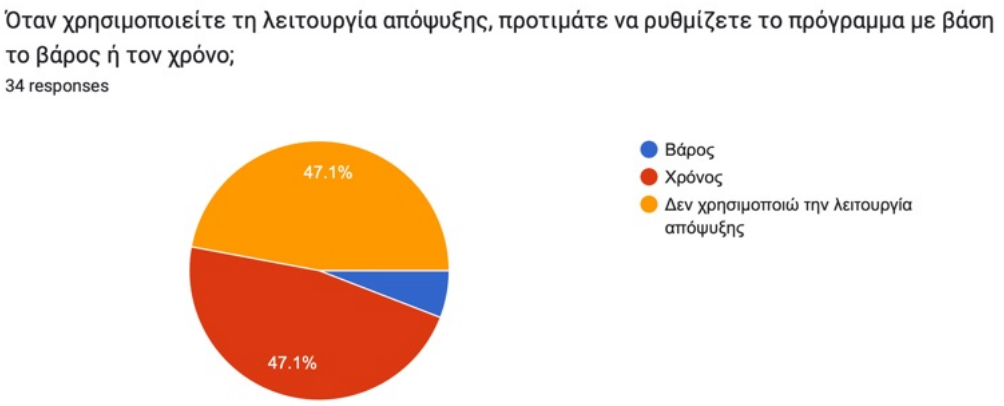

Figure 4: Mass-based defrosting (blue) VS. Time-based defrosting (red) VS. none (yellow).

An essential aspect of a microwave's functionality is its power adjustability, often measured in wattage. The ability to modulate the heating power is crucial for the cooking or reheating of various food items, as it allows for a fine-tuned, tailored approach to heating, thereby ensuring the quality and texture of the food are maintained.

In our quest to offer an interface that not only delivers on functionality but also aligns with the preferences and needs of the users, we propose to incorporate this wattage control feature in the final product design. This proposal is borne from our understanding of the practical significance of wattage control in everyday cooking and reheating tasks.

To validate our proposal and to engage the consumer perspective, we extended a survey to our users. The results, as depicted in figure 5, revealed that approximately 57% of respondents have, at one point or another, adjusted the microwave's power to their custom preference. This is a substantial proportion, indicating that the power control feature isn't merely an option but a utilized functionality for a majority of users.

Thus, these survey results not only confirm our initial proposition but also emphasize the necessity of including a wattage control feature in our final design. The data reinforces our understanding of user habits and preferences, strengthening the foundation of our design philosophy which is deeply rooted in user-centricity and functionality.

In pursuit of further streamlining our interface while simultaneously expediting user interaction, we sought feedback on an approach to setting the time for the reheat and defrost functions. Specifically, we introduced the idea of a button that, when pressed, adds a fixed increment of time (e.g., `30 seconds`) to the current timer setting. This was envisioned as a means to hasten the process of setting the timer.

Interestingly, the responses we received revealed that about 70% of respondents typically set their microwave timers to end either on the minute (`:00`) or half-minute mark (`:30`). This observation is clearly represented in figure 6.

However, it is important to note that the remaining 30% of respondents reported a preference for setting their timers to specific, non-standard times. This indicates a potential need for a more flexible timing function, possibly to accommodate foods that require a precise amount of heating or defrosting time. This insight underscores the importance of preserving user customization within our interface to cater to such specific needs.

Finally, in the course of our research, we observed a particular feature common to many white appliances that seemed to resonate with users - an embedded real-time clock. This feature serves the dual function of informing the user about the ongoing microwave operation and providing a readily available time reference in the kitchen environment.

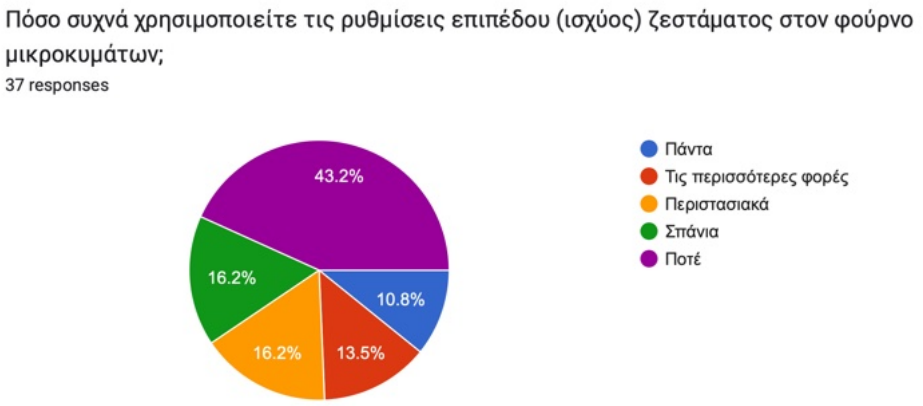

Figure 5: Frequency of setting the power (wattage); Always (blue), most of the time (red), occasionally (yellow), rarely (green), never (purple).

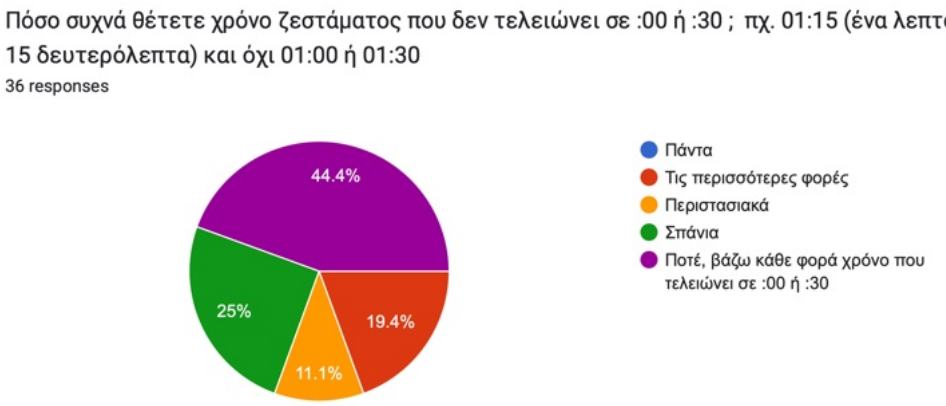

Figure 6: Frequency of setting time left ending in `:00` or `:30`; Always (blue), most of the time (red), occasionally (yellow), rarely (green), never, I always set time ending in `:00` or `:30` (purple).

However, the integration of a clock into our design posed a dilemma. Our core design philosophy is to prioritize a minimalist and intuitive interface, and the inclusion of a clock feature appeared to challenge this notion, potentially cluttering the interface and complicating the user experience.

Despite our reservations, we sought the opinions of our user base, asking them about their usage and preferences regarding the clock feature. The responses, illustrated in figure 7, indicated that nearly 46% of respondents regularly use the embedded clock on their microwave. This is a significant percentage and clearly illustrates a genuine user interest in having such a feature.

In light of this evidence, and keeping in mind the importance of meeting user needs and preferences, we have decided to incorporate the clock feature into our final design.

3.3 Description and Development of Cycle 1 Prototypes

Incorporating the insights and discoveries gleaned from the detailed analysis in paragraph 3.2, we embarked on the design of two distinct prototypes for the first cycle. These were independently developed by two members of our team. The design process was structured in a manner that the designers worked in parallel but independently, thereby minimizing the potential for cross-influence.

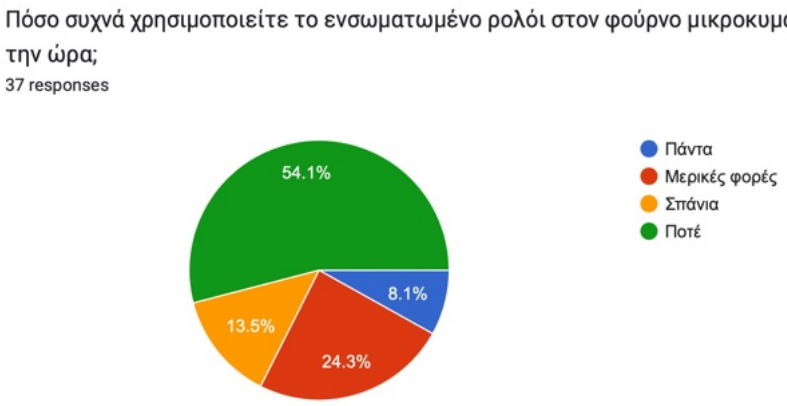

Figure 7: Frequency of using the embedded clock to tell the time; Always (blue), sometimes (red), occasionally (yellow), never (green).

3.3.1 Prototype 1

The first of our prototypes, which can be seen in figure 3.3.2, features a distinct skeuomorphic design element at its center: a rotary knob, just below the timer. This knob is designed to control the timer; by turning it clockwise, the user increases the timer, and turning it counterclockwise reduces the time set. In addition, two modifier buttons are located below the knob, designed to allow the user to add preset time increments to the timer - specifically, `30 seconds` and `1 minute`, respectively.

Below these controls, we find two more buttons, intended for starting the microwave operation (`START`) and for performing dual roles of resetting the timer (`RESET`) and halting the reheat or defrost process (`STOP`).

Located at the base of the interface is the navigation bar, which provides options for the three primary functions: `REHEAT`, `DEFROST`, and `COOK FOOD`. The `DEFROST` function offers a mass-based interface contrary to the `REHEAT` function. The `COOK FOOD` button facilitates selection of presets related to different food options.

Lastly, to the right of the interface, the `ADVANCED` button serves as a gateway to a secondary screen where users can fine-tune the power level according to their specific needs. This layout, while complex, aims to ensure maximum functionality.

3.3.2 Prototype 2

The second prototype, while bearing some similarities to the first due to a shared conceptual base during the team's research and discussion phase, offers several distinct design differences. This model also integrates a skeuomorphic rotary knob under the timer to adjust both time and mass for the `REHEAT` and `DEFROST` functions, mirroring the first prototype.

However, this version relocates the modifier buttons to the right of the interface, and includes a new button to decrease time or mass by increments of `-30 seconds`, offering a higher level of specificity in user input.

An interesting divergence is the consolidation of the navigation menu at the bottom into a single button, which expands upon user touch to reveal the full range of functional selections. This compact design choice streamlines the overall interface.

Lastly, the control button for adjusting the microwave power output has been repositioned to the bottom right corner of the interface, optimizing the layout for user accessibility and visual balance.

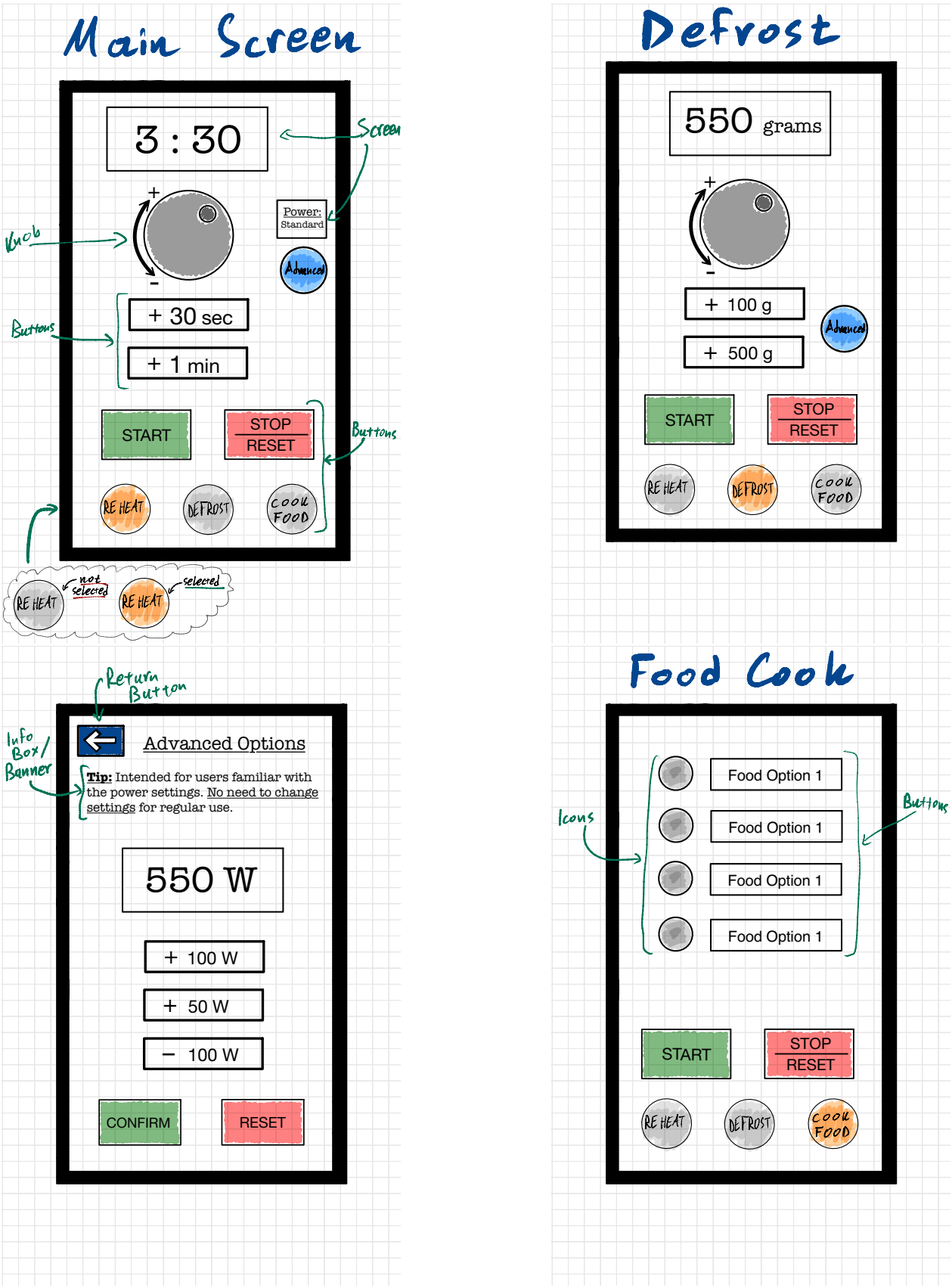

Figure 8: Cycle 1, Prototype 1

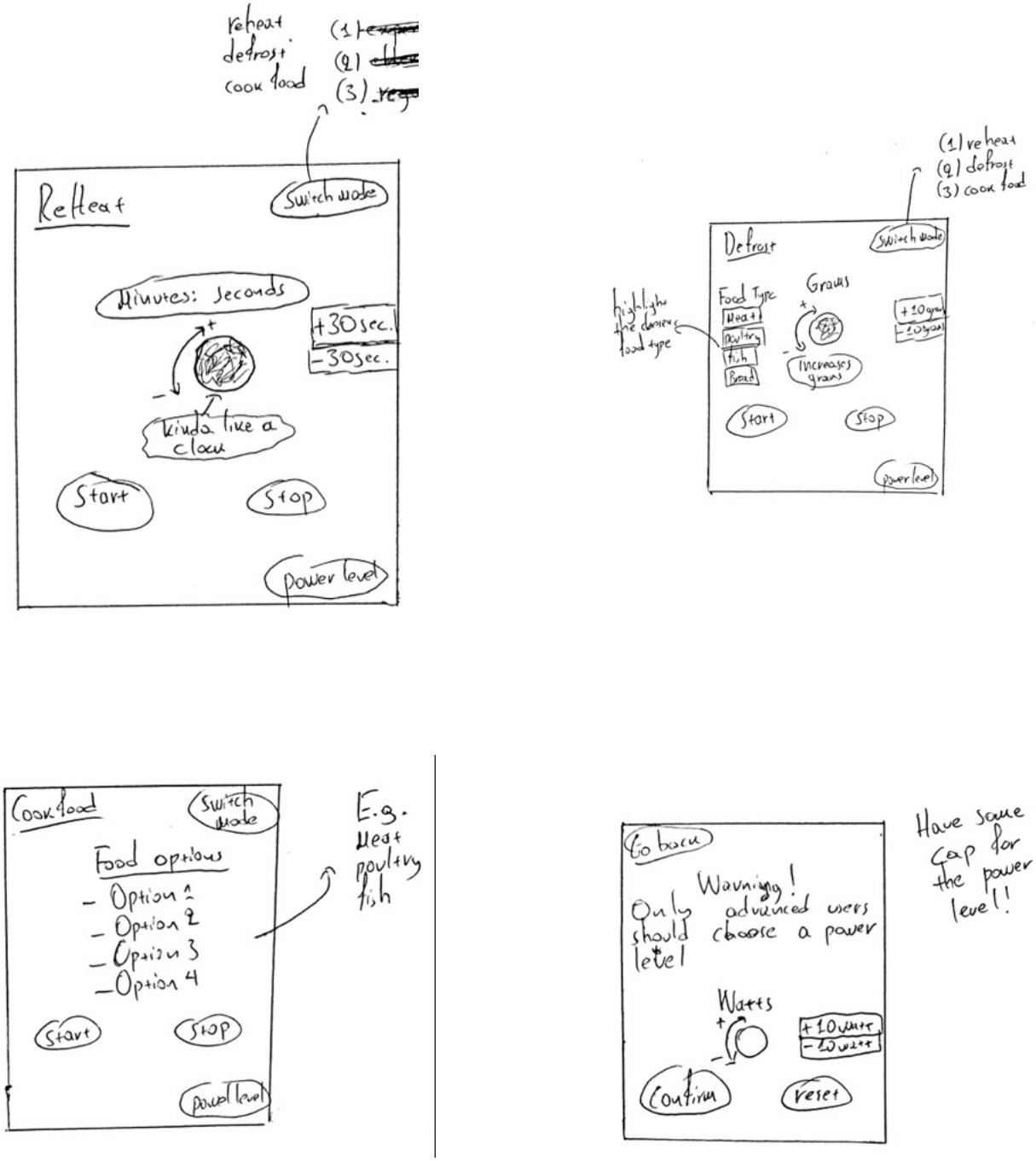

Figure 9: Cycle 1, Prototype 2

3.4 Evaluation Methodologies and Results for Cycle 1

3.4.1 Methodology 1: Interview

In the interview with Nikos, a tech-savvy young adult, the prototype interface was generally well-received. He found the rotary knob for setting the timer intuitive and reminiscent of analog microwaves. The modifier buttons, offering preset increments of time, were found useful for quick reheating or defrosting. Nikos also reported clear differentiation between the reheating, defrosting, and 'Cook Food' functions, but suggested labels or descriptions for the latter, which was designed for food presets. The 'Advanced' button was deemed ambiguous, suggesting a need for a more indicative label. Nikos rated his overall experience with the interface as 8/10, with room for improvement in terms of labeling enhancements.

The interview with Roland, an older participant, revealed some initial hesitations due to the unconventional interface featuring numerous buttons. Although the rotary knob was new to him, he appreciated the modifier buttons for their convenience. The 'Start' and 'Clear' buttons were straightforward to use, and the navigation bar was appreciated for its simplicity, although it would require some getting used to. As for the 'Advanced' button for power adjustment, Roland shared that while he rarely adjusts microwave power, the feature could be beneficial for some.

In summary:

- Nikos found the rotary knob intuitive and reminiscent of older microwaves, while Roland felt overwhelmed and preferred traditional number pads. However, both participants found the modifier buttons, which add preset increments of time, to be useful.
- Both users could easily navigate and differentiate between the 'REHEAT', 'DEFROST', and 'COOK FOOD' options on the navigation bar, but Nikos suggested adding a label or description to the 'COOK FOOD' option for clarity.
- Nikos found the 'Advanced Settings' button ambiguous and suggested relabeling it to better indicate its function. Roland, on the other hand, rarely adjusts power levels but could see the potential utility for others. He found the placement of the button to be appropriately out of the way.
- Roland found the microwave's controls to be clear due to their labels, and while he found the interface initially overwhelming, he believed he could become accustomed to it over time.
- In terms of overall experience, Nikos rated the interface 8 out of 10, appreciating its modern design but suggesting a few labeling enhancements.

Lastly, both users found the interface to be mostly user-friendly with some room for improvement, particularly in the labeling and clarity of certain functions. Both interviews reflect promising acceptance of the interface.

3.4.2 Methodology 2: Think Aloud

During Roland's 'Think Aloud' session, he showed confidence interacting with the prototype. He easily used the rotary knob and '30 seconds' button to set the timer, and identified the 'START' button to begin heating. The 'RESET' button was correctly assumed to clear the timer. He could identify the 'DEFROST' function in the navigation bar, although he struggled to access power level settings, which were under an 'ADVANCED' button.

Theodora's session highlighted some design issues. She found the rotary knob challenging to control due to its design and preferred to use the modifier buttons. She recognized the 'START' and 'RESET' buttons for their respective functions and could identify the 'DEFROST' function in the navigation bar. Like Roland, she guessed that the power settings were under the 'ADVANCED' button, but it wasn't immediately clear. Both sessions underline that the 'ADVANCED' button needs to be more intuitive and the design of the rotary knob should be reconsidered.

4 Spiral Model Cycle 2: Iterative Prototyping

4.1 Reflections on Cycle 1 and Adjustments

In the first cycle of our research, we conducted in-depth interviews and 'Think Aloud' sessions with participants of varying technical abilities to understand their interactions and experiences with our prototypes. These user evaluations shed light on several aspects of our design that can be refined to enhance user experience, navigation, and accessibility.

One prevalent finding was the difficulty experienced by the participants in manipulating the rotary knob's touch functionality. Despite their technical familiarity, both tech-savvy participants struggled with the responsiveness of this control, suggesting that its touch sensitivity might need adjustment. Moreover, providing clearer visual feedback in response to user interactions with the knob could assist in confirming the effective selection of time or mass.

The functionality of the buttons, including the `'START'`, `'RESET'`, and the modifier buttons, were well-understood by participants, indicating that these design elements were intuitively labelled and placed. To further optimize these components, their size and spacing could be reviewed to ensure they support easy and efficient touch interactions.

Our navigation bar and `'ADVANCED'` settings were not as immediately apparent to users as desired. Making these elements more explicit, either through more descriptive labels or distinct icons, might assist in their discoverability. Similarly, the `'ADVANCED'` button could be rendered more explicit by providing a more descriptive label or incorporating a helper tooltip.

Moreover, the questionnaire deployed in the first cycle of our research also offered significant insights. A striking finding was the apparent indifference from the majority of the respondents towards the usage of presets, a feature we had initially considered integral to the interface's functionality. Specifically, the `'COOK FOOD'` option, which served to facilitate the selection of presets related to different food options, seemed to be of minimal importance to the users.

Given this, it would be prudent to reconsider its inclusion in the interface. Eliminating this option could declutter the interface, allowing for a simpler, more streamlined user experience. We could then devote more interface real estate to enhancing the visibility and accessibility of the remaining critical controls.

Participants' struggles with certain aspects of the interface also indicated a need for more on-screen guidance. Implementing tooltips, tutorial guides, or visual cues could alleviate these difficulties by providing immediate, context-sensitive support.

While these reflections provide valuable insights into potential areas of improvement, it is vital to note that they are based on a limited sample of user interactions. As we proceed to the second cycle of our research, we plan to conduct additional interviews with a broader range of potential users and carry out more comprehensive usability testing. These measures will further refine our understanding of user interactions over time, enabling us to incrementally optimize the design of our interface towards maximum user satisfaction and functionality.

4.2 Description and Development of Cycle 2 Prototype

In the design of our second cycle prototypes, we transitioned from the initial paper mockups to a more sophisticated digital design tool, *Figma*[1], enabling us to refine our designs and edge closer to a representation of the final product. This transition is a fundamental step in our iterative design process. By increasing the specificity and realism of our prototypes with each cycle, we aim to facilitate convergence within the design team and aid in eliciting more accurate responses from the user groups involved in our research. The following sections will articulate the key changes and adjustments implemented in this second cycle, informed by insights gleaned from our analysis of the first cycle's user feedback.

[1] https://www.figma.com

In the second cycle of prototypes, a fundamental modification lies in the relocation of the function navigation bar from the bottom to the top of the interface. This change is rooted in the observation that users, influenced by the top-down reading patterns of most human languages, tend to first direct their gaze towards the upper portions of an interface, akin to the reading of a book page.

The supported functions were consolidated into three key options, namely, `REHEAT`, `DEFROST`, and `WATT`, which are now presented in the navigation bar as illustrated in figure 10. The `COOK FOOD` function, initially serving as a preset selector, was omitted due to its insignificant usage by our user groups and replaced by the `WATT` function, a more intuitive iteration of the first cycle's `ADVANCED` button, allowing users to specify the microwave's power level.

A noteworthy addition in this cycle is the introduction of color to the interface, devised to enhance cognitive associations between color and corresponding actions. For instance, the `REHEAT` function is represented by an orange hue (emblematic of heat and flame), `DEFROST` by light blue (recalling the color of frost), and `WATT` by teal, selected for its distinct contrast with the other two colors, facilitating older users or those with vision issues in recognizing functions without relying solely on text.

Diverging paths were taken regarding certain interface elements, as shown in figure 10. The button-based and rotary knob-based interfaces from the first cycle were further refined for the `REHEAT` and `DEFROST` functions. The formerly supported mass-based defrosting was replaced by a time-based interface, following lackluster interest expressed in the cycle one questionnaire (figure 4). Moreover, in the button-based interface, modifier buttons were incorporated around the main timer, facilitating incremental adjustments in units of minutes or seconds. A slightly darker background was assigned to the `+1 min` button to ensure immediate visual differentiation.

The `START` and `CLEAR` functions, universally present across both interface versions, were visually enhanced with green and red coloring respectively, adhering to the rationale underpinning the color scheme of the navigation bar.

As for the display of ongoing actions, we developed two alternative designs, presented in figure 11. The first is predicated on a progress bar, offering users a visually intuitive representation of time passage, while the second leverages a traditional digital timer, providing a precise numerical account of remaining time.

With respect to the `WATT` function, two versions were designed - a button-based interface and a slider-based interface, as depicted in figure 12.

Lastly, in response to the requirement for popup dialogues, we conceptualized both verbose and laconic interface options, depicted in figure 13. A minor yet consequential amendment is the introduction of contextual icons in the navigation bar corresponding to each function (figure 14), enhancing the visual cues and recognition for users.

4.3 Evaluation Methodologies and Results for Cycle 2

4.3.1 Methodology 1: Questionnaire

A crucial aspect of our research and development process in this second cycle centered on the methodology by which users set the time for reheat and defrost functions. We recognized this as a key interaction point within the microwave's user interface, and thus, dedicated our attention towards creating a design that would optimize this experience.

To this end, we developed two distinctive designs - a button-based interface and a knob-based interface. The button-based design prioritizes direct input and straightforward functionality, whereas the knob-based design borrows from the skeuomorphic principles, offering a sense of familiarity and ease, particularly beneficial to the older demographic who are accustomed to the traditional analog microwaves.

In order to determine which of these designs would best cater to our user base, we conducted a comparative analysis using the refined prototypes. The response from our users, as demonstrated in figure 10, was markedly in favor of the button-based interface, with nearly 91% of respondents indicating a preference for this design.

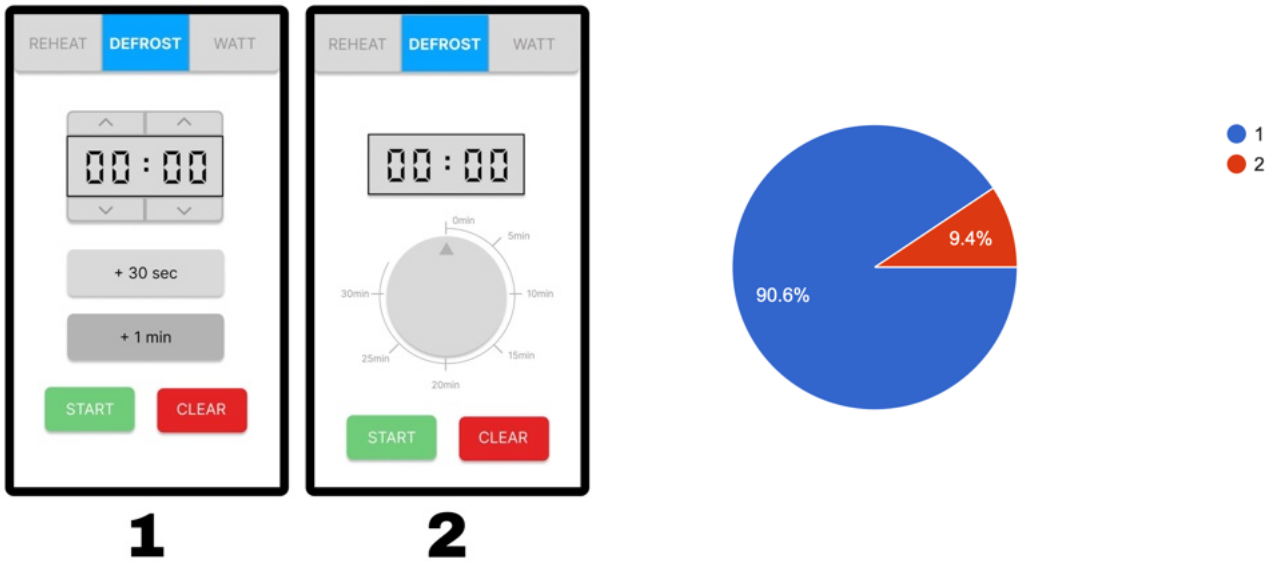

Figure 10: Interface Comparison; user preference in setting the time for the reheat and defrost function.

This overwhelming preference for the button-based interface provides valuable insights into the user's interaction habits and expectations, guiding us towards a design solution that aligns closely with the majority of our user base. It underscores the significance of straightforward, digital input mechanisms in a modern microwave interface, thereby informing our next steps in the interface refinement process.

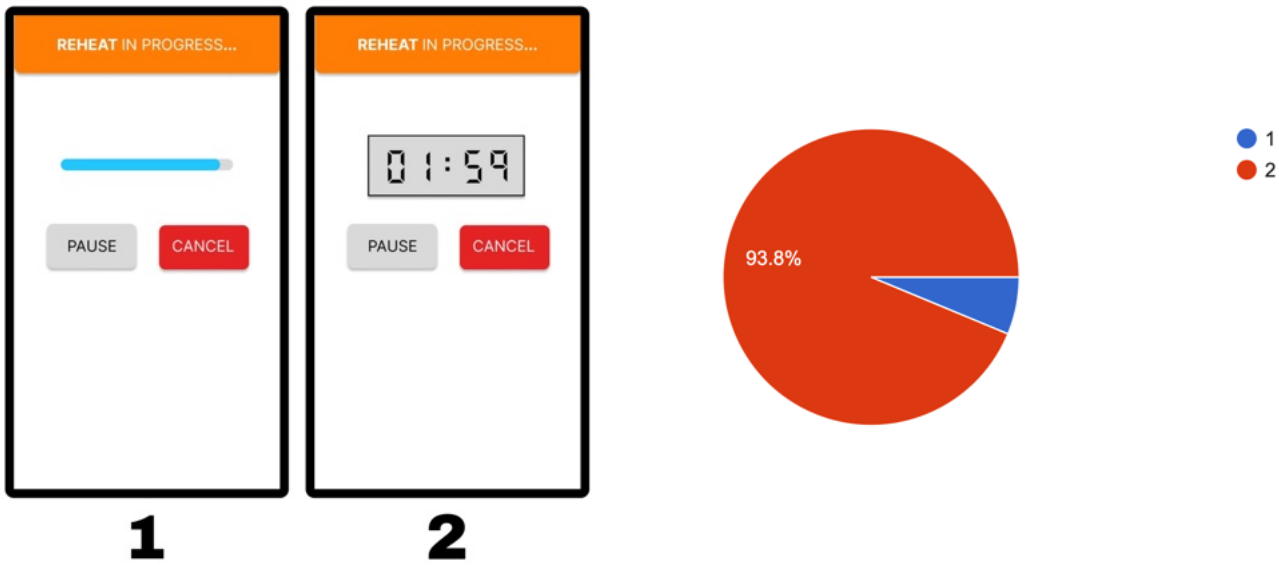

Figure 11: Interface Comparison; user preference in the remaining time graphic for the reheat and defrost function.

The second aspect of our design process that required careful consideration involved the decision on how best to communicate the remaining time for the reheat and defrost functions to our users. We understood that this feature would directly influence the user's perception of the ongoing microwave operation, and hence, needed to be both intuitive and informative.

Two design alternatives were conceptualized in response to this requirement. The first one was based on a progress bar, a graphic indicator providing an intuitive, visual representation of the elapsed time, allowing users to gauge the remaining time at a glance. The second alternative hinged on a traditional timer, offering a more precise, digital readout of the exact time remaining.

We introduced these two versions to our respondents to gauge their preferences. As illustrated in figure 11, an overwhelming 94% of respondents expressed a preference for the traditional timer over the progress-bar based design.

This marked preference for the traditional timer underscores the users' inclination towards precise, real-time information. It suggests that, in the context of microwave usage, the assurance of knowing the exact time remaining for a task holds more appeal than a visual approximation. These insights will be instrumental in guiding our design choices as we move forward in our iterative design process.

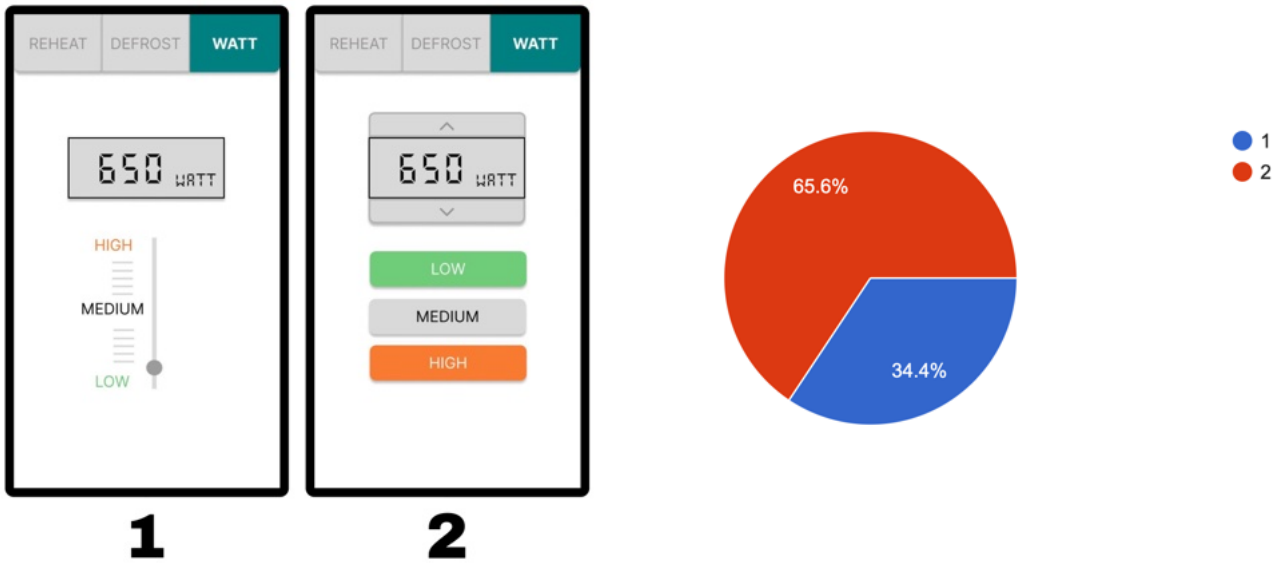

Figure 12: Interface Comparison; user preference in setting the power (wattage) for the reheat and defrost function.

Our attention then shifted to the third core functionality of our microwave interface: the capacity to adjust the power to custom levels. We understood this feature to be fundamental for facilitating a nuanced cooking or reheating process, and hence, sought to ensure its ease of use and accessibility.

In alignment with our previous design approaches, we developed two prototypes based on distinct interaction principles. The first prototype leaned on skeuomorphic design principles, presenting the user with a conventional slider to adjust the wattage, ranging from `LOW` to `HIGH`. This design choice aimed at promoting intuitive interaction, leveraging the user's familiarity with traditional appliance controls.

The second prototype implemented a button-based interface, facilitating precise and swift input from the user. This design recognizes and respects the increasing digital fluency of modern users, offering a straightforward and direct means to control the microwave's power level.

The responses hint a significant inclination towards the button-based interface was observed, as shown in figure 12. This preference provides a clear indication of the user's comfort with digital input methods and the perceived ease and precision such an interface offers. These findings will be instrumental in guiding our design strategy as we move forward in refining our microwave interface.

Transitioning to more nuanced elements of our interface, we turned our focus to the nature of informational messages presented to users during microwave interaction. The manner in which information is delivered can significantly influence the user experience, potentially affecting their understanding, perception, and overall satisfaction with the interface.

To explore this facet, we designed two prototypes encapsulating distinct aesthetic and communicative strategies. The first prototype utilizes a neutral color palette, aimed at eliciting a sense of calmness and confidence. This, coupled with a verbose messaging style, creates an environment of clarity and thoroughness in the communication of pertinent information to the user.

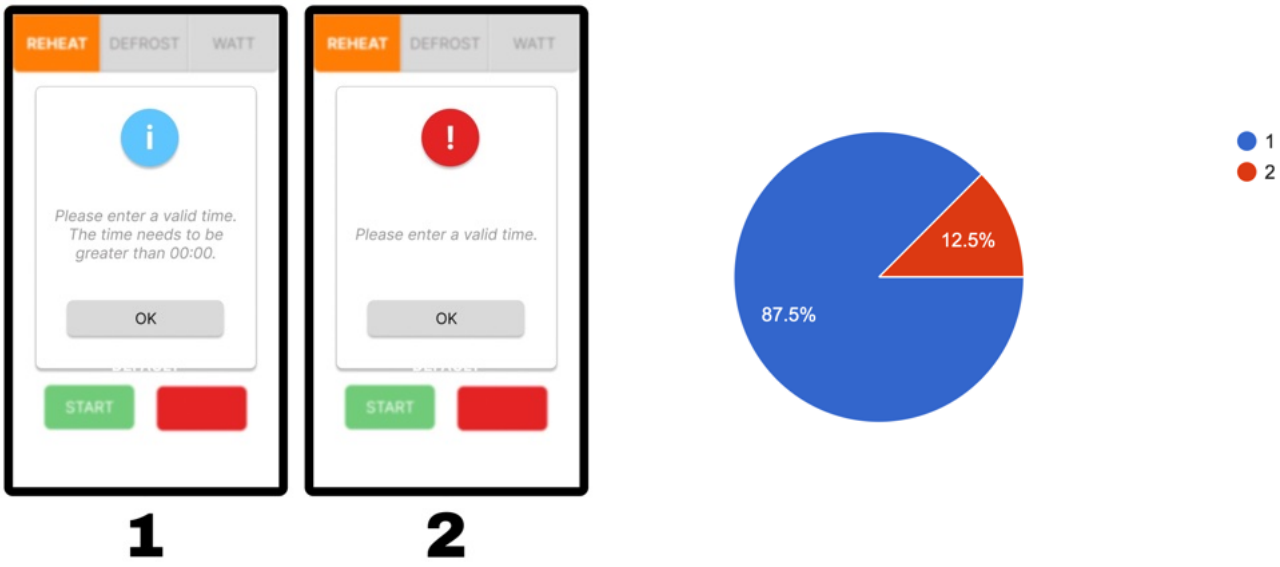

Figure 13: Interface Comparison; user preference in communicating informational messages.

Contrastingly, the second prototype adopts a more aggressive color palette, aiming to grab the user's attention promptly. Furthermore, this design employs a direct, concise approach to message delivery, reducing potential ambiguity and focusing on the immediate delivery of information.

The comparison of these two distinct designs, as presented in figure 13, revealed a user preference for the first prototype. This indicates a favorable response to the calm, confidence-inducing aesthetic coupled with verbose, detailed messaging. This finding guides us towards a user experience design that prioritizes clarity and thoroughness in information delivery, shaping our future decisions as we continue refining the user interface.

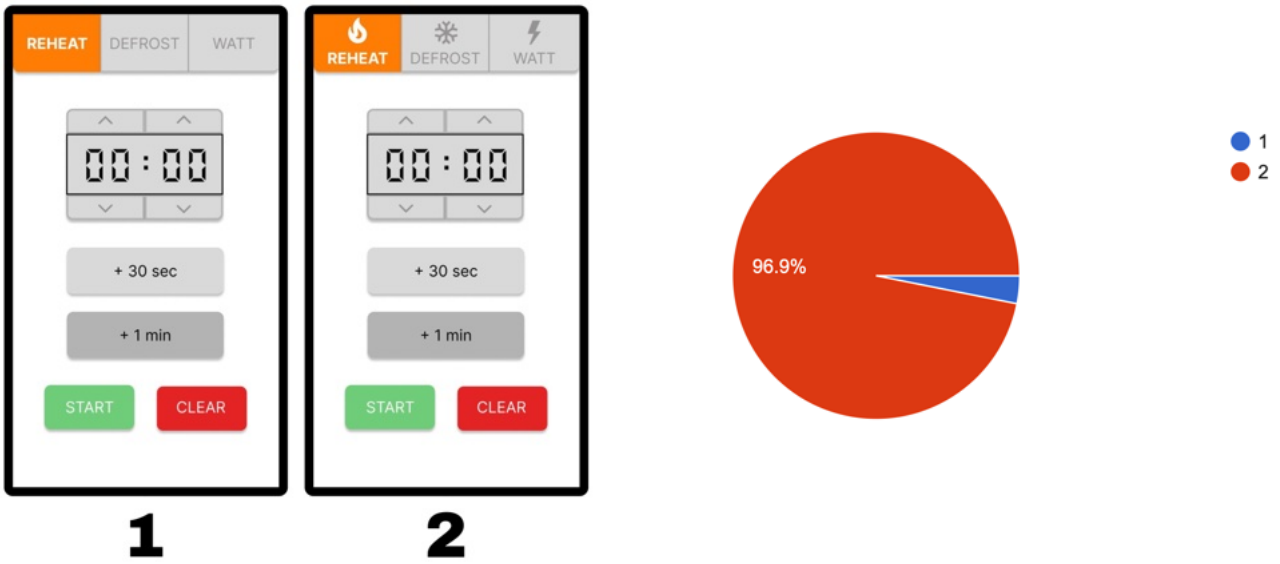

Figure 14: Interface Comparison; user preference in the navigation bar.

Our final focus, drilled down to the finest details, sought to enhance the usability of our interface for the visually impaired demographic and also address potential language barriers within the broad user base. Central to this endeavor was the design of the top navigation bar, the pivotal element that orchestrates the flow of our interface and guides the user through the three main functions.

We constructed two prototypes, each bearing similarities yet distinguished by a key design aspect. Both designs feature distinct, vibrant colors to demarcate the three functions, aiming to expedite user interaction over time and enable visually impaired users to differentiate between the functions via color cues.

The second prototype diverges from the first by incorporating contextual icons alongside the function labels. For instance, the 'reheat' function is complemented by a flame icon, symbolizing heat, while the 'defrost' function is denoted by a snowflake. The snowflake, although arguably counter-intuitive, is widely recognized across microwave interfaces, providing a familiar cue for the 'defrost' function. A more literal representation, such as a melting ice cube, was deemed potentially confusing and possibly contributing to interface clutter.

To resolve this, we turned to our user base for their input. The feedback, as illustrated in figure 14, was unequivocal. An overwhelming majority of 96.9% expressed a preference for the second prototype, featuring the contextual navigation bar. This powerful endorsement underscores the value of user familiarity and the positive impact of contextual icons in making an interface more accessible and user-friendly.

4.3.2 Methodology 2: Interviews

The interviews from cycle two reflect on the updates made to the microwave interface prototype.

Roland, the older participant, found the design more visually appealing, with the relocated navigation bar to the top being intuitive and noticeable. He also liked the introduction of color associations for functions. However, he still expressed discomfort with the rotary knob for time-setting, preferring the traditional number pad. He appreciated the addition of modifier buttons for quick adjustments. Despite the introduction of a progress bar for the timer, he still preferred a traditional digital timer for a precise sense of remaining time. Lastly, he preferred verbose versions for popup dialogues for additional information.

On the other hand, Nikos, the younger participant, appreciated the simplified and less cluttered interface, finding the color coding for different functions particularly helpful. He felt comfortable with both button-based and rotary knob interfaces, but found button-based to be quicker for inputting specific times. Like Roland, Nikos also preferred a traditional digital timer over a progress bar for precision. However, he liked the slider-based interface for adjusting the power levels, calling it more intuitive. Lastly, Nikos preferred laconic versions for popup dialogues, as he felt confident in understanding the interface without needing much explanation.

To summarize:

- Both participants appreciated the relocation of the navigation bar to the top of the interface and the introduction of color coding for different functions.
- While Nikos was comfortable with both rotary knob and button-based interfaces for time-setting, Roland continued to struggle with the rotary knob.
- Both participants preferred a traditional digital timer over a progress bar for precision.
- Roland was open to the idea of experimenting with power level adjustments due to the interface changes, whereas Nikos preferred a slider-based interface for power adjustments.
- For popup dialogues, Roland preferred verbose versions for additional information, while Nikos preferred laconic versions due to his comfort and familiarity with tech interfaces.

In summary, the redesign was generally well received by both participants. The feedback indicates that the interface needs to balance the needs of tech-savvy users who prefer directness and less explanation, with those of less tech-savvy users who appreciate additional help and instructions.

4.3.3 Methodology 3: Think Aloud

The second cycle 'Think Aloud' sessions focus on two participants, Theodora and Roland, attempting tasks on the updated microwave interface prototype and expressing their thoughts throughout.

Theodora, a younger participant, found the color-coded function buttons distinct and self-explanatory, making it easier to navigate the reheating and defrosting processes. However, she was not comfortable with the rotary knob for time-setting due to its touch accuracy, expressing a clear preference for button-based controls. She appreciated the green 'START' button and red 'CANCEL' button, finding the color associations clear and logical. When adjusting the power level for defrosting, she was relieved to see a button-based interface after pressing the 'WATT' button.

On the other hand, Roland, the older participant, also found the 'REHEAT' and 'DEFROST' buttons easily accessible but struggled with the rotary knob for time-setting due to its precision control. Like Theodora, he found the color-coded 'START' and 'CANCEL' buttons intuitive. However, he initially had difficulty identifying how to decrease the time setting until he tried turning the knob counterclockwise. When it came to changing the power level to 600 watts, he found the button controls on the secondary screen easier to manage.

In summary:

- Both participants appreciated the color-coded function buttons for intuitive navigation.
- The rotary knob interface was consistently seen as challenging due to issues with touch accuracy and precise control. Both participants expressed a preference for button-based interfaces.
- The green 'START' and red 'CANCEL' buttons were seen as logical and intuitive due to their color associations.
- When adjusting power levels, both participants preferred the button controls available on the secondary screen.

5 Spiral Model Cycle 3: Final Prototyping

5.1 Reflections on Cycle 2 and Adjustments

Reflecting on Cycle 2 of our iterative design process, we gained valuable insights that significantly influenced the subsequent development and refinement of our microwave interface. Primarily, users demonstrated a clear affinity towards the colorful and simplified interface. The use of distinct, color-coded buttons for different functions notably improved the interface's accessibility and intuitiveness, an element that we decided to retain in our final design.

Contrary to our expectations, there was a marked preference for button-based interfaces across tasks, from setting the timer to adjusting wattage. Despite exploring a rotary knob for timer settings and a vertical slider for power adjustments —both leveraging skeuomorphic principles— the button-based approach appeared to provide users with greater control and precision. This trend prompted us to transition away from skeuomorphic designs, focusing instead on the button-based interfaces for the final product.

Users also expressed a preference for a precise countdown timer over an abstract progress bar during task execution. While the progress bar served to simplify and visually represent the process, it was clear that the users valued the exactness of the countdown timer, as it provided them with a precise understanding of the remaining time. Thus, in the final design, we opted to include the traditional digital countdown timer.

Finally, user feedback from interviews suggested that a more verbose version of popup dialogues was preferred. This preference was particularly significant among less tech-savvy users, who valued the detailed

information provided by verbose dialogues. As such, this user preference significantly influenced the text representation in our final interface design.

Overall, Cycle 2 affirmed that our design prototypes resonated with our target user groups, while also providing constructive suggestions for improvement.

5.2 Description and Development of Cycle 3 Prototype

Figure 15: Cycle 3 prototype featuring main and in-progress reheating screens.

The peak of our iterative design process is incorporated in the final product, which represents a synthesis of the most effective aspects from our Cycle 2 prototypes. Foremost, we integrated button-based interfaces into all supported actions, including `REHEAT`, `DEFROST`, and `WATT`. This modification was predicated on user feedback highlighting a clear preference for button-based interactions due to their straightforward, user-friendly nature.

Complementing this, we incorporated the favored contextual icons into the navigation bar, which correspond to each action. Furthermore, our team revised the icons on the modifier buttons, which serve to increment or decrement the time and wattage. Rather than continuing with the abstract up/down arrow design, we transitioned to a more intuitive plus/minus sign. This subtle but vital change was made in response to user feedback from Cycle 2, where the clarity of functionality provided by these buttons was underscored.

In response to a clear user preference, we integrated a countdown timer to indicate task progress and verbose popup dialogues for more explicit communication with users.

As we aimed to merge the most successful elements from our previous iterations, a popular feature from Cycle 1 was reintroduced into the final prototype; an always-on-display that activates when the microwave is inactive. An embedded clock feature was implemented in response to significant user demand. To determine the optimal positioning, we introduced a feature that activates the clock after a period of inactivity. The microwave can then be reactivated either by user proximity, utilizing facial recognition via computer vision (as detailed in section 6), or manually through the touch of an unlock button on the screen.

In a commitment to inclusivity and enhanced usability, our final product also includes an optional voice command feature, specifically targeting visually impaired and handicapped user groups. This function, which leverages speech recognition through Natural Language Processing, as outlined in section 6, underlines our mission to make our interface accessible to as wide a demographic as possible.

5.3 Evaluation Methodologies and Results for Cycle 3

5.3.1 Methodology 1: Questionnaire

In this section, we present the results of our final user questionnaire, which aimed to gauge users' comprehension of our interface's functionality when confronted with specific tasks. The questionnaire consisted of multiple-choice questions designed around various usage scenarios, such as:

- *"After a tiring day at work, you return home and wish to use the microwave to reheat leftover food. You are presented with the following screen. How would you proceed?"*
- *"Upon seeing the following screen, you decide to defrost some food. What steps would you take?"*
- *"Based on your judgement, what function might the circled button serve in the following screen?"*

The user responses demonstrated an encouraging average task success rate of 92.78% among the 37 respondents. However, two aspects of the interface proved less intuitive for some users, namely, the always-on-display and the action cancellation function.

In the case of the always-on-display (figure 22), 10.8% of participants misinterpreted the wake-up process. They believed that touching any part of the screen would bring the microwave out of its inactive state. However, the intended behavior was to press the specific button marked with an unlocked lock icon.

Similarly, there was some confusion concerning the cancellation of in-progress actions (figure 26). In this scenario, 13.5% of users chose to pause the task instead of terminating it, highlighting a potential area for clarification in the user instructions or interface design.

Overall, participants rated the interface an average of 4.3 out of 5 in terms of its simplicity, aesthetic appeal, informational transparency, and practical utility (figure 16). This positive reception underscores the success of our design while also suggesting areas for further refinement.

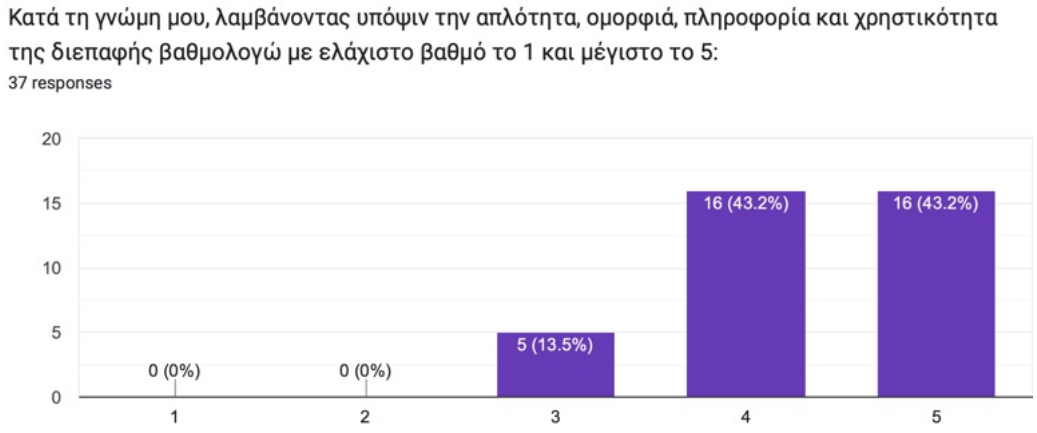

Figure 16: Interface user-rating in terms of simplicity, aesthetic appeal, informational transparency, and practical utility.

5.3.2 Methodology 2: Interview

After conducting interviews with Nikos and Roland, several insights regarding the always-on-display and face recognition, as well as the speech-recognition features of the microwave interface, were obtained:

- Nikos, being tech-savvy, was intrigued by the always-on-display feature, citing the interface as modern and functional. He understood the integration of face recognition with the display and appreciated the smooth transition from the always-on to active state without the need for any button pressing. The only concern raised was the potential difficulty in recognizing faces in dimly lit rooms.
- Nikos also tested the button provided to bypass face recognition. Although it functioned as expected, he preferred to use the face recognition feature as it felt more efficient.
- On the other hand, Roland, who is not as tech-savvy, initially found the speech-recognition feature slightly intimidating. However, he was intrigued and appreciated the ability to communicate using natural language, without having to remember specific phrases.
- Roland noted some instances where he had to repeat himself or speak more clearly when the system failed to understand his instructions. While the transition to using voice commands required some getting used to, he found the system surprisingly convenient once he acclimated to it.
- Roland tested the deactivation of the voice command feature once and found it straightforward. However, he mostly preferred to leave the feature activated for regular use.

Overall, the new features of the microwave interface, while sparking some initial apprehension among less tech-savvy users, were generally well-received and appreciated for their functionality, efficiency, and modern touch. Further adjustments could be made to improve recognition accuracy in different lighting conditions and speech variations.

5.3.3 Methodology 3: Think Aloud

Based on the interviews conducted with Theodora and Thymios, several observations and insights on the speech-recognition feature of the microwave interface were gathered:

- Both Theodora and Thymios found the activation and deactivation commands ("Okay Microwave" and "deactivate", respectively) straightforward and easy to remember.
- The freedom to express commands in a natural, conversational manner was seen positively by both users. Theodora remarked it was "more natural this way", while Thymios appreciated not having to remember specific phrases and found the interaction "quite intuitive".
- There were concerns raised about the system's ability to accurately understand voice commands in situations where the user might have an accent or when there is background noise. These issues did not surface during the interviews, but both users identified them as potential challenges.
- The voice command feature was seen as useful, especially when the user's hands are occupied or when multitasking. Theodora, a student, mentioned she would definitely find the feature handy in such situations.
- While Theodora expressed enthusiasm for using the feature regularly, Thymios had mixed feelings. He acknowledged the convenience of the feature but wasn't certain about how often he would use it, preferring traditional methods.

Overall, the speech-recognition feature was viewed as a positive addition to the microwave interface, appreciated for its intuitive, hands-free operation. Potential misunderstandings were identified as a potential area of concern that may require further testing and refinement.

Figure 17: Meet Aliki. She's a 62-year-old retiree who enjoys cooking. She's not very technologically savvy but uses a smartphone to video call her children. She is used to conventional microwaves and is trying this new voice-enabled microwave for the first time.

5.3.4 Methodology 4: Cognitive Walkthrough

The task It is clear that understanding the tasks that the users are expected to accomplish is pivotal. This understanding directly informs the design process and enables us to evaluate the usability and accessibility of the interface.

In this context, the task we aim to examine through a cognitive walkthrough is as follows: *'Utilizing the voice command feature to operate the microwave for heating a meal'*. This task encapsulates a typical use case scenario that a user, particularly someone like our defined persona, Aliki (figure 17), may encounter in everyday life. The successful execution of this task relies not only on the accessibility and responsiveness of the voice command feature but also on the clarity and intuitiveness of the instructions provided to the user. Through this task, we can assess how effectively the interface communicates with the user and how easily the user can accomplish a standard operation on the microwave with the help of voice commands.

This sets a concrete basis for the subsequent cognitive walkthrough. By exploring each step required to achieve the task's successful completion, we can gain insights into potential bottlenecks or ambiguities in the interface, and as a result, be equipped to suggest pertinent improvements.

Document the Action Sequence The task of *'Utilizing the voice command feature to operate the microwave for heating a meal'* can be broken down into the following sequence of actions:

1. Aliki approaches the microwave.
2. She says, "Okay Microwave".
3. She then gives the command, "Microwave on high for 2 minutes".
4. The microwave confirms the command and starts heating.

By documenting this sequence, we create a clear pathway through the task, which we can then scrutinize at each step during the cognitive walkthrough. It will enable us to isolate any problems or inefficiencies within each individual action, thereby enhancing the system's overall usability.

The Walkthrough In the cognitive walkthrough, we will embody the aforementioned user profile of Aliki.

1. **Aliki approaches the microwave**: As Aliki is used to traditional microwaves, approaching the appliance would be a natural and straightforward step. She knows that she needs to be close to the device to use it, and successfully approaching the microwave would signal progress towards her goal.
2. **Aliki says, "Okay Microwave"**: Aliki knows that saying "Okay Microwave" should activate the voice-command feature, given the instructions which she was given. A clear audio or visual indication that the system is listening is crucial here, thus, Aliki would be reassured that she is progressing towards her task.

3. **Aliki gives the command, "Reheat for 2 minutes"**: Aliki might not be accustomed to the specific command structure required by a voice-activated appliance. It would be helpful that the system is designed to understand natural language and can accept a range of similar commands. Upon Aliki's successful command, an auditory or visual signal from the system, such as an affirmation of the command and a countdown, is crucial to assure her that the microwave has understood and is executing her command.

4. **The microwave confirms the command and starts heating**: Once the microwave begins the heating process, Aliki should intuitively understand that her command was successful. The microwave should provide continuous visual feedback, such as a countdown timer, to assure Aliki that the microwave is heating as per her command and making progress towards the task's completion.

Concerns

1. **Clear feedback after the wake word**: The first issue identified was the possible lack of a clear visual or auditory indicator that the microwave is actively listening after Aliki uses the wake word, "Okay Microwave". Users like Aliki, who are less technologically adept, might find this confusing or might not be sure if the microwave has registered the wake word. The system could improve by providing a clear, immediate, and unmistakable signal, such as a distinctive sound or a light, that the voice command feature has been activated and is ready for the next command.

2. **Need for command acknowledgment**: After Aliki issues the microwave command, it's unclear whether the system provides any visual or auditory confirmation that the command was understood and is being processed. This ambiguity could lead to user anxiety and uncertainty about whether the task is proceeding as desired. The design could benefit from incorporating a feature that confirms to the user that their command has been recognized. This could be an auditory confirmation repeating the command or a visual display of the command on a screen.

By conducting a cognitive walkthrough, we have been able to isolate some areas of the voice-enabled microwave interface that could be improved for users like Aliki. The next steps would involve brainstorming potential solutions for these issues, designing prototypes, and conducting further usability testing to ensure their efficacy.

6 Use of Natural Language and/or Computer Vision

Throughout the development process, we evaluated the potential benefits of integrating Natural Language and Computer Vision technologies into our interface. The goal was to enhance usability by providing additional means, such as voice and facial recognition, for user-device interaction. Each feature was carefully designed to add value to the overall user experience and accommodate specific user groups like the elderly, without complicating the interface. Ultimately, we incorporated two such features: User Face Detection to unlock the interface, and Voice Commands for interface operation and navigation.

6.1 Technologies

6.1.1 Face detection

BlazeFace [1], a lightweight, efficient face detection model developed by Google Research, was chosen for our face recognition tasks. Part of the MediaPipe framework, BlazeFace is known for its real-time operation across devices such as smartphones, embedded systems, and desktop computers, making it ideal for applications like facial recognition and emotion analysis. Key aspects of BlazeFace include:

- Architecture: BlazeFace uses a lightweight deep neural network architecture, integrating the principles of Single Shot MultiBox Detection (SSD) for a balance of speed and accuracy.
- Efficient Design: It is designed for fast performance, even on devices with limited computational resources.
- Face Detection: Specifically designed for face detection tasks, BlazeFace can handle a variety of face poses, sizes, and orientations.
- Real-time Performance: It operates in real-time, achieving high frame rates for face detection tasks.
- Cross-platform Compatibility: The model is designed to run on a variety of devices and platforms.
- Open-Source Implementation: BlazeFace is open-source and is part of the MediaPipe framework, allowing for easy integration into various projects.

6.1.2 Speech Recognition

To detect speech, we used the Web Speech API which integrates speech recognition and synthesis capabilities into web applications. The user's voice input is tokenized and passed to an embedding layer, Universal Sentence Encoder (USE) [2], a model developed by Google Research for transforming sentences into fixed-length vector embeddings. The USE plays a pivotal role in natural language processing and is known for its exceptional performance and efficiency.

6.2 User interface

6.2.1 Always-on Display

We incorporated the BlazeFace model into our application for face detection, more specifically for an automatic interface locking and unlocking mechanism; an always-on-display.

When the application is idle or inactive for a predetermined period, say 30 seconds, the interface automatically locks, restricting further user interaction until the user's presence is verified. This design approach ensures the secure usage of the application and prevents inadvertent activations.

Once a user's face is detected within the camera's field of view, the BlazeFace model's efficient and accurate face detection capabilities trigger an automatic unlock. The user can simply unlock the interface by staring at the camera, providing a seamless, convenient, and intuitive user experience, especially beneficial in scenarios where hands-free operation is needed.

To handle situations where the BlazeFace model cannot detect a face, or when the user prefers manual control, we also offer an alternative unlocking mechanism. A dedicated unlock button has been integrated into the interface, granting the user the ability to manually unlock the interface regardless of face detection outcomes. This fallback mechanism guarantees that users can consistently access the interface even if face detection is temporarily unavailable or undesired.

6.2.2 Voice Commands

We utilized a Speech-to-Text (STT) model for the recognition and conversion of the user's spoken words into text. This conversion facilitates the operation of the interface through voice commands, a valuable addition for users who prefer or require voice-based interactions.

To begin voice command interactions, the user initiates the system by saying "Okay Microwave." This wake-up phrase signifies the user's intention to provide voice commands. The system remains in this activated state, listening for the user's commands until it receives a "Deactivate" command, which signals that the user wishes to discontinue voice-based interactions.

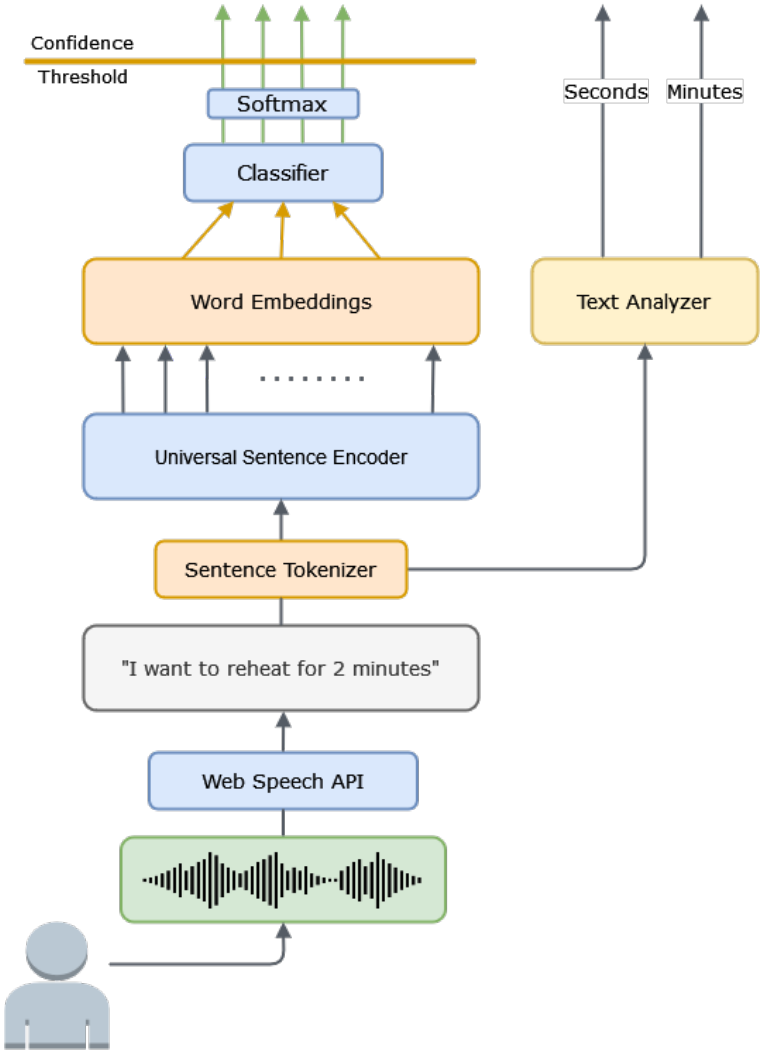

Figure 18: Speech Recognition architecture used in voice commands.

Once the system receives a voice command, it processes the input by breaking the speech into individual units, known as tokenizing. The tokenized units are then passed through an embedding layer, which generates a meaningful representation of the input. This process captures semantic information and contextual understanding, crucial for the next step, intent extraction.

The primary goal of intent extraction is to decipher the user's intended action from the voice command, such as `REHEAT` or `DEFROST`. For the system to perform the action correctly, the user needs to specify the associated metric with each command, such as the duration in minutes and seconds for the `REHEAT` command. By explicitly stating the metric, the system can avoid any ambiguity, accurately interpreting and executing the user's command as intended.

7 Conclusion

Throughout the three iterative cycles of this project, we observed the invaluable role of user-centered design in shaping a user-friendly interface. The methodologies utilized, ranging from questionnaires and interviews to think-aloud sessions and cognitive walkthroughs, provided rich insights into user behavior, preferences, and difficulties. The modifications made at each stage, guided by these insights, significantly enhanced the usability and accessibility of the interface for various user categories. A demo[2] of our product

[2] `https://youtu.be/B6Jepy5Hvfo`

and the source code[3] of our project can be found online.

Reflecting on the project, it is clear that iterative prototyping and constant user feedback are vital to the development of effective and user-centric designs. It was an enlightening experience to witness the transformation of the interface with each prototyping cycle, informed by user input.

While we achieved significant enhancements in the interface's design, the process underscored the evolving nature of user-centered design. As user preferences and technologies continue to advance, ongoing testing and refinement will remain essential to maintain the interface's usability and relevance.

Looking forward, the lessons learned from this project will serve as a valuable guide for future endeavors in user interface design. In particular, the importance of truly understanding user needs, embracing an iterative design process, and utilizing diverse evaluation methodologies will be carried forward in all future projects.

[3] https://github.com/gsiros/CookMate

Appendix

User Questionnaires and Responses

Cycle 3 - Questionnaire

Figure 19: Interface Comprehension; setting a timer and reheating food. 94.6% of the users managed to successfully complete the task.

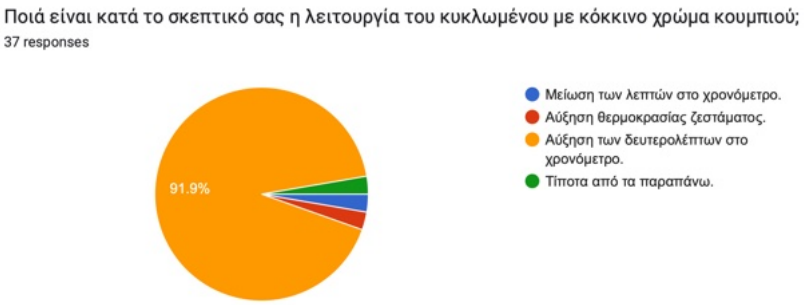

Figure 20: Interface Comprehension; button functionality. 91.9% of the users were able to grasp the functionality of the button.

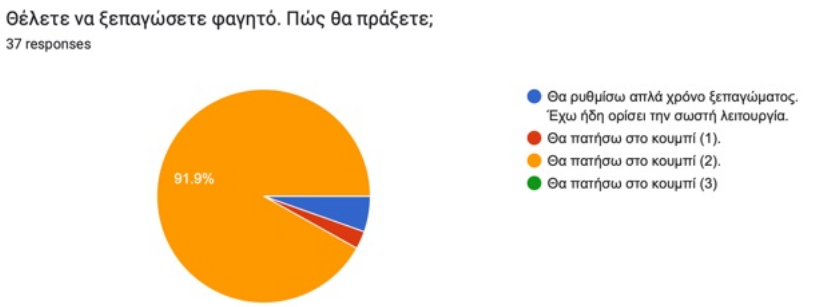

Figure 21: Interface Comprehension; navigation. 91.9% of the users managed to successfully complete the task.

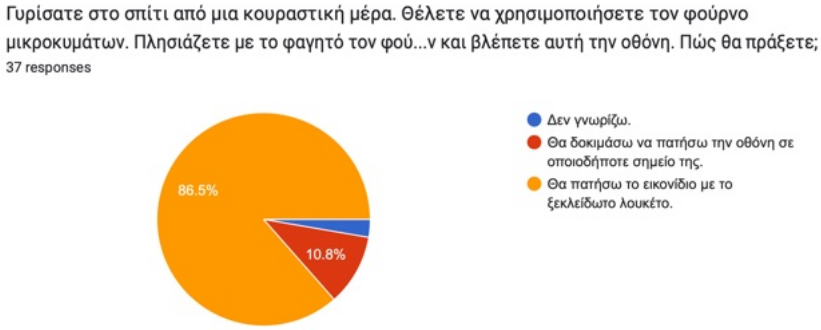

Figure 22: Interface Comprehension; waking the microwave up from sleep. 85.5% of the users managed to successfully complete the task. Another 10% almost succeeded, while the rest failed.

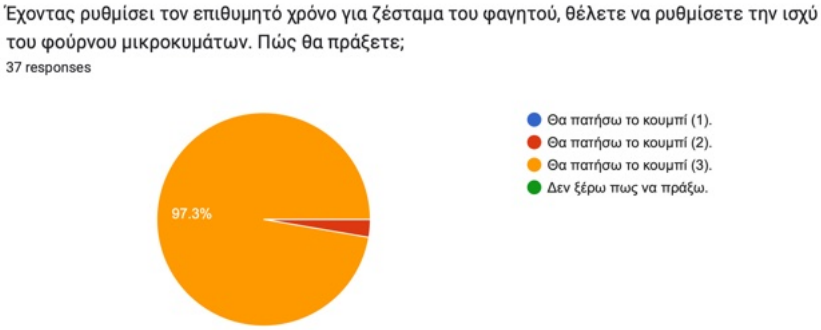

Figure 23: Interface Comprehension; navigation. 97.3% of the users managed to successfully complete the task.

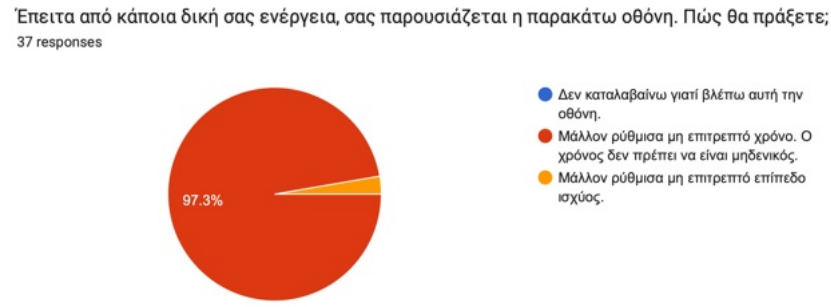

Figure 24: Interface Comprehension; dialogue comprehension. 97.3% of the users managed to understand the message and the reason behind the message.

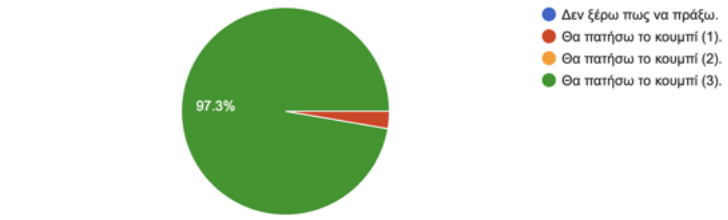

Figure 25: Interface Comprehension; resetting a timer. 97.3% of the users managed to successfully complete the task.

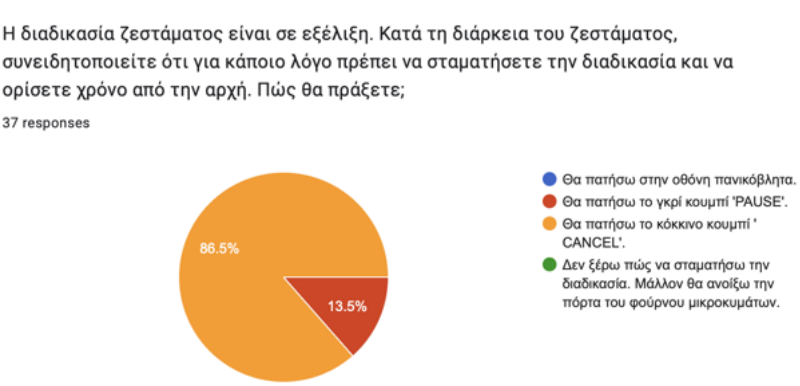

Figure 26: Interface Comprehension; cancelling an ongoing task. 85.5% of the users managed to successfully cancel the task, while a surprising 13.5% did not understand the request.

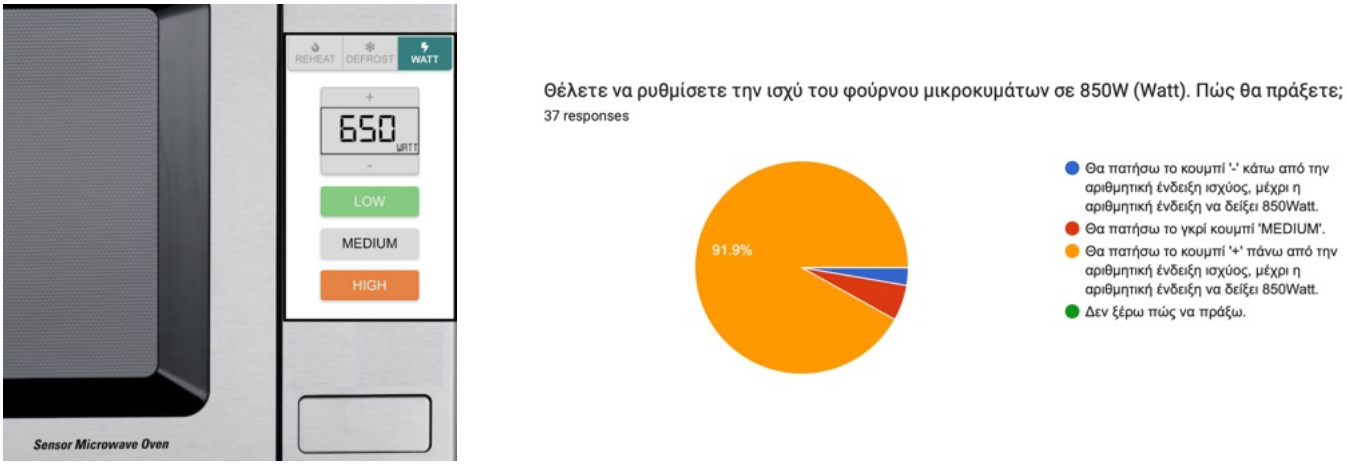

Figure 27: Interface Comprehension; setting the power to an exact value. 91.9% of the users managed to successfully complete the task.

Interview Transcripts

Cycle 1 - Interview No.1

Researcher

Thank you for taking the time to participate in this interview, Nikos. As a tech-savvy individual, your insights will be valuable for our research. Have you had a chance to interact with our microwave interface prototype?

Nikos

Yes, I've spent some time playing around with it.

Researcher

Excellent! Let's begin then. Firstly, how intuitive did you find the use of the rotary knob to set the timer?

Nikos

I think it's pretty straightforward. It reminds me of the old analog microwaves, and it's simple to adjust.

Researcher

How about the modifier buttons that add preset increments of time to the timer? Did you find those useful?

Nikos

Yes, definitely. For quick reheating or defrosting, those preset increments are a nice touch.

Researcher

Speaking of reheating and defrosting, were you able to easily navigate and differentiate between these functions and the 'Cook Food' option on the interface?

Nikos

Yes, the navigation bar was very clear. I liked having those three distinct options.

Researcher

How was your experience with the 'Cook Food' option? Was it clear that it was meant for selecting presets related to different food options?

Nikos

It was, but I would suggest perhaps adding a label or some description. Some users might not immediately realize that it's for food presets.

Researcher

That's a valid point, Nikos. We appreciate your feedback. Now, how about the advanced settings button? Was it clear to you what its function was and did you find navigating to the secondary screen for power adjustment convenient?

Nikos

The 'Advanced' button is a bit ambiguous at first glance. I clicked on it out of curiosity. Once I was there, the power adjustment was easy, but maybe you could consider relabeling the button to something more indicative of its function.

Researcher

That's insightful feedback, Nikos. Lastly, how would you rate your overall experience with the interface on a scale of 1-10, and why?

Nikos

I would say a solid 8. It's pretty user-friendly and I liked the modern design. But, as I mentioned, a few labeling enhancements could make it perfect.

Researcher

Thank you for your time and valuable insights, Nikos. We'll definitely consider your feedback for our future design iterations.

Cycle 1 - Interview No.2

Researcher

Hello, Mr. Roland, we appreciate your time in joining us today. We'd like to discuss our microwave interface prototype with you. First off, could you tell us your general impression of this prototype?

Roland

Well, it's quite different from what I'm used to. It has a lot of buttons which I found a bit overwhelming initially.

Researcher

Thank you for that, Roland. Let's talk about the rotary knob at the center of the prototype. Did you find this method of controlling the timer intuitive and easy to use?

Roland

To be honest, I'm not used to such controls on a microwave. I usually prefer the traditional number pad. But with some usage, I guess it could become familiar.

Researcher

I see. How about the modifier buttons that add preset time increments to the timer? Did you find those helpful?

Roland

Yes, those buttons were handy. It's easier to just press a button for adding 30 seconds or a minute, instead of fiddling with the knob.

Researcher

Understandable. Now, there are two other buttons, one for starting the operation and the other for resetting the timer or stopping the operation. Did you find them conveniently placed and easy to use?

Roland

Yes, those buttons were straightforward to use. Their labels made their functions clear.

Researcher

Great. Could you share your thoughts about the navigation bar at the base of the interface?

Roland

The navigation bar is simple and I liked that. The three functions are easy to distinguish. I guess it would just take some time to get used to the different options and what each one does.

Researcher

Thank you. Finally, there's an Advanced button to adjust the power level. What are your thoughts about this feature?

Roland

Honestly, I rarely adjust the power level on my microwave. But I can see how it might be useful for some people. The button is a bit out of the way, which I guess is good since it's not a commonly used function.

Researcher

We appreciate your feedback, Roland. Your insights will greatly aid us in improving our design.

Cycle 2 - Interview No.1

Researcher

Hello again, Mr. Roland. Thank you for joining us to review the updates we've made to our microwave interface prototype. To start, could you share your initial impressions of the revised design?

Roland

I see some changes. The colors are a nice touch, and I noticed you've moved the navigation bar to the top. It's a bit more visually appealing this time around.

Researcher

We're glad you noticed, Roland. Speaking of the navigation bar, do you find its new position at the top more intuitive, considering our usual top-down reading patterns?

Roland

Yes, I think that makes sense. It's the first thing that I noticed, so it works.

Researcher

Great. In this updated design, we've replaced the 'COOK FOOD' function with a 'WATT' function for adjusting power level. What are your thoughts on this change?

Roland

Well, I mentioned last time that I rarely adjust the power level. But having it more visibly present might encourage me to experiment with it.

Researcher

That's interesting to hear. We've also introduced color associations for functions: orange for 'REHEAT', blue for 'DEFROST', and teal for 'WATT'. Do you find these colors help you in identifying functions quickly?

Roland

I think so. The colors add a nice visual cue, especially for someone like me who is not very tech-savvy. It's a good idea.

Researcher

Thank you, Roland. Now, in regards to time-setting, we've continued with both the rotary knob and button-based interface designs. We also added modifier buttons around the timer for quick adjustments. Do these enhancements make the time-setting process easier for you?

Roland

I do appreciate the modifier buttons for quick adjustments. They're certainly handy. But, I still feel a bit out of my depth with the rotary knob.

Researcher

That's understandable. For ongoing operations, we've developed two designs: a progress bar-based design and a traditional digital timer. Do you have a preference between the two, and if so, why?

Roland

I think the traditional digital timer is what I'm most used to. I can understand the progress bar, but numbers give me a precise sense of how much time is left.

Researcher

Makes sense. Lastly, we've designed verbose and laconic versions for popup dialogues. Which version do you think you'd prefer and why?

Roland

I think I would prefer the verbose version. It might take up a bit more space, but the extra information would be helpful for me.

Researcher

Thank you, Roland, for your valuable insights. We appreciate your time and feedback, and it will be very helpful in further refining our design.

Cycle 2 - Interview No.2

Researcher

Welcome back, Nikos. We're eager to hear your thoughts on the second iteration of our microwave interface. What's your initial reaction to the new design?

Nikos

It looks much cleaner now. The added colors and relocated navigation bar are great improvements.

Researcher

We're glad to hear that. How about the consolidation of the supported functions into 'REHEAT', 'DEFROST', and 'WATT'? Is this simplification helpful in your opinion?

Nikos

Absolutely. Fewer buttons and clear functions make the interface less cluttered. I also like the replacement of the 'COOK FOOD' function with the 'WATT' function. It's more direct.

Researcher

Excellent. How about the color scheme for each function? Does the association between color and function help you navigate the interface?

Nikos

Yes, it does. The color coding makes it visually easier to distinguish between the functions.

Researcher

We've maintained both button-based and rotary knob interfaces for 'REHEAT' and 'DEFROST' functions. Do you have a preference between the two?

Nikos

I'm comfortable with both, but the button-based interface seems quicker for inputting specific times.

Researcher

Understandable. Now, we have two versions of the timer: a progress bar design and a traditional digital timer. Which one do you prefer and why?

Nikos

The progress bar is a nice visual touch, but I prefer the precision of the digital timer.

Researcher

That makes sense. For the 'WATT' function, we've designed a button-based interface and a slider-based interface. Do you have a preference here?

Nikos

I think the slider-based interface could be more intuitive for adjusting power levels. It gives a visual sense of increase and decrease.

Researcher

Great point. Lastly, we have verbose and laconic versions for popup dialogues. Which version do you think you'd prefer?

Nikos

I would go for the laconic version. As a tech-savvy user, I don't need much explanation once I get the hang of it.

Researcher

That's understandable. Thank you for your time and insightful feedback, Nikos. It will be very helpful as we continue refining our design.

Cycle 3 - Interview No.1

Researcher

Hello Nikos, thank you for taking the time to speak with us today. As a tech-savvy user, your insights into our microwave interface, especially the always-on-display and face recognition feature, will be highly valuable. To start, could you tell us about your initial impressions when you first saw the always-on-display feature?

Nikos

Sure, I was quite intrigued. I haven't seen many microwaves with a feature like this before. The interface felt modern and the embedded clock gave it a functional touch when not in use.

Researcher

Interesting. Now, could you describe your understanding of how the face recognition feature works in conjunction with the always-on-display?

Nikos

From my understanding, the microwave enters an always-on-display mode after a period of inactivity. In this mode, if I stand in front of it, the built-in camera recognizes my face, and the microwave transitions from the dimmed screen to active use.

Researcher

That's a good understanding. Would you think of any challenges when using this feature? If so, could you describe them for us?

Nikos

The only issue I imagine is in a dimly lit room where the face recognition would struggle.

Researcher

Thank you for sharing that. In terms of usability, do you find the transition from the always-on-display to active use smooth?

Nikos

Yes, the transition is pretty smooth. I like that I don't have to press any buttons, and it just recognizes me and transitions to the active state.

Researcher

Good to know. The always-on-display also has a button to bypass face recognition. Have you used this feature? If yes, how was your experience with it?

Nikos

I tried it once just to test it. It worked as expected. However, I mostly use the face recognition feature because it feels more efficient.

Researcher

We appreciate your feedback on that. Thank you for your valuable feedback and insights. It was a pleasure speaking with you.

Nikos

Anytime! Thanks for having me!

Cycle 3 - Interview No.2

Researcher

Hello Roland, thank you for joining us today. Despite not being highly tech-savvy, your views on our microwave's speech-recognition feature will be of great value. Could you please share your first impressions when you used the voice command functionality?

Roland

Well, initially, it was a bit intimidating. I've used microwaves for decades without ever talking to them. However, I was curious and intrigued to try this new feature.

Researcher

That's a good start. Could you describe your understanding of how the speech recognition feature works in our microwave interface?

Roland

As I understand it, I can activate the microwave's listening mode by saying "Okay Microwave", and then I can give it commands, such as to reheat or defrost food for a specific amount of time or set the wattage. What I liked is that there's no specific phrase to remember. It seems to understand natural language.

Researcher

Indeed, the design is intended to comprehend natural language. Did you encounter any difficulties while using this feature? If yes, could you elaborate?

Roland

There were a few times when it didn't quite catch what I was saying. I had to repeat myself or speak more clearly. It wasn't a big issue, but it happened.

Researcher

I see. And in terms of usability, did you find the transition to using voice commands smooth and intuitive?

Roland

Honestly, it took me a few tries to get used to it. I had to remind myself that I could just talk to it. But once I got the hang of it, it was surprisingly convenient.

Researcher

Your feedback is greatly appreciated. Have you tried to deactivate the voice commands feature? If so, could you share your experience with this aspect?

Roland

Yes, I tried deactivating it once by saying "deactivate". It was straightforward and worked as I expected. I mostly leave it on, though.

Researcher

Thank you for sharing your experiences. Your insights are incredibly valuable to us, and we appreciate your time.

Roland

I'm happy to help. Thanks for giving me the opportunity to share my thoughts.

Think Aloud Transcripts

Cycle 1 - Think Aloud session No.1

Researcher

Hello Roland, thank you for joining us today. We're going to conduct a 'Think Aloud' session. We'll ask you to interact with our prototype and we would like you to verbalize your thought process as you perform a given task. Are you ready?

Roland

Yes, I think so. What do I need to do?

Researcher

Thank you, Roland. First, we'd like you to set the microwave timer to heat something for 1 minute and 30 seconds. Please explain your actions and thoughts as you do this.

Roland

Alright, let me see. First, I see this rotary knob here. I'm assuming this sets the time. So, I'm going to turn it clockwise... It seems to be increasing the time... I'll stop at 1 minute. Then I see a button that says '30 seconds'. I'll press that to add the extra 30 seconds.

Researcher

Excellent, Roland. Now, can you tell us how you would start the heating process?

Roland

Well, there's a button here labeled 'START', so I guess I would just press that.

Researcher

Thank you, Roland. Now, let's say you mistakenly set the timer for too long. How would you reset the timer?

Roland

I see a 'RESET' button here. I think pressing that would reset the timer.

Researcher

Very good. Now, can you find the option to defrost something?

Roland

Hmm, let's see... There's a navigation bar at the bottom with 'REHEAT', 'DEFROST', and 'COOK FOOD'. I would press 'DEFROST' I believe...

Researcher

You're doing great, Roland. Lastly, how would you access the power level settings?

Roland

That seems a bit trickier... Ummm... uhhh... Oh, I see an 'ADVANCED' button to the right of the interface. Ehhh.. I guess I'd click on that? I am not sure, I apologize.

Researcher

It is okay. Thank you, Roland, for your valuable insights. They will certainly help us improve our design.

Cycle 1 - Think Aloud session No.2

Researcher

Hello Theodora, we appreciate your participation in this session. Today, we'll be conducting a 'Think Aloud' session where you'll be asked to interact with our prototype and express your thought process as you perform a given task. Is that okay with you?

Theodora

Sure, that sounds fine.

Researcher

Excellent, Theodora. First, can you please set the microwave timer to heat something for 2 minutes? Please share your thoughts and actions as you do this.

Theodora

Okay, I see this rotary knob which I think is for setting the timer. I'm... I do not know how am I supposed to turn the knob with my fingers touching it. I mean, on a traditional microwave the knob has volume and sticks out, but this? Yeah... it's a bit difficult to control. I think I'll just use the modifier buttons instead. There's one
that says '1 minute', so I'll press that twice.

Researcher

Thank you for your feedback, Theodora. Now, how would you start the microwave?

Theodora

There's a button labeled 'START', I'd press that to begin the heating process.

Researcher

Good job. Now, suppose you set the timer for longer than you intended. How would you reset the timer?

Theodora

There's a button here labeled 'RESET'. I assume pressing that would reset the timer.

Researcher

That's correct, Theodora. Now, how would you go about defrosting something by mass?

Theodora

I see a navigation bar at the bottom. It has options for 'REHEAT', 'DEFROST', and 'COOK FOOD'. I guess I'd press 'DEFROST' for that.

Researcher

Yes, that's right. And lastly, how would you adjust the power level settings?

Theodora

Hmm, that's not as straightforward. But there's an 'ADVANCED' button to the right of the interface. I would press that, I think.

Researcher

Thank you for your valuable insights, Theodora. Your experiences will help us improve our design.

Cycle 2 - Think Aloud session No.1

Researcher

Thank you for joining us, Theodora. Today we're going to conduct a 'Think Aloud' session. I'll ask you to perform certain tasks with our microwave interface, and I want you to describe your thought process as you do so. Ready to start?

Theodora

Sure, let's do this.

Researcher

First, could you please try to reheat a dish for two minutes?

Theodora

Alright. I see the 'REHEAT' button in orange on the top. I guess that's where I start. It's great that the button is so distinct and self-explanatory. I'll go ahead and tap that... Okay, now I have the rotary knob again...

Researcher

What are your thoughts on the rotary knob?

Theodora

I can see how it might be intuitive for some, but as I said last time, I'm not very comfortable with it. I'm not sure if my touch gestures will control the knob correctly. I still prefer the button interface. I hope you haven't abandoned that option yet!

Researcher

No we have not, Theodora, thank you for your feedback. Alright, let's continue then.

Theodora

OK. I guess I'll have to rotate the knob clockwise until the timer shows 2:00. [...] It seems like I struggle to set the time at exactly 2 minutes with the rotary knob. The touch accuracy is... meh. [...] That's done now.

Researcher

Great. What would be your next step?

Theodora

I see a green 'START' button which seems to be the logical next step to initiate the reheating process. I like the use of green; it gives a clear 'go!' signal.

Researcher

Now, suppose you want to stop the reheating midway. What would you do?

Theodora

I think I would press the 'CANCEL' button, given it's red, it's pretty self explanatory.

Researcher

Perfect. Now, could you try to defrost a dish for five minutes?

Theodora

Alright. I see the 'DEFROST' button in light blue. I'll tap that... Okay, I again see the rotary knob. Same as the 'REHEAT' procedure.

Researcher

Great. And how would you adjust the power level to 1000 watts for this defrosting process?

Theodora

Let me see... There's a 'WATT' button here in teal. I'll tap that... Now, I see a button-based interface. Buttons! That's better! I guess I'll use the button-based interface. I'll press the increase power button on top of the timer until I reach a wattage of 1000..

Researcher

Excellent. Thank you for sharing your thought process, Theodora. Your feedback will help us refine the design and make it more user-friendly.

Cycle 2 - Think Aloud session No.2

Researcher

Hello again, Roland. It's a pleasure to have you back. We're going to continue our 'Think Aloud' session with some new tasks. Are you ready to begin?

Roland

Yes, let's proceed.

Researcher

Thank you, Roland. Today we'd like you to reheat a dish for three minutes. Could you please walk us through your process as you do so?

Roland

Of course. I recall that the 'REHEAT' button is at the top, so I'll start by pressing that... I see the rotary knob again. I know from last time that this sets the time. I'll try to set it to three minutes... I'm finding it a bit challenging to precisely control the time with the knob... But I managed to set it.

Researcher

Thank you for sharing your thoughts, Roland. Now, can you tell us how you would start the reheating process?

Roland

I believe that would involve pressing the 'START' button. It's green and stands out, so it seems like the logical choice.

Researcher

Perfect. Now, let's say you accidentally set the timer for too long. How would you adjust the time down?

Roland

I remember there's a 'CLEAR' button, but that's not exactly what I want here... I don't see an explicit 'decrease time' button, but I'm guessing I can turn the knob counterclockwise to decrease the time. Let's see... Yes, it seems to work that way.

Researcher

Well done, Roland. Now, let's try defrosting. Could you attempt to defrost something for five minutes?

Roland

Alright. I remember the 'DEFROST' button from last time. I'll select that... And I assume I will use the same knob for setting the time again.

Researcher

Great job. Lastly, how would you change the power level for defrosting to 600 watts?

Roland

This might be a bit harder... Ah, there's a 'WATT' button. Let's try that... Alright, it brings up a secondary screen with power levels. It seems I have button controls here... That's much easier for me. I'll use the decrease button under the timer to decrease the power to 600 watts. [...] Huh?! It worked!.

Researcher

Excellent, Roland. Your feedback and insights are invaluable. They will certainly aid us in refining the interface for more intuitive use. Thank you.

Cycle 3 - Think Aloud session No.1

Researcher

Hello Theodora, thank you for agreeing to participate in our session today. We'd like you to use our microwave's speech-recognition feature while expressing your thoughts aloud. Let's start by asking you to activate voice commands. Can you share what you're thinking as you try this?

Theodora

Alright, so I'm going to say "Okay Microwave". I think it's kind of cool, like I'm talking to a person.

Researcher

Thank you for sharing that, Theodora. Now, please tell the microwave to perform a specific task using your own words. Remember to share your thoughts and expectations as you do so.

Theodora

Okay, I'll ask it to reheat my coffee for two minutes. So, I'll say, "please reheat my coffee for 2 minutes". It's nice not having to remember specific phrases. It feels more natural this way.

Researcher

Indeed, the intent is to create a more natural interaction. Now, could you please tell us about any concerns or issues you foresee or have experienced when using the voice command feature?

Theodora

Well, I guess I'm a bit worried about whether it will always understand me correctly. What if other people are having a conversation behind me?

Researcher

This is a valid concern, Theodora. How about the deactivation process? Could you try deactivating the voice command feature now and share your thoughts as you do so?

Theodora

Sure, I'm going to say "deactivate". It sounds straightforward enough. Let's see if it works as expected.

Researcher

Thank you for that. As a student, do you see the voice command feature being useful to you on a regular basis?

Theodora

Definitely! Especially when my hands are full or when I'm multitasking. It's easier to just say what I need rather than having to manually input it.

Researcher

That's a helpful insight, Theodora. Thank you for your time and for sharing your thoughts. Your feedback is greatly appreciated.

Theodora

No problem, happy to help. It was fun interacting with the microwave this way!

Cycle 3 - Think Aloud session No.2

Researcher

Hello Thymios, we appreciate your participation in this think aloud session. As someone who enjoys technology, we're interested to hear your thoughts on our microwave's speech-recognition feature. Could you start by activating voice commands and sharing your initial thoughts as you do so?

Thymios

Sure, I just say "Okay Microwave", correct? That's straightforward enough, I like that.

Researcher

Exactly, Thymios. Now, could you please use a voice command to perform a specific task with the microwave, and narrate your thoughts as you do this?

Thymios

I'll tell it to reheat some soup for 2 minutes. So, "Reheat my soup for 2 minutes." It's good that I don't need to remember specific phrases. It's quite intuitive.

Researcher

Great to hear that, Thymios. Now, could you tell us about any concerns or potential issues you might foresee or have already encountered while using the voice command feature?

Thymios

Well, I'm thinking about potential misunderstandings. What if I have an accent or if the room is noisy? But so far, it seems to work fine.

Researcher

Those are valid points, Thymios. How about deactivating the feature? Could you try to say "deactivate" and share your thoughts during the process?

Thymios

I'll say "deactivate" then. It's simple and easy to remember.

Researcher

Indeed, we aimed for simplicity. As a final point, do you think you would use the voice command feature often?

Thymios

I am not sure. I just find it more convenient to use it in the traditional way. But, it sure is good to have.

Researcher

That's wonderful feedback, Thymios. We appreciate your time and thoughts shared today. Thank you.

Thymios

It was my pleasure. I enjoyed testing this out. Thank you.

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