Engineering Strategies & Practice

University of Toronto
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APS111
Conceptual Design Specifications (CDS)

Team #	161	Date	March 23, 2025

Project Title	Case Study # 5 Micheal (47M) with traumatic brain injury, who has challenges with memory, executive functioning, and anger management.
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State your document wordcount: 3295 words (word count excludes Cover Page, Executive Summary, Reference List and Appendices)

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- ✔ Cover Page
- ✔ Executive Summary
- ✔ Introduction
- ✔ Problem Statement
- ✔ Service Environment
- ✔ Stakeholders
- ✔ Detailed Requirements (FOCs)
- ✔ Generation, Selection and Description of Alternative Designs
- ✔ Alternative Designs Selection Process
- ✔ Alternative Design Descriptions
- ✔ Proposed Conceptual Design Specification
- ✔ Measures of Success (MOS)
- ✔ Conclusion
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Executive Summary

Erica Dennis and the team of behaviour psychology specialists at St. Lawrence College (SLC) presented the case of Micheal, a 47-year-old man who suffered a traumatic brain injury, which diminished his independence in completing daily tasks. The team has told us that Micheal's shame over his lack of independence has led him to lash out in irritation at his children, leading to them developing a fear of him. This situation presents the need for a design that assists Micheal in regaining his independence, and this document outlines the parameters for such.

Micheal currently resides in a New York City apartment with his wife and three children, ages: 4, 7 and 12. The apartment temperature ranges from 20.5ºC - 23.3ºC, has a total size of 1000ft^2, 5G cellular service, WIFI access, and a minimum of two electrical outlets per room. In this space, Micheal's wife and children are the most directly affected by the design, and their positive experiences must be prioritized.

This design primarily enables Micheal to complete tasks independently. Consequently, the device stores information regarding Micheal's tasks, communicates this information to Micheal, and allows Micheal to engage with it to update his progress regularly. Additionally, the facilitator, Micheal's psychologist, regularly receives information on Micheal's progress. The design's key goal is to actively remind Micheal of his tasks; the design should proactively interact with Micheal and remind him without requiring his initiative. Additionally, the disturbances to his family should be minimized, as measured by the noise and/or light emitted from the design. The Consumer Product Safety Improvement Act asserts constraints on child-proofing the design, with the Americans Disability Act contending additional limits. Additionally, as the design transmits data, data protection sections in the Health Insurance Portability and Accountability Act apply.

Through a seven step brainstorming and idea selection process, three alternate designs are presented.

Mike-Lens AR is a pair of augmented reality (AR) glasses that would provide Micheal with a heads-up overlay that displays current active tasks, while using image recognition software to highlight key objects related to the current task(s), and gives beeps to notify Micheal. While providing a convenient and eye-catching overlay, the theoretical battery limitations prevent the glasses from functioning for an entire day of usage.

JAMNS is an earpiece that gives Micheal artificial intelligence (AI) powered voice prompts for his tasks, allowing for conversation and confirmation of task completion. The device would activate when an incomplete task is upcoming, or upon Micheal actively speaking to it. While this device offers incredible flexibility, the possibility of Micheal forgetting to equip it, as well its possibly negative impacts on his peripheral hearing must be kept in mind.

Questify is a mobile application based on Micheal's Android phone with a user interface (UI) that displays a bird's eye view of his home, with pins appearing at the appropriate location when the task is active. The app would send haptic and sound notifications to Micheal whenever a new task is activated, or reminders for incomplete tasks. With the base of a pre-existing smartphone, battery and forgetfulness concerns are much less evident, though cues may not be noticed in a noisy environment. This is our recommended idea, as it most effectively fulfills our top objectives. To measure the success of Questify, we will implement a three-day-long process in which all team members will send messages to a specific member with the same model phone as Micheal, who will then timestamp and respond to the message as soon as he sees them, with data on his response time and frequency being collected. This method measures the effectiveness of our proposed method of actively reminding Micheal, our main objective.

With fully defined alternate solutions, the next steps would be implementing the measure of success test with the chosen design and affirming associated costs.

1.0 Introduction

This document outlines the development of a memory assistive tool designed to support Micheal, a 47-year-old man who sustained traumatic brain injury (TBI) in a motorcycle accident three years ago [1]. Presented as a case study by Erica Dennis and her team at SLC, Micheal has faced significant memory challenges [2], impacting his ability to complete daily tasks independently, straining his relationship with his family members.

This report evaluates three alternative designs: Questify, Mike Lens-AR and JAMNS. These designs were assessed on their effectiveness in reminding Micheal, minimizing disturbances to his family, and integrating into his environment while considering key stakeholders and meeting design constraints.

This report also outlines the idea generation and selection process behind these solutions.

2.0 Problem Statement

The team at SLC presented the case study of Micheal, who, after sustaining a traumatic brain injury, experiences memory issues, hindering his ability to complete daily tasks independently [1] [3]. His declining memory prevents him from recalling 75%-80% of his daily tasks leading to angry outbursts, straining family relationships due to his shame over lost independence [Appendix A.1].

Micheal currently lacks tools to support his memory and task completion. The SLC team highlights the need for a tool that will assist Micheal in completing daily tasks, restoring his independence, and repairing familial relationships.

The design scope is constrained by Micheal's New York City apartment unit, which features full cell service, along with consistent electrical power (Section 3.3), allowing usage of electronic devices. The influence of governing bodies such as the US Department of Justice Civil Rights Division and US Department of Health and Human Services prohibits solutions modifying Micheal's body. The device should be operable within this space and focused on aiding his memory inconsistencies in completing daily tasks. Furthermore, the design can utilize devices Micheal currently possesses, as outlined in Section 3.2, Table 3.

3.0 Service Environment

This section describes the environment in which the design will function.

3.1 Physical Environment

The design will be implemented in Micheal's apartment in Manhattan, New York, USA. The apartment contains three bedrooms, two bathrooms, and a kitchen (Figure 1). The conditions of the average New York City apartment are listed in Table 1, and various conditions that Micheal is subject to daily, are in Table 2.

Figure 1. Floor plan of apartment. Adapted from [4]

Table 1. Conditions of an average New York apartment

Parameter	Average apartment in Manhattan
Temperature (°C)	20.5 - 23.3 [5]
Noise (dB)	40 - 60 [6]
Number of Electrical outlets (per room)	2 [7]
Voltage of electrical outlets (V)	120 [8]
Size (ft^2)	1000 [4]

Table 2. Conditions Micheal is exposed to daily

Parameter	Bathroom conditions	Kitchen conditions
Moisture Exposure (IP)	IP48 [9]	-
Humidity Exposure (RH)	~60% [10]	-
Heat Exposure	-	40° C [11]

3.2 Living Things

Micheal's family lives with him in the apartment, including his wife and three children, aged 4, 7, and 12 years old.

3.3 Virtual Environment

Manhattan has access to 5G Ultra Capacity (Figure 2), defined in Appendix B. Micheal can use electronic devices such as smartphones, watches and computers. These devices' capabilities (camera, voice recognition, microphones, speakers) are also within scope [Appendix A.1]. Given the existing infrastructure of these devices, the solution must be compatible with systems listed in Table 3.

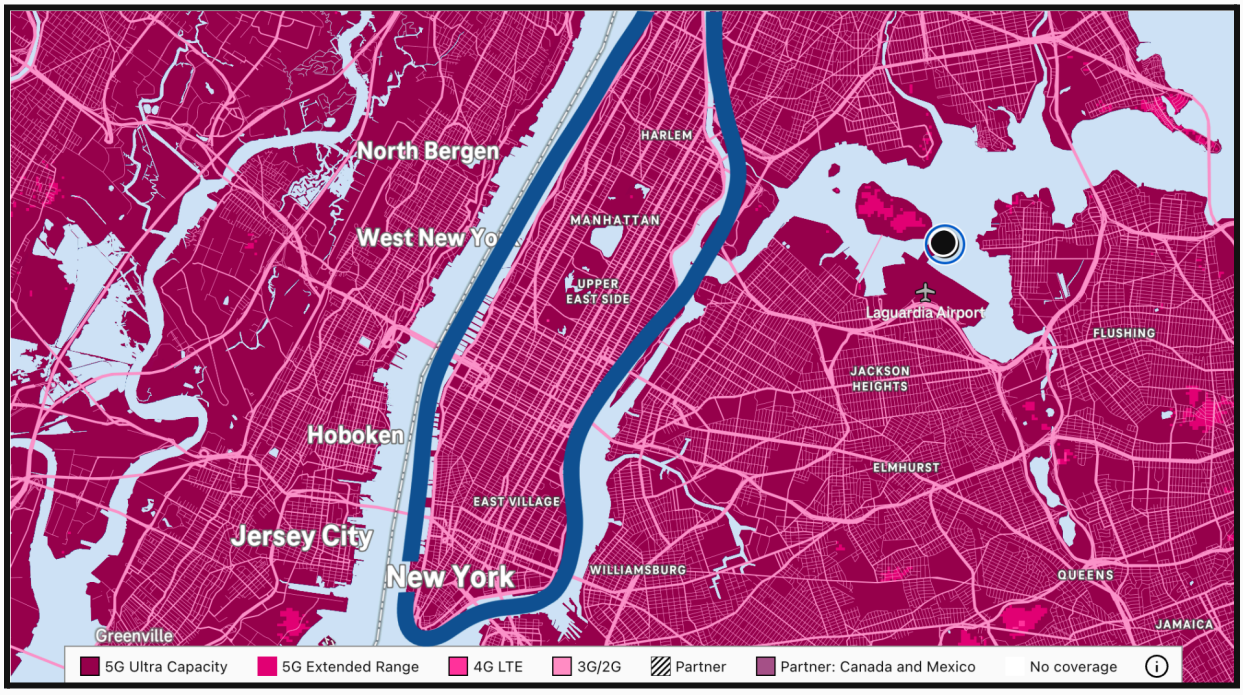


Figure 2. T-Mobile cellular service coverage map [12]

Table 3. Accessible technological specifications

Device	Main Operating System	CPU Speed	Battery Life [Hours]
Smartphone	Android OS [13]	2.00 GHz to 3.6 GHz [14]	Up to 22 [15]
Smartwatch	Apple Watch OS [16]	1.8 GHz [17]	18 to 36 [18]
Desktop	Windows [19]	2.5 GHz to 3.5 GHz [20]	-
Laptop	MacOS [21]	4.05 GHz [22]	15 to 18 [22]

4.0 Stakeholders

This section highlights the key stakeholders and their roles in this project. Stakeholders are ranked in terms of priority, in Table 4.

Table 4. Focus stakeholders for this design, ranked by priority from top to bottom. [Appendix C]

Priority	Stakeholder	Interest/Influence	References (See Table 7 for Constraints)
1	US Department of Justice Civil Rights Division	ADA compliance	Constraint #5
2	Wife	Primary caregiver and makes decisions regarding Micheal's treatment	[Appendix A.1]
3	US Department of Health and Human Services	Health Insurance Portability and Accountability compliance	Constraint #4
4	Children	Living with Micheal; should not be negatively impacted	[Appendix A.1] Constraint #1
5	NYC Department of Buildings	Compliance with Electrical Code and Noise Law	Constraint #2 Constraint #3
6	Neighbours	Maintain peaceful living environment	Constraint #3

5.0 Detailed Requirements

This section discusses the functions, objectives, and constraints.

5.1 Functions

This section outlines what the design must do to aid Micheal in completing his daily schedule.

Primary and secondary functions were derived using the Black Box Method [Appendix D.1].

Table 5. Primary functions with corresponding secondary functions.

Primary Functions		Secondary Functions
1	Support Micheal's independent completion of tasks	Store information regarding Micheal's tasks
		Transmit information to Micheal physically, aurally or visually
		Inform Micheal of his daily tasks
		Enable Micheal to engage with design and update progress throughout the day
2	Inform facilitator of Micheal's progress	Track Micheal's daily progress
		Transmit information of Micheal's progress to facilitator
		Present information to facilitator aurally or visually

5.2 Objectives

This section outlines design expectations and evaluates performance using metrics (Table 6). The objectives were created and prioritized using a How-Why Tree [Appendix E.1] and a pairwise comparison table [Appendix E.2].

Table 6. Objectives prioritized from top to bottom.

Priority	Objective (Design should…)	Metric	Goal
1	Actively remind Micheal	Percentage of all reminders that result in Micheal's interaction with design	>70% [Appendix A.1]
2	Minimize disturbance to his family	Family experiences minimal disruptions by limiting sound and light emitted	Sound: <65dB at 50cm [23] Brightness: 300-500lm [23]
3	Be adaptable to Micheal's progress	Number of weeks of full retention for a task before being removed	3 Weeks [Appendix A.1]
4	Store sufficient number of Tasks	Number of tasks design can store at a time	15+ [Appendix A.1] (see Table 5)
5	Frequently notify Micheal of tasks	Regularity of notification of tasks for Micheal	3 per task per day[Appendix A.1]
6	Offer multi-condition usability	Functionality in specified conditions	IP48 >40℃ RH: ~60% (see Table 2)
7	Allow for operational uptime	Number of hours design can operate without losing functionality	> 16 Hours [24]
8	Allow for minimal external maintenance	Number of months before design requires maintenance	> 3 Months [Appendix A.1]
9	Offer multimodal presentation of information	Capability to present information aurally, visually or physically	2 Different Ways (see Table 5)

5.3 Constraints

The following section outlines the design's constraints. Table 7 highlights regulatory organizations and governing entities.

Table 7. Constraints that the design must adhere to.

#	Constraint (Design must adhere to…)	Organisation & Law	Description
1	Child Proof Regulations	Consumer Product Safety Improvement Act (CPSIA) [25]	- No detachable parts < 1.25” in diameter nor < 2.25” in length
2	Electricity Law	New York Apartment Standard Utility Code [8]	- ≤ 80% of circuit load - Operate at standard 120V [8] (See Section 3.3)
3	Noise Law	Environmental Protection [26]	Noise level must not exceed: - 7dB above ambient level from 10PM to 7AM - 10dB above ambient level from 7AM to 10PM Within a receiving property or 15ft from a public right-of-way [26].
4	Data Protection	Health Insurance Portability and Accountability Act (HIPAA) [27]	- ≥ AES-128 data transmission encryption level [Appendix F] - Requires unique access ID - Must maintain logs of all access to health info - Ensure the confidentiality, integrity, and availability of all electronic health information [27].
5	ADA Compliance	Americans Disability Act (ADA) [28]	- ≤ 5lbs to activate - Be operable with one hand - Must have visual/auditory cues [28]

6	Accordance with Brain Injury Canada	Brain Injury Canada [29]	- Device must use plain language :
			  - Communication should not exceed an 8th-grade reading level
			  - Utilize plain, nonmedical language [30]

6.0 Generation, Selection, Description of Alternative Designs

This section outlines idea generation, selection, and details of the alternative designs.

6.1 Idea Generation Process

The idea generation process produced 56 complete ideas, fulfilling functions and constraints. Three main tools were used, outlined below in Figure 3.

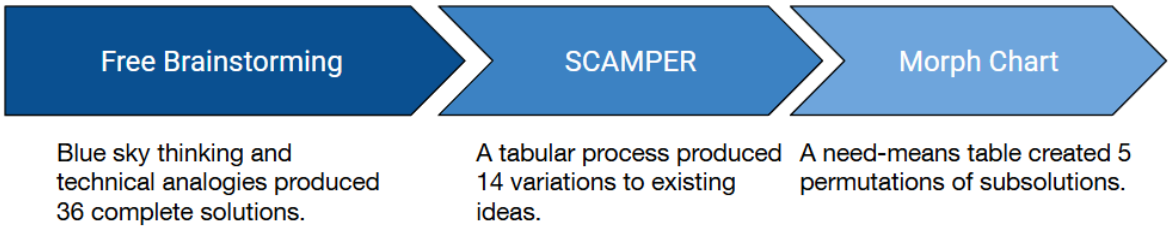


Figure 3. Tools of idea generation.

These ideas were shared via Google Doc for consolidation, found in Appendix G.1, Table G.1.1, and Table G.1.2. Common themes among the designs arose (Table 8).

Table 8. Common themes from idea generation

Theme	Example [Appendix G.1]
Wearable Reminders	9. Smartwatch Buzzer
Location Tracking	33. Haptic Floor Tiles
Smart Home Integration	7. Smart Mirror System
Audio Reminders	13. Smart Home Voice AI
Visual Reminders	21. Baseboard LED Light Path
Haptic/Tactile Reminders	12. Haptic Doorknob

6.2 Idea Selection Process

A four-step approach narrowed potential ideas [Appendix G] down to a final solution (Figure 4).

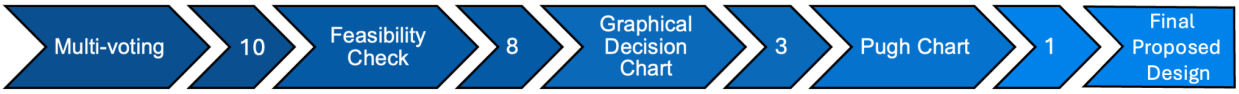


Figure 4. Idea Selection Process

Initially, multi-voting took place. Eight votes from each member were distributed among the 56 solutions. Ideas with two or more votes were retained.

A feasibility check was applied to the remaining ideas, evaluated based on ethical, legal and practical reasoning. See Appendix G.2, Table G.2.1 for methodology.

The remaining concepts were assessed using a graphical decision chart [Appendix G.2, Figure G.2], comparing each idea's performance against top objectives: 'Ability to Remind Mike' and 'Minimizing Disturbance to Family'. The top three ideas advanced to the final phase.

The final step involved the Pugh Chart [Appendix G.2, Table G.2.2], with 'Questify' as the datum for comparison. Each alternative idea was scored based on objective alignment relative to the datum. Points were assigned through discussion, and Questify received the highest score.

6.3 Alternative Design Description

This section outlines the three final solutions, describing how each meets functions, objectives, and constraints.

6.3.1 Mike-Lens AR

This design integrates AI-powered object recognition highlighting "task-associated key objects" with AR overlay. A front-facing ultra-wide 12-megapixel camera [Appendix G.3.1] recognizes pre-programmed objects, delivering alerts through visual overlay (Figure 6) and beeps, (Figure 5). Design includes sensor triggered alarm if left unequipped for 10 minutes. A daily PDF update is sent to facilitators (Figure 7)

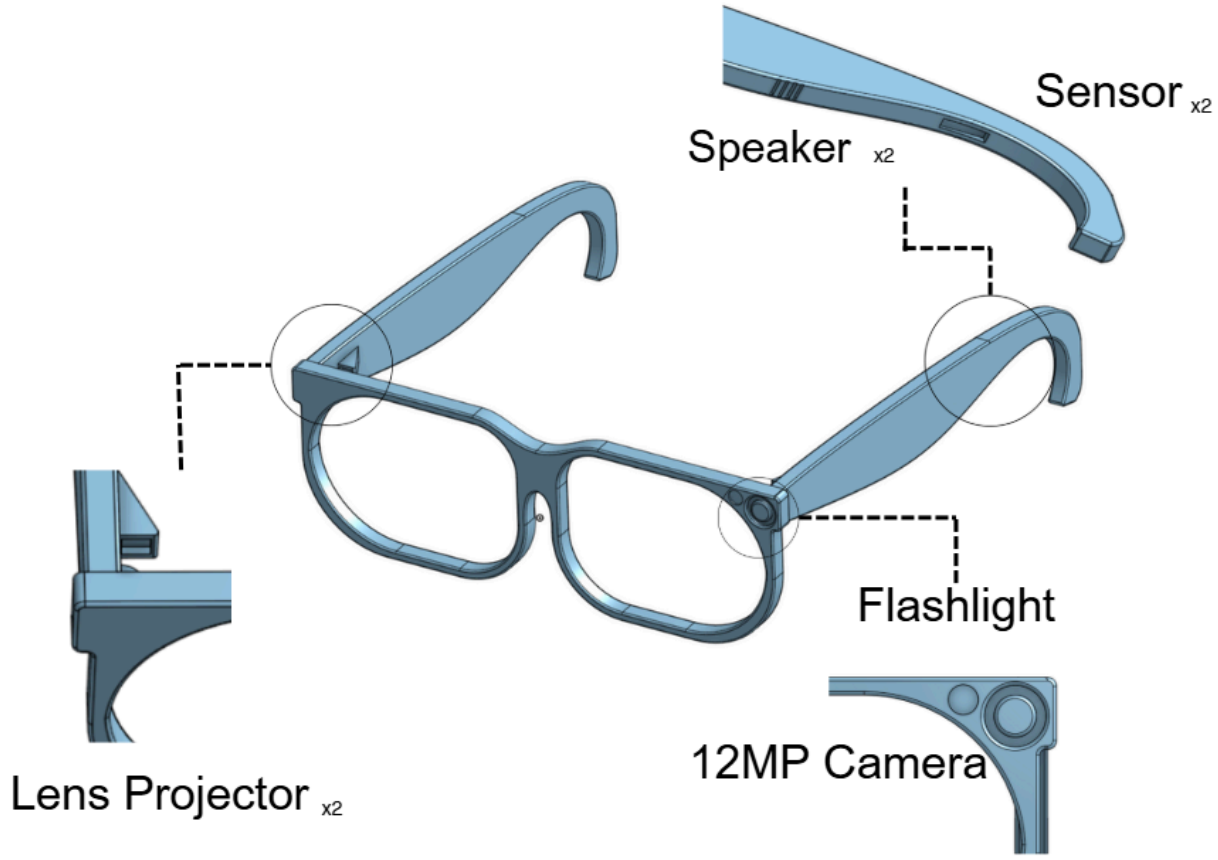


Figure 5. Mike-Lens AR Model [34][35].

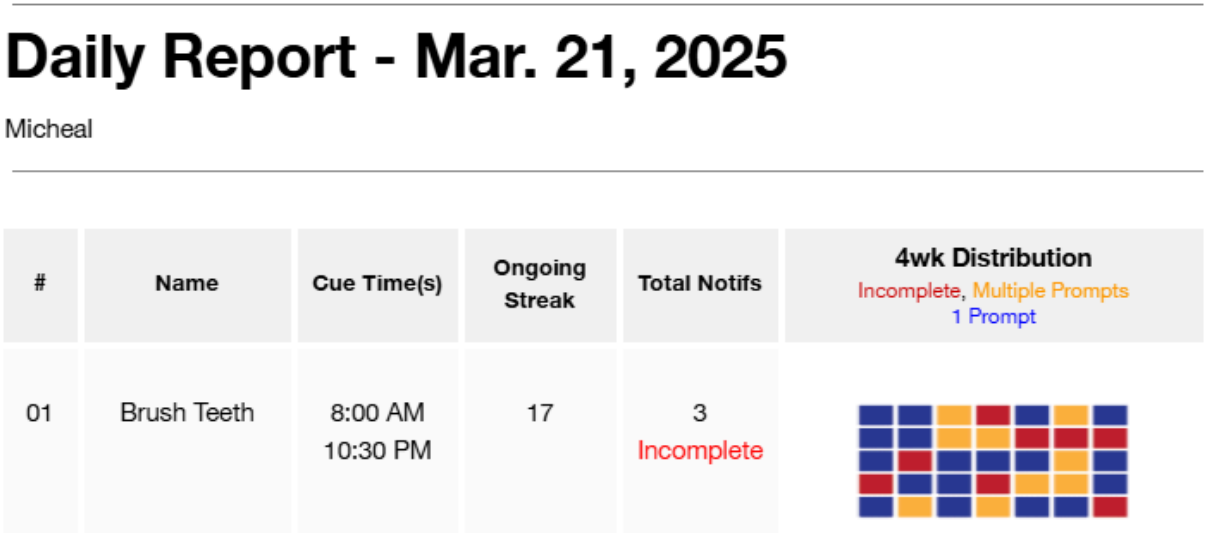
The design meets specified objectives (Table 9).

Table 9. Functions of design satisfying objectives

Objective	Objective-Enabling Features
Actively remind	Visual: - AI object recognition outlining objects - Flashing visuals Auditory: - Beeping alerts
Minimize disturbance	Visual: - AR overlay Auditory: - Only user can hear beeps
Be adaptable	Facilitator can add/remove tasks according to progress
Store sufficient tasks	- Stores maximum three preprogrammed tasks per room with respective key items
Frequently notify	Visual and auditory reminders follows process below: - Once at task start time - At every interval, calculated by half of the remaining task duration
Offer multi-condition usability	Does not meet objective: IPX4 rating [36]
Allow for operational uptime	Does not meet objective: - Battery lasts up to 4 hours [37]
Allow for minimal external maintenance	Components requiring servicing after prolonged use: - Camera - Speaker - Sensors
Offer multimodal presentation	Visual: - AR overlay Auditory: - Beeping alerts

Design meets all constraints [Appendix G.3, Table G.3.1].

Figure 6. UI of Micheal's View



Daily Report - Mar. 21, 2025

Micheal

#	Name	Cue Time(s)	Ongoing Streak	Total Notifs	4wk Distribution Incomplete, Multiple Prompts 1 Prompt
01	Brush Teeth	8:00 AM 10:30 PM	17	3 Incomplete	

Figure 7. Sample PDF for facilitator

6.3.2 JAMNS

This design is a single-ear earpiece that utilizes AI voice interaction to support Micheal's daily schedule, addressing his memory challenges (Figure 8). Micheal can interact vocally or tap the device to confirm the completion of tasks (Figure 9).

Facilitators must specify a task name, start time(s), and time frame duration to add a task, as shown in the facilitator UI (Figure 10).

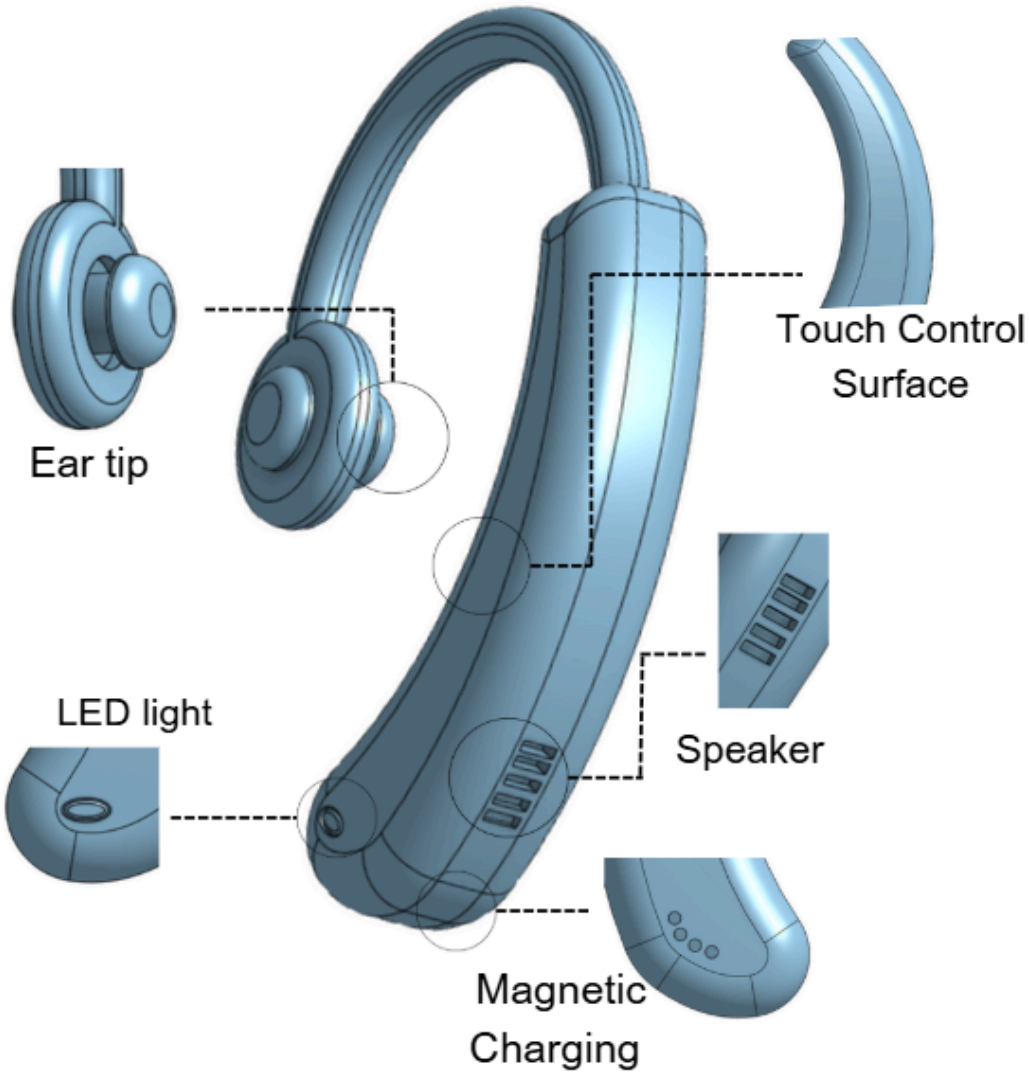


Figure 8. JAMNS Model [35].

The design meets specified objectives (Table 10).

Table 10. Functions of design satisfying objectives

Objective	Objective-Enabling Features
Actively remind	AI voice prompts and beeps
Minimize disturbance	Reminders directly delivered to Micheal through earpiece
Be adaptable	Adjusts notification frequencies based on Micheal's response patterns
Store sufficient tasks	Equipped with preprogrammed list of tasks
Frequently notify	Frequency of notification increases until expiration time or completion
Offer multi-condition usability	Functionality in various conditions: - IP67-rated waterproof and dustproof protection [38]
Allow for operational uptime	Dependent on battery life and charging habits: - Must charge overnight - Battery lasts 5-6 hours with consistent use [39]
Allow for minimal external maintenance	- Hardware maintenance after 2-3 years of consistent use [40]
Offer multimodal presentation	Auditory: - AI voice prompts - Beeps

Design meets all constraints [Appendix G.3, Table G.3.2].

AI: "Micheal, go brush your teeth! Let me know once you finish"

Micheal: "I brushed my teeth!"

AI: "Got it!"

Figure 9. Sample voice interaction between Micheal and JAMNS

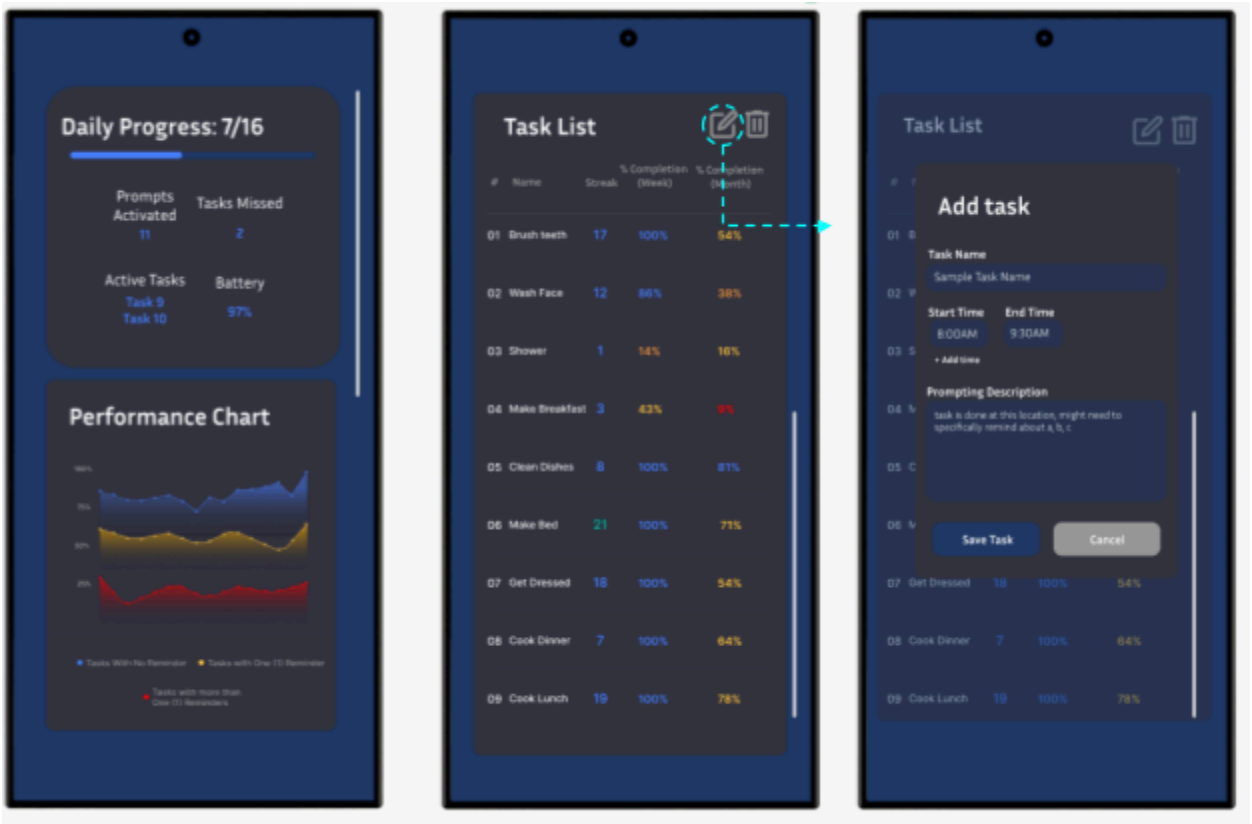


Figure 10. Facilitator UI for JAMNS [41] (94 words)

6.3.3. Questify: M.I.Q.E. (My Interactive Quest Engine)™

This design proposes an Android mobile app with an interactive map and indoor positioning system (IPS) to assist Micheal with task management (Figure 12). Tasks appear as pins on a calibrated floor plan of Micheal's apartment, all running on a Samsung S23 (Figure 11).

Micheal can view details by selecting a task and being guided to its location. Upon arrival, the task can be marked completed. The app incorporates completion streaks for all tasks.

The system monitors Micheal's progress through interactions, seen in facilitator UI, to analyze completion progress (Figure 13). Monthly reports are automatically saved to Google Drive with AES-256 encryption [42] (Figure 14).

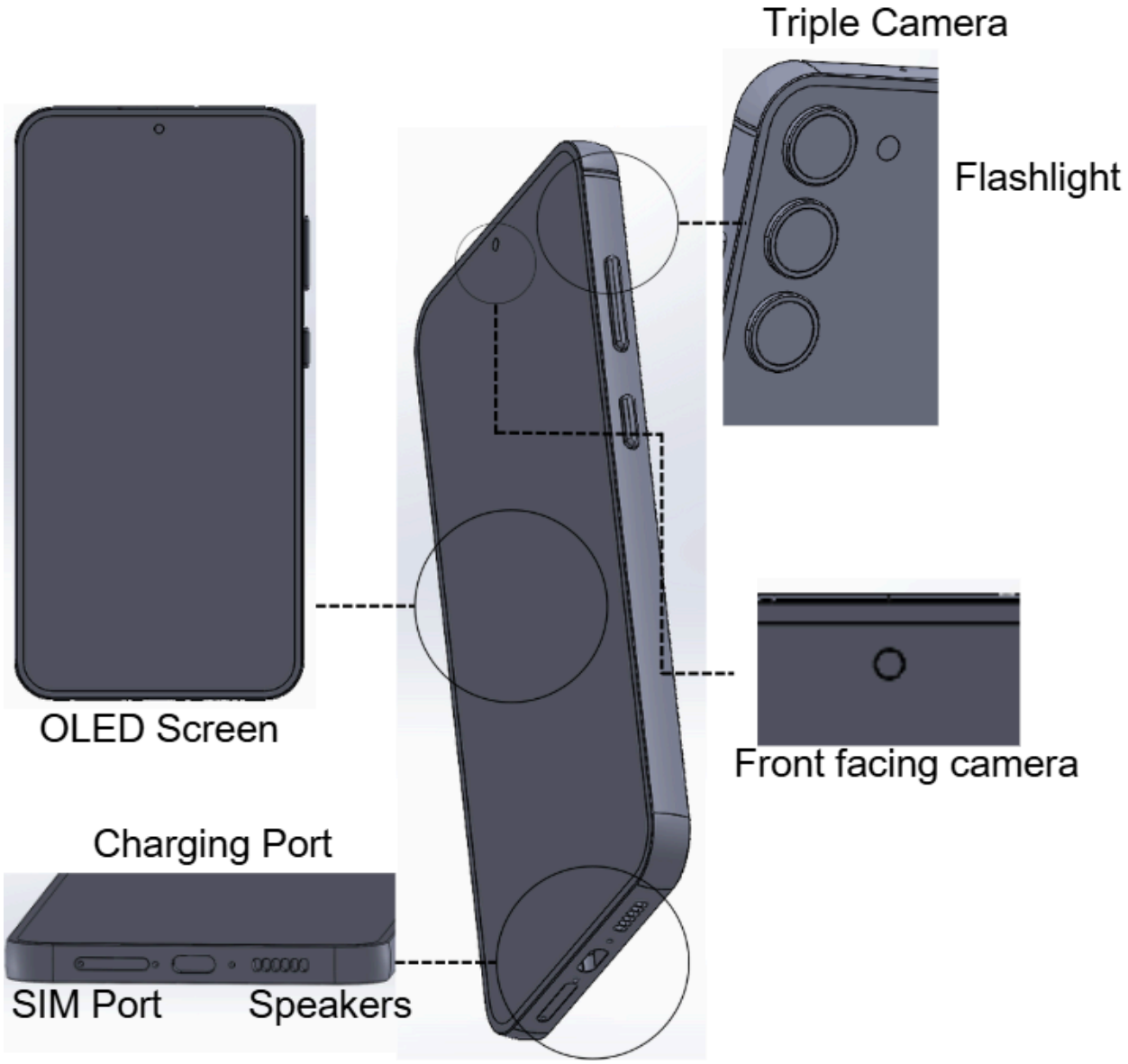


Figure 11. Samsung S23 model [43].

This design incorporates features that satisfy all objectives listed (Table 11).

Table 11. Functions of design satisfying objectives

Objective	Objective-Enabling Features
Actively remind	Through Samsung S23: - Vibration Motor: Haptics [44] - Speakers: Auditory cues [45]
Minimize disturbance	Audio emitted through Samsung S23: - May disturb those nearby Haptics affect only Micheal
Be adaptable	Monitors Micheal's progress through interactions - Removes tasks with a completion streak of 3 weeks
Store sufficient tasks	Notifications follow this process: - Once at task start time - At every interval, calculated by half of the remaining task duration
Frequently notify	Allows input of tasks anytime by facilitators and Micheal - Requires: - Task name - Start/end time - Drag/drop pin on floorplan
Offer multi-condition usability	Samsung S23's functionality in various conditions - IP68 rating [46] - Temperature: 0℃-35℃ [47]
Allow for operational uptime	Battery capabilities of Samsung S23 - Nine hours under consistent GPS use. [48]
Allow for minimal external maintenance	- Lifespan of smartphones ~3 years [49]
Offer multimodal presentation	Visual: - Text and images detailing tasks Auditory: - Narration of tasks' details

Design meets all constraints [Appendix G.3, Table G.3.3]

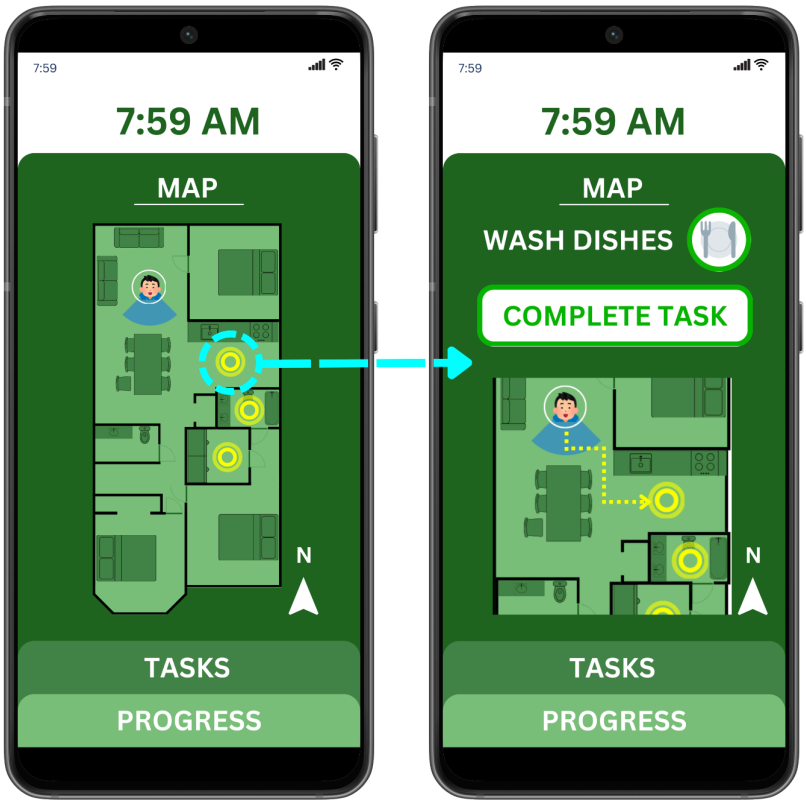


Figure 12. Questify's Micheal UI. [34]

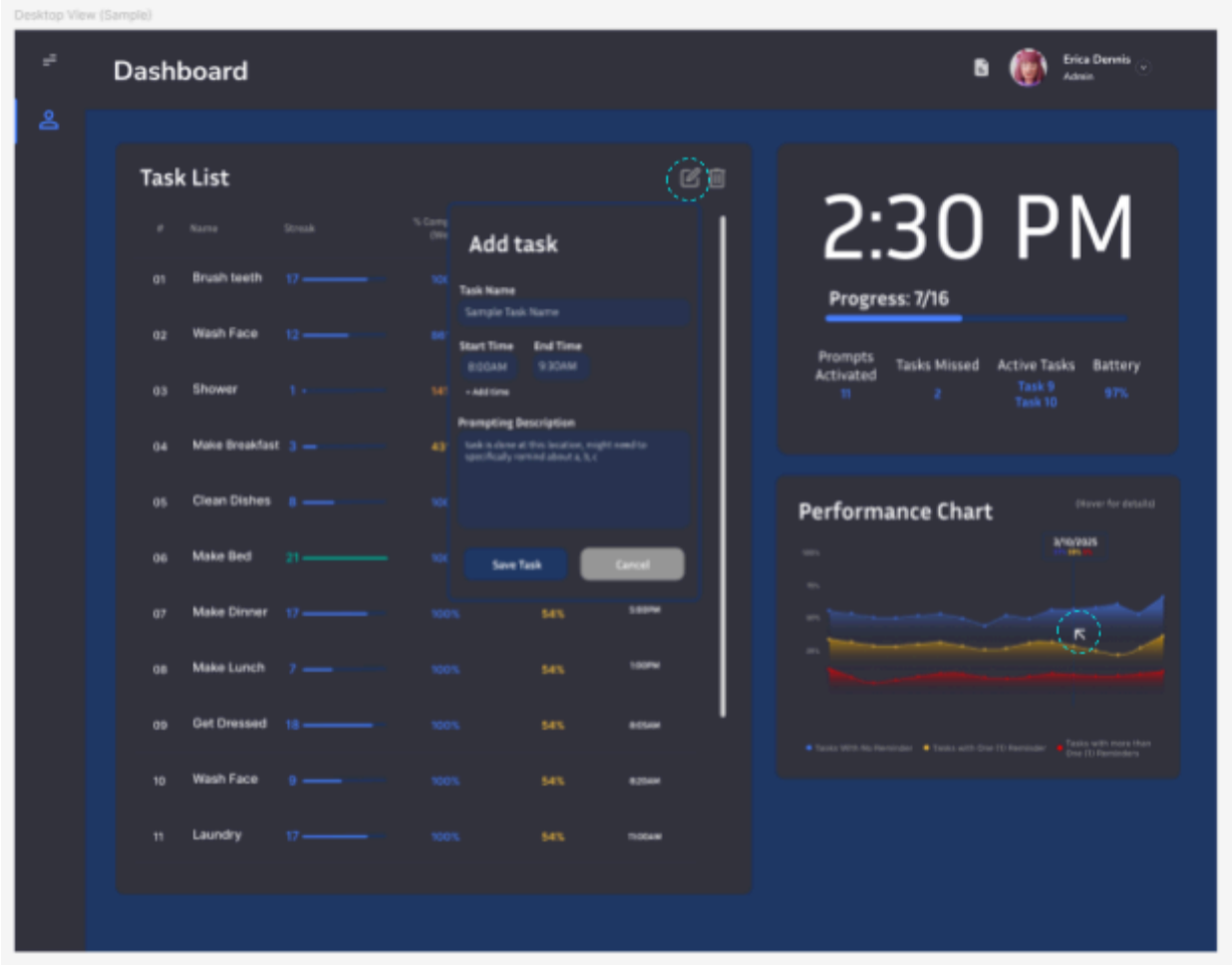


Figure 13. Questify facilitator UI [41] (108 words)

Monthly Report - Feb. 2024

Micheal

#	Name	Cue Time(s)	Ongoing Streak	Completion	Distribution Incomplete, Multiple Prompts 1 Prompt
01	Brush Teeth	8:00AM 10:30PM	17	54%	

Figure 14. Questify sample monthly report

7.0 Proposed Conceptual Design Specification

The designs described in Section 6.3 were compared using a Pugh Chart [Appendix G.2, Table G.2.2]. The proposed design, ‘Questify’ scored the highest as it best satisfied the objectives.

Questify integrates an interactive, map-based app that utilizes IPS, using task pins to support Micheal's memory loss (Figure 15). The UI displays active, upcoming and late tasks (Figure 16), with an integrated streak and completion tracking system to inform facilitators (Figure 17).

This design assists Micheal with tasks and sending data to facilitators, fulfilling the client's request. Design features satisfy all objectives, bridging the gap between the client’s needs and wants. [Appendix A.1] Furthermore, the app's appearance utilizes colours like green [50] and larger text fonts beneficial to TBI patients [51].

This design relies on Micheal's preferred display device, which must last all day while supporting notifications and GPS. It may also distract Micheal from his surroundings, creating hazards [52]. Similar to the other alternative designs, it requires consistent server connection to be usable by Micheal [Appendix G.4, Table G.4].

Despite its tradeoffs, the design best meets the client’s needs, aligns with objectives, and avoids the severe limitations of other designs, supporting its selection [Appendix G.4, Table G.4]. Having the most potential for scalability, least interference with Micheal’s life, and capability to provide reminders of daily tasks effectively while monitoring Micheal's progress ensures a user-centred approach to the client's request [Appendix G.4, Table G.4].

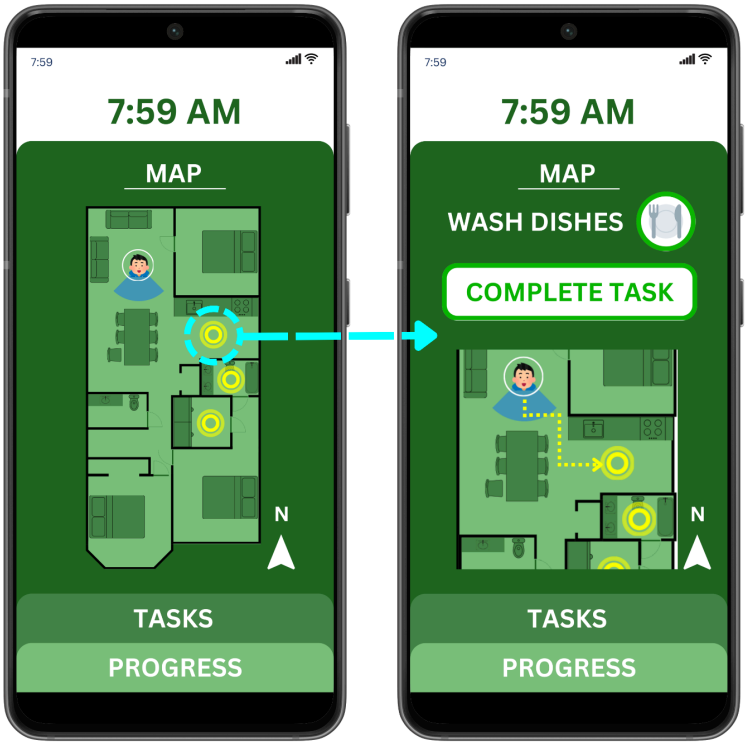


Figure 15. Questify's interactive map UI [34]

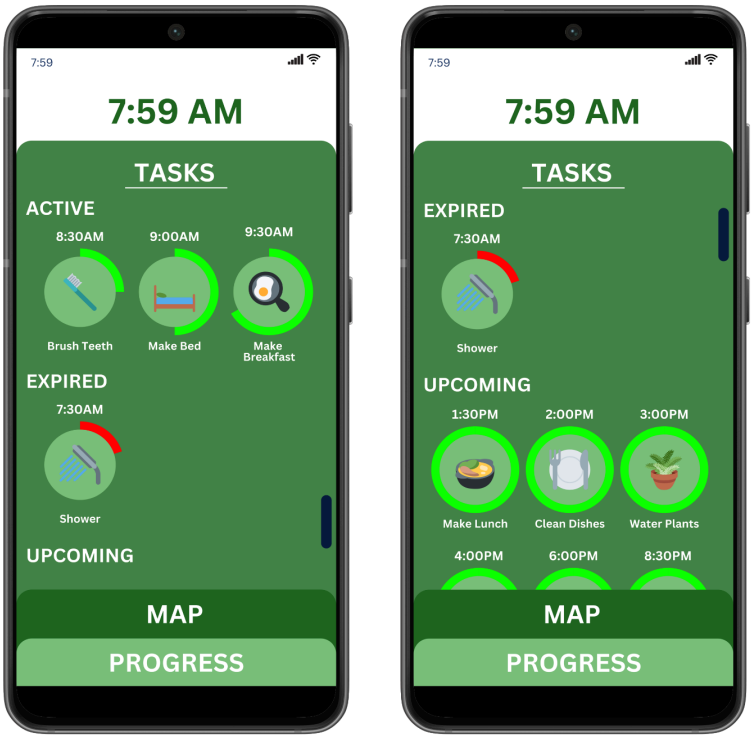


Figure 16. Questify's task menu UI [34]

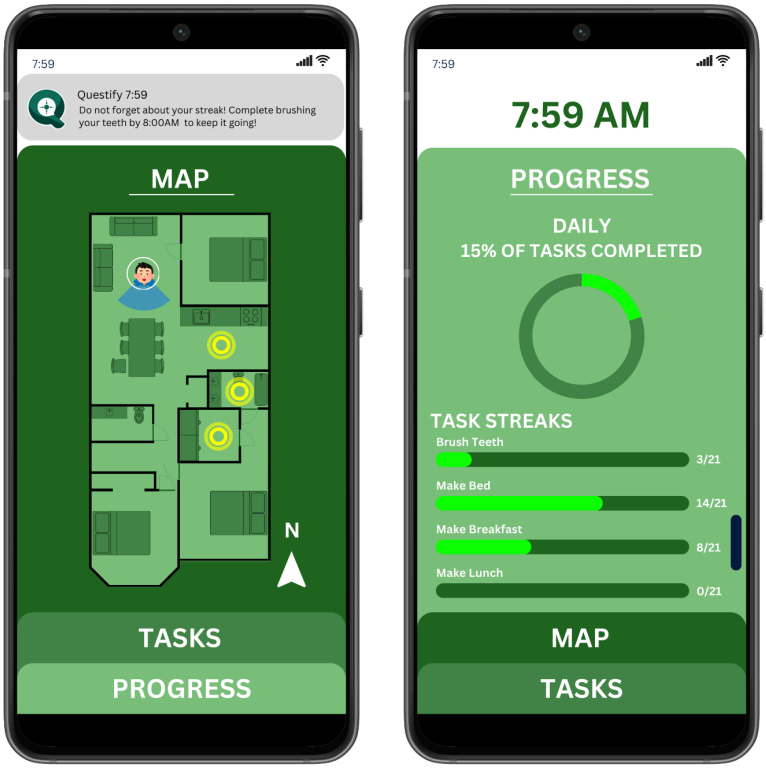


Figure 17. Questify's streak and progress UI. [34]

8.0 Measures of Success

This section outlines the evaluation of the most important objective to determine the success of the Proposed Conceptual Design through innovative methodology, evidence collection, results, and relevance.

8.1 Methodology

The proposed test plan for evaluating the task reminder system is in Table 12.

Table 12. The test plan

Component	Description	Justification
Objective being tested	Actively remind Micheal (Table 6).	- Notifications are the first and most critical step to Micheal remembering his task
Procedure	1) Participant will receive a number of notifications randomly throughout the day via mobile device. 2) Participant opens notification when they notice. 3) Participant will acknowledge notification via reply.	- Measures app notification effectiveness in real-world environments
Notification Method	Noise and Vibration	- Notification technology already integrated into Androids [53] - Multimodal forms of notification improve user notification alertness [54]
Duration	Three consecutive days; data collection on random day	- Simulate Micheal's daily routine - Participant is not wary of plan
Personnel	Participant: Team member with Android phone Conductors: Remaining team members	- Participant acts as Micheal - Team members simulate facilitators
Setting	Date: Three consecutive days between March 24-28. Location: Anywhere	- Personnel availability

8.2 Evidence Collection

The metrics used to evaluate the test plan are shown below in Table 13.

Table 13. Metrics of test plan

Metric	Justification
Reminders: Amount of notifications per day - Recorded by conductors	Simulates Micheal's routine/schedule of tasks
Checks: Number of notification acknowledgement - Recorded by participant	Measures confirmation of notification by interaction

8.3 Results

The criteria for determining test results are in Table 14.

Table 14. Determination of results

(CHECKS / REMINDS) x 100% = Rate of getting the user to interact/check their mobile device (%)	<70%	Objective failed
	≥70%	Meets client's expectation - objective achieved [Appendix A.1]
	100%	Ideal result

8.4 Relevance

This test plan simulates the Proposed Conceptual Design's effectiveness in capturing Micheal's attention and actively reminding him of tasks via smartphone notifications. Micheal's acknowledgement of the notification increases the likelihood of task completion and memory performance [55]. Limitations include using an active, non-TBI participant instead of Micheal, who stays home. However, the test remains valid as it closely simulates Micheal's interactions.

9.0 Conclusion

The conceptual design proposed is Questify. It assists Micheal with task management and relays data to facilitators while satisfying all objectives and constraints. The next steps involve executing the measure of success plan and analyzing results to determine the proposed design's efficacy. As the design reaches its implementation phase, the team will consult with the client for refinement and reiterations.

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Appendix A: Introduction and Problem Statement

Appendix section for the introduction and problem statement.

Appendix A.1

Consolidated notes, taken by group members, during the first client meeting.

Memory Loss (Most important aspect)

- Struggles to remember basic tasks (15 tasks)

    - Getting dressed
    - Brushing Teeth
    - Showering
    - Cooking lunch, dinner
    - Making Bed
- Forgets 75% to 80% of tasks
- Want Micheal to remember >85% of tasks after ~3 months of use

Anger Management
- CAUSE: feeling incapable due to not being able to remember things
- Dismissive/Pushes family away
- Wants to be treated as an adult not a child
    - Gets annoyed, angry when others try to help him

Family-Connections
- Dismissive of children
    - Snaps at children when they try engaging with him
- Shut-downs with family
- Not inclusive
- Does not go out often
    - Feels secluded from outside world

Client Proposals:
- Reminder app
    - Timed prompts for tasks throughout the day.
    - Check off tasks once done.
    - Send info back to the facilitator.
    - After ~3 or 4 weeks, task can be replaced

- Prompting “Alexa”
    - Verbal reminders
    - Timed reminders

- Physical reminding system
    - Wristband/ buzzer
    - Reference list he needs to look at

Family should also know how the tool works and why it is important
If Micheal goes back to work, it should also be used there too
Should work after 3 months of use

Appendix B: Service Environment

5G Ultra Capacity WIFI, also known as 5G UC is a type of 5G network, which mainly uses mid-band 5G networks. It works best in many urban and suburban areas that require wide coverage that is able to handle multiple connected devices [31].

Compared to another common type of 5G network, 5G Ultra Wideband (5G UW), which offers the fastest speeds and lowest latency, but sacrifices coverage [31].

Appendix C: Stakeholder

Stakeholder	Justification For Priority Order
1. US Department of Justice (ADA Compliance) - Constraint #5	The device must comply with ADA Compliances to ensure legality, accessibility, and independent function. Failure to comply may result in hindrance to recovery or fines and thus it is placed as the highest priority stakeholder.
2. Wife (Primary Caregiver) - [Appendix A.1]	Micheal's wife is the primary caregiver, and thus has the most direct influence on his daily activities, well-being, as well as authority over whether it meets his medical and personal requirements.
3. US Department of Health and Human Services (HIPAA Compliance) - Constraint #4	The device, if it collects, stores and shares medical data, it must comply with HIPAA regulations to protect Micheal's privacy. This is important but secondary to the impact of the primary caregiver.
4. Children (Aged 4, 7, 12) - Constraint #1 [Appendix A.1]	The device should not negatively impact the well-being of Micheal's children and its presence must be taken into consideration especially if it affects caregiving dynamics. However, ensuring the legal compliance and proper integration into Micheal's care takes precedence.
5. NYC Department of Buildings (Electrical Code & Noise Law) - Constraints #2, #3	Compliance with electrical and noise law is important if the device requires electricity or emits noise but these concerns are secondary to Micheal's health.
6. Neighbours - Constraint #3	Maintaining a friendly environment with neighbors is important for Micheal's wellbeing but it ranks lowest in terms of priorities because compliance with codes and Micheal's health takes precedence over potential neighbor concerns.

Appendix D: Functions

Appendix section for functions.

Appendix D.1

The Black Box method is done by the team to derive our primary and secondary functions.

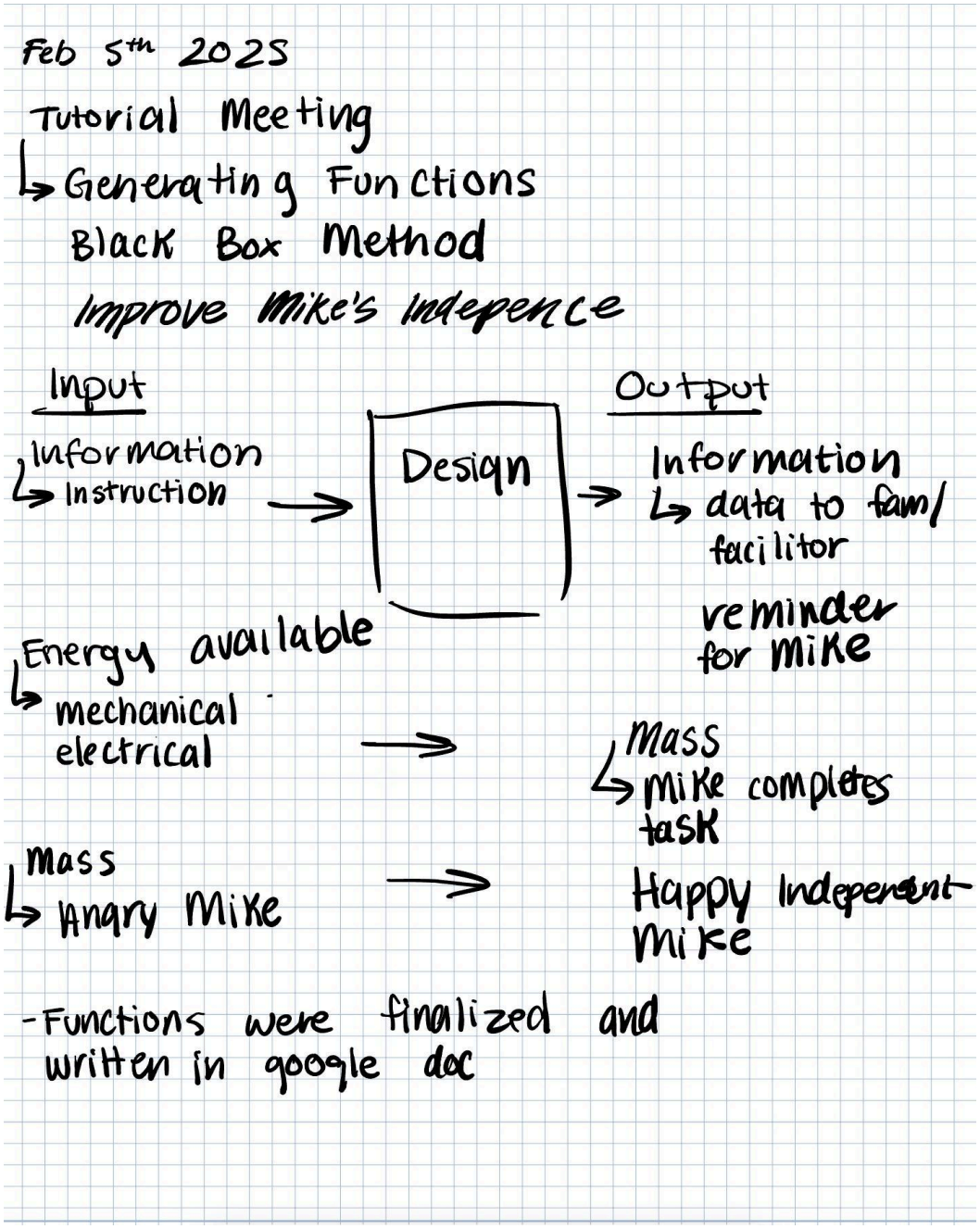

Figure D.1. Screenshot of Nadira's engineering notebook, specifically of the black box method.

Appendix E: Objectives

Appendix section for objectives.

Appendix E.1

How-Why Tree is done by the team to create objectives that state what the design should be and how to measure the design's success. All final entries are objectives.

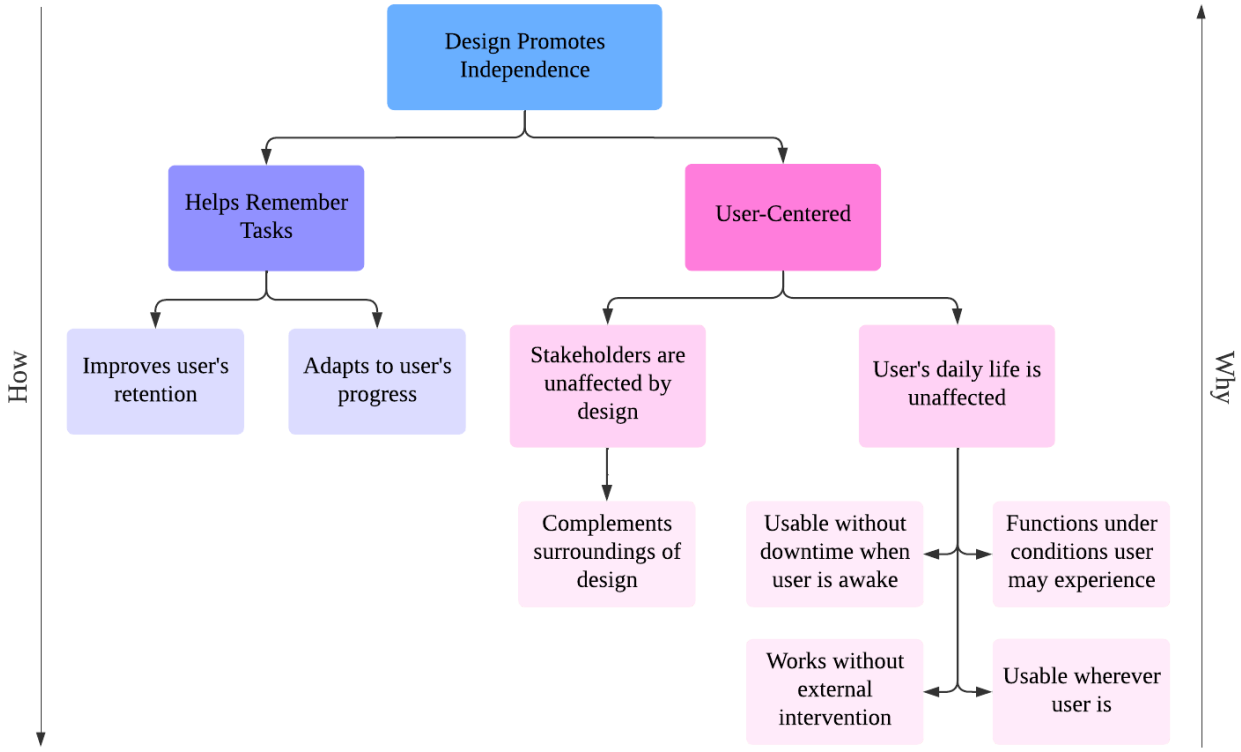

Figure E.1. Ideas from How-Why-Tree

Note: Revision removed and generated new objectives through group discussion and functions

Appendix E.2

The Pairwise Comparison Table was completed during a discussion with the team on prioritizing objectives.

Table E.2. Pairwise Comparison Table to prioritize objectives

Factor	Minimize Disturbance	Operational Uptime	Actively Remind Micheal	External Maintenance	Frequently Notify	Adaptable to Progress	Multi-Condition Usability	Stores Tasks	Multimodal Presentation	Overall Score
Minimize Disturbance	-	1	0	1	1	1	1	1	1	**7**
Operational Uptime	0	-	0	1	1	0	0	0	0	**2**
Actively Remind Micheal	1	1	-	1	1	1	1	1	1	**8**
External Maintenance	0	0	0	-	0	0	0	0	1	**1**
Frequently Notify	0	1	0	1	-	0	1	0	1	**4**
Adaptable to Progress	0	1	0	1	1	-	1	1	1	**6**
Multi-Condition Usability	0	1	0	1	0	0	-	0	1	**3**
Stores tasks	0	1	0	1	1	0	1	-	1	**5**
Multimodal Presentation	0	0	0	0	0	0	0	0	-	**0**

Appendix E.3

After the design is complete and is in use by Micheal, a survey will be sent to his family to measure their satisfaction with the design and how it complements its surroundings.

Appendix F: Constraints

AES-128 is a standard encryption algorithm that protects digital data by converting the data/message into an unreadable format using a 128-bit cipher key [32]. AES-128 operates on 128-bit blocks and transforms

them using multiple rounds of substitution, permutation, mixing, and key addition to effectively encrypt the desired message.

For general usage, AES-128 is quite secure, but any encryption algorithm that is designated as AES-*N* that has a number *N* greater than 128 is more secure, as this means the algorithm uses a larger key size [32]. Commonly used sizes include AES-192 and AES-256.

Appendix G: Generation, Selection, Description of Alternative Designs

Appendix G.1: Idea Generation Procedure

Table G.1.1: SCAMPER chart used in idea generation.

	Smart Home Voice AI	Augmented Eye Glasses
Substitute	Substitute a person to observe Micheal through cameras in device, and remind him of tasks through built in speaker	Substitute glasses w/ contact lenses
Combine	Combine smart home voice AI with augmented glasses	Combine with airtag-like devices to verify location of Mike and types of objects the glasses can recognize
Adapt	Adapt AI to recognize Mike's mood and adjust tone accordingly (e.g., more encouraging if he is frustrated).	Adapt glasses to assist colorblind users by enhancing color perception.
Modify/Minify/Magnify	Alexa is a small clip-on device to be w/ Mike anywhere.	AI Augmented Visor device-performing same tasks as augmented glasses
Put to another use	Instead of speaking directly to Mike, the device recites a story containing all the tasks Mike must complete	The glasses give Mike 20/20 vision by auto eye calibration.
Eliminate	Eliminate AI from the device, and the device will only recite the tasks that are inputted, and Mike cannot speak back to it.	Eliminate the visual display and only rely on auditory cues
Reverse	Instead of the AI listening and responding, it asks Mike questions to confirm he remembers his tasks.	Instead of enhancing vision, glasses reduce distractions by blurring unnecessary information.

Table G.1.2 Morph Chart used in the idea generation process

Morph Chart

Secondary Functions	Means	Means	Means	Means	Means
Store information regarding Micheal's tasks	Voice recording of tasks	SSD storage (digital)	Guy with best memory remembers his tasks	A piece of paper/notebook	Morse Code
Transmit information to Micheal in some form of communication (physically, aurally, visually)	Drone drops a written paper	Micheal's fax machine prints out a paper	Metal can and string (telling Mike through Can-phone)	Screen that displays information	AI Voice speaks to Mike
Inform Micheal of his daily tasks	List of tasks communicated	Visual interpretation of tasks Mike must complete	Story containing tasks	Physical vibration related to tasks	Song about his tasks
Enable Micheal to engage with design, allowing him to update his progress throughout the day	Touch screen	Button	Voice activation	Lever	Pressure plate
Track Micheal's daily progress	A man follows him and checks off completed tasks in a notebook	Spreadsheet Mike fills out daily	AI w/ motion sensors tracks Mike's movements and checks tasks off list	Online Cloud database (SQL)	Voice recording of finished tasks
Transmit information of Micheal's progress to facilitator	Man reports to facilitators with his daily activities	Facilitators receive a daily automated call summarizing Mike's activities	Facilitators get faxed with every piece of data	AI direct message facilitator	Facilitator receives daily email

The following is the full list of 50 complete (meets Functions and Constraints). These stemmed from free brainstorming (36 ideas), as well as SCAMPR (14 ideas) and Morph Chart (5 ideas).

1. Mobile Device

   A portable device where Mike can input task data throughout the day. Will use AI to turn his to-do list into a story narrative - can be displayed aurally or visually. Mike can "check off" tasks by interacting with the device, and the data is sent to a facilitator who monitors his progress.

2. Earpiece-like Device

A small earpiece that provides reminders for Mike's tasks throughout the day by speaking into his ear. The device speaks tasks to him as he goes about his day, helping him remember steps and tasks. Mike can also speak back to the device to confirm task completion or ask for additional reminders. This allows him to complete daily tasks with ease.

3. Augmented Eye Glasses

These glasses provide a visual of checklists and task reminders directly in Mike's vision. The device uses image recognition technology to identify objects in its environment, highlighting objects related to specific tasks. As Mike completes tasks, the glasses automatically update and send data to the facilitator. It can track his movement and keep Mike's progress up-to-date.

4. Ankle Monitor

A wearable device that attaches to Mike's ankle which uses location-based technology to provide reminders. It vibrates when Mike enters specific rooms, notifying him of tasks related to that room's activity (brushing teeth in the bathroom or washing dishes in the kitchen). This device helps make sure the reminders are relevant to the situation/room he is in.

5. Portable Tags

Small, brightly coloured devices that Mike can place in various rooms or locations around his home. The tags light up and emit beeping noises when Mike is near them, signaling him to complete tasks in that area. These tags use sensors to create a visually and audibly engaging reminder system. This allows Mike to follow through on his tasks as he moves through his home.

6. Necklace Device

A wearable necklace that provides location-based and time-based task reminders. It uses sensors to detect Mike's position in the house and provides auditory or haptic reminders accordingly. The necklace can be customized to alert Mike about specific tasks based on time or location, and he can confirm task completion by pressing a button or speaking to the device.

7. Smart Mirror System

A mirror with integrated smart technology that can display task reminders, and his schedule. It uses a camera to detect when Mike is in front of the mirror and adjusts the display based on his location and the time of day. Mirror is linked to an online scheduling/management system. Device integrates well into the home and does not disrupt the family.

8. Couch Checklist

A device that connects with Mike's phone or laptop (bright neon lighting/sticker) to allow him to create a personalized to-do list for the day. This device is placed on the couch and can be unlocked via fingerprint scanning. It provides an easy-to-access checklist that Mike can check while resting, reminding him of tasks and helping him stay on top of his responsibilities.

9. Smartwatch Buzzer

A smartwatch that integrates well with other devices and with Mike's task reminders - provides vibrational alerts when he is near a task location. The watch buzzes when Mike walks into a room or area with outstanding tasks - offers a non-intrusive way to keep him on track. The device also tracks progress and can display visual reminders, helping Mike manage his day efficiently.

10. Hologram Systems

A futuristic system of projectors that display task reminders and real-time home maps. It can create 3D holographic visuals of Mike's home and project reminders directly onto surfaces or walls, and provides a guide to tasks. The system adapts to Mike's daily schedule and movements. Projections can either display urgent task reminders, or otherwise a real time map of his home with marked spots for tasks.

11. SPOT (Robotic Dog)

A small robotic dog that provides visual and auditory task reminders in a friendly manner. The robot can follow Mike around his home, and gives reminders for tasks as it moves. It could be perceived as childish by Mike and is very expensive. However, it is fully programmable, and can work in any environment.

12. Haptic Doorknob

A doorknob that provides tactile feedback, such as a vibration or sound, when Mike touches the knob and enters a room. This haptic feedback or voice reminds Mike of any tasks associated with that room. It uses sensors to detect when the door is opened and gives reminders in a subtle, efficient manner that doesn't disrupt Mike's routine.

13. Smart Home Voice AI

A smart-home voice assistant that is integrated within the house. It provides Mike with reminders throughout the day with speakers. It talks to Mike like a human as it offers task reminders contextually throughout the day. For example, it could remind Mike to brush his teeth when he enters the bathroom or suggest actions as he moves from room to room. The system is customizable which allows facilitators to update or adjust tasks remotely.

14. AI Shirt or Small AI Device Clipped onto Clothing

A piece of adaptive clothing or a small device that clips onto Mike's clothing and uses haptic feedback, temperature adjustments, and motion tracking to remind him of tasks. The system learns and adapts Mike's daily habits and routines, giving him tasks at the proper time. It gives reminders through a vibration or a temperature change. For example, it vibrates when Mike forgets to get his keys.

15. AI House Perfume Scent

A smart AI-powered diffuser that releases specific fragrances related to Mike's tasks. For example, it might diffuse mint for a reminder to brush his teeth or citrus for a reminder to prepare breakfast. The scent helps Mike associate certain tasks with particular smells, improving his memory and task completion. Over time, these smells will become secondary and Mike won't need an external device to do tasks.

16. AI Smart Belt Reminder

    A smart belt that uses vibrations, LED indicators, and audio reminders to guide Mike through his day. The belt learns Mike's habits and behaviour over time, to give him the proper tasks accordingly. This wearable device reminds Mike by telling him tasks throughout the day and is non-disruptive to the house.

17. AI Pin

    A small wearable pin that has a camera, voice assistant, haptic feedback, and motion sensors. The pin can provide task reminders through voice prompts and vibrations, which can help Mike stay focused on his tasks. It can give step-by-step guides for tasks to help Mike go through his daily routine with ease. Mike can talk back to the pin and converse.

18. Smart Ring

    A smart ring that vibrates and lights up to remind Mike of important tasks. The ring tracks his movement, health, and progress and gives reminders when it's time to complete something. Mike can tap the ring to confirm completion, helping him stays on top of his responsibilities. Can be connected to an external app/device and has a customizable system.

19. Digital Photo Frame System

    A network of digital photo frames that display visual and auditory task reminders. These frames can be updated remotely by facilitators and provide an interactive way for Mike to engage with his to-do list. Photo frames are location specific - certain tasks in certain rooms. Frames will be regular photo frames when not in use to integrate within home. Display reminders and interaction through touch or voice activation.

20. Memory Playlist / Daily Schedule Song

    A curated playlist with song lyrics corresponds to Mike's tasks for the day. Each song gives a reminder for specific activities, helping Mike with his daily schedule with music. The playlist can be played through earbuds or headphones giving auditory cues to keep him on track with his to-do list. Song lyrics can be changed to curate his tasks for the day. Once the task is done, Mike can check it off his phone/device.

21. Baseboard LED Light Path

    LED lights installed along the baseboards of Mike's home that light up to guide Mike to rooms where tasks need to be completed. When Mike enters a room, the lights provide a visual reminder of the task waiting for him. Will help with memory improvement by allowing him to remember instead of an immediate prompt, highlighting independence.

22. Memory Recall Keychain

    A keychain that plays a reminder of Mike's next task when pressed. The keychain cycles through tasks in a linear sequence, and will go to next tasks until Mike confirms completion. Can play prerecorded or AI messages of his incomplete task. If the expiration time of the task is near, it will vibrate/buzz for Mike. Has a button for tasks and a button for completion.

23. Gamified Task System (ANTI Couch Potato System)

An app that turns task completion into a game which rewards Mike with points for each task he completes on time. If Mike misses a task, the app prompts to do an exercise challenge. Progress is tracked using a fitness device like fitbit or phone. The longer Mike takes to complete a task, he loses more points and does more exercise.

24. Smart Recliner

A recliner that gives task reminders via visual and audio cues integrated into the armrest. The chair also includes vibration/haptic feedback to alert Mike when it's time to complete a task. Also has a built-in screen on the armrest that can give visual cues of his next task.

25. Smart Whiteboard

A digital whiteboard at home that displays Mike's tasks and allows him to write them using a smart pen. The board can store tasks digitally, providing a visual reminder of everything Mike needs to do. Facilitators and family can remotely add tasks that appear in Mike's own handwriting. When there are forgotten tasks, the writing changes colours and the board plays a sound whenever Mike walks past it due to the motion sensors.

27. Small Device Integrated into Furniture

A set of devices integrated into Mike's everyday furni ture, such as his chair, bed, or dining table, features screens and sound capabilities. These devices can include lights, screens, vibrators, speakers, and microphones. Sensors detect interaction with the furniture, allowing facilitators to track task completion and adjust prompts accordingly while minimizing disruption. For example, a chair could vibrate and display a task reminder on a small screen, a bedside lamp could change color to draw attention to a screen, and a dining table setup could incorporate a screen and speaker to remind Mike of his tasks.

28. Plush Toy

A soft, plush device with a built-in system provides auditory and visual task reminders. Its mouth contains a speaker, while its eyes or belly feature a screen, and it can be customized to Mike's preference. The plush can speak reminders in an AI voice, display tasks on a screen in its belly, or hold a sign showing tasks. If suitable, built-in lights in its eyes can change color to indicate different task categories. A button in its hand can play audible reminders if Mike remembers to press it. Facilitators and family can program and monitor tasks through an app.

29. Pressure Plate Display Tile

A floor-integrated tile with a display, projector, and speaker provides auditory reminders when stepped on, activating only under adjustable pressure for Micheal or his wife. It displays incomplete tasks and can project them onto a nearby wall. Near the end of the day, Micheal can confirm task completion by stepping on it—once for no, twice for yes. Another nearby device can allow confirmation through kicking or pressing a button for stress relief.

30. Interactive DnD Table

An interactive table simulates a DnD game while consistently reminding Mike of tasks. It features a touch display for selecting dialogue/actions, a speaker for narration, and an app for storing

reminders. A motion sensor detects movement to draw Micheal's attention. It can replace a frequently used table, such as his dining or bedside table, and even integrate Baldur's Gate 3. Task reminders can replace dialogue options, requiring completion to progress, or appear with a timer—either pausing the game until the task is done or rewarding him with a special item. The game is dynamic and can be updated.

31. GPS GameBoy

A game similar to Pokémon Go, but tailored to Micheal's home, uses a portable GameBoy-like device or his phone. Throughout the day, it vibrates or plays an audio cue when a new "random" task appears. The display shows a map of his home with tasks scattered throughout, allowing him to tap, view details, and start a task, guiding him to its location. Tasks are set using a drop-pin system, like GeoGuessr. Completing tasks earns rewards, and Micheal can also input tasks with locations. The game can be customized—collecting creatures, earning virtual money—while data is turned to data that is readable by the facilitators.

32. Interactive Projection Wall

A projection system that turns a section of Mike's wall into an interactive task reminder space. It uses motion sensors to detect Mike's presence and allows him to mark tasks completed by gestures or voice commands. Projector can beam visual cues, schedules and checklists onto a blank wall at different times of the day.

33. Haptic Floor Tiles

A system of pressure-sensitive floor tiles that provide haptic-feedback when Mike enters a room with incomplete tasks. They also communicate with other devices in his home so that reminders are sent out through various forms when a task is left undone. This helps Mike be reminded of tasks throughout the house constantly.

34. Daily Task Jar

A task system using two jars: a "To-Do" jar filled with task slips and a "Complete" jar for finished tasks. Mike pulls a slip from the To-Do jar, completes the task, and places it in the Complete jar. By the end of the day, the To-Do jar should be empty, and the Complete jar full. Tasks are then poured back into the To-Do jar to restart the cycle.

35. Reminder Doorbell

A doorbell system placed on room doors plays a message when opened. For example, entering the bathroom prompts, "Time to brush your teeth." Programmed with time controls and uses motion detectors to activate only when Mike walks through. Only activates when Mike is recognized so his family is not disturbed.

36.Scorekeeper Type Reminder

A variety of blocks with task drawings, such as brushing teeth or taking medication, arranged in chronological order. Mike completes a task by sliding its block to the finished side, and then placing a blocker in the middle to prevent it from returning to the incomplete side. This design acts like a scorekeeper and helps track progress through visual means.

37. Personal Attendant

Instead of employing a smart AI model to voice reminders to Mike, 360º cameras are scattered throughout Mike's home accessed and monitored by a facilitator 24/7. The monitor would voice concerns and reminders throughout the day.

38. Augmented Reality (AR) Contact Lenses

Contact lenses, instead of glasses, provide Mike with visual checklists/reminders of tasks Mike must complete. Lenses can recognize objects within Mike's viewpoint and highlight objects relating to his tasks. The device will automatically recognize when Mike has completed a task and update facilitator.

39. Smart home voice AI with visual feedback

A smart home AI voice, similar to Alexa or Google Home, which reminds Mike audibly of his daily tasks that were not yet completed. The design receives visual feedback from Mike's glasses that provides real-time feedback to a cloud server that uses AI image recognition to assess Mike's current location, completed tasks, etc.

40. Airtag-supported Augmented Eye Glasses

Expanding on the concept of AR glasses for Mike, image recognition for the current room could be substituted by a simple calculation of the distance to the nearest planted Airtag, with one located at each significant place of tasks (e.g. bathroom [brush teeth, wash face, etc], kitchen [wash dishes, start washer, etc]).

- Reduces inaccuracies with AR technology
- Increases set-up time/costs as well reduces flexibility if the Airtag coverage is limited

41. Mood-Adaptive AI Voice

This variation enhances the AI's ability to recognize Mike's mood and adjust its tone accordingly. If Mike seems frustrated, the AI can speak more gently and offer encouragement. If he's feeling motivated, it can maintain a neutral and supportive tone. This emotional awareness helps create a more engaging and effective experience, ensuring Mike feels supported rather than pressured.

42. Color-enhancing Glasses

Specifically designed to help with slight color blindness, this variation not only provides visual checklists and task reminders, but also provides contrast and hue adjusting technology. This could help mike focus on specific objects, especially those relating to his tasks, such as labelled bottles or items

43. Clip-on Voice Device

Instead of being integrated within only the home, this version of the AI voice assistant ios a small clip-on device that stays with Mike wherever he goes. It can provide reminders and conversations throughout the day, ensuring that Mike receives guidance even when he might be in a room that a traditional Alexa might have issues reaching. This may make it easier for him to stay on track with his tasks regardless of location.

44. Augmented Reality Visor

Very similar to the AR glasses, but uses a larger, high-tech visor with more immersive display due to covering more FOV. This could support larger overlays such as guided pathways or overlays. However, it should be noted that this variation could be more uncomfortable for Mike to wear 24/7

45. Task-based Storytelling AI Voice

Instead of reading out and listing tasks, the AI voice turns them into an engaging story. For example, if Mike needs to brush his teeth and take medication, the AI might tell a short adventure about a hero who needs to complete these actions to continue his journey.

- Can be more entertaining and less directive, appealing to those who engage better with narratives.
- However, may be boring/frustrating for Mike to listen through

46. Auditory Cue-based Glasses

A variation of the AR glasses that relies on auditory cues of Mike's impending/in-progress tasks instead of visual overlays and lists. This could work more as an earpiece-like device. This eliminates issues of potential missing of visual details with the traditional AR glasses.

47. Basic Task Recitation ALEXA

This version removes AI entirely from the advanced Alexa, simplifying the system to a basic task-recitation device such as conventional Alexas/GHomes. It only plays pre-set reminders (by facilitators) without responding to Mike's input. This would be more straightforward and direct way of speaking to mike, though still retains the issue of being a bit disruptive

48. Distraction-Reducing Glasses

In addition to visual indicators and lists through the usage of AR glasses, these distraction-reducing glasses would selectively slightly blur out unnecessary things in Mike's FOV, allowing him to focus more on the task at hand. This may help with more focus, but could also cause safety issues due to induced visual impairment.

49. Question-Based AI Alexa

Instead of directly reminding Mike of tasks and requiring his confirmation, this version asks him questions to encourage his own thinking and memory recall. If he does not remember, gentle reminders and hints could also be given to prevent immediate frustration.

50. Auto eye-calibrated 20/20 Vision Glasses

A version of the AR glasses that highlights its possible use in enhancing Mike's vision to allow him to more easily focus on the task at hand. It could also selectively focus/sharpen specific parts in Mike's FOV to highlight what task he might need to focus on at the moment.

51. Task-based Singing Device

A device that has voice recordings of songs about Mike's tasks, that are communicated through a device Mike can interact with via touchscreen. The device can track and store his daily progress on an online cloud database. Information is transmitted back to facilitators via email.

52. Task List Recitation AI Voice

AI voice that communicates a list of tasks to Mike aurally, with which Mike can interact using voice activation. To track Mike's progress, motion sensors are used to track Mike's whereabouts and movements to check tasks off the list. AI sends direct message to facilitators to inform them of his progress.

53. Story-based Personal Memory Assistant

A hired personal assistant with exceptional memory communicates with Mike via metal can and string, delivering a story containing his tasks. Mike engages with the assistant via voice activation, and the assistant tracks progress by following Mike around throughout the day and checking off completed tasks. Assistant then reports back to facilitators with information on Mike's daily activities.

54. Drone Assistant

Drone-like device that flies around Mike's apartment, delivering pieces of paper containing a story-based task list to Mike. Mike can interact with drone by pulling on a lever to release the list. To track his progress, Mike must fill out a daily spreadsheet (physical paper) with which he must fax back to his facilitators

55. Morse Fax Machine

Mike is delivered a morse code message of his daily tasks which are sent to him through a fax machine that both prints the visual code and beeps the code out to him. Tasks are given to him as a list outlining his daily schedule, and Mike may interact with the machine via button. Mike then must fill out a spreadsheet (cloud based) to track his progress which will be summarized to facilitators through a daily automated call

56. Desk Buddy (Anki Vector Robot)

A small AI-powered robot, similar to Anki Vector, that sits on Mike's desk or bedside table - that gives task reminders in a friendly and conversational way. The robot can interact with Mike, providing reminders with a combination of speech, movement, and sound. This system encourages independence by asking "do you know what to do next?" It is able to move around and make sounds when a task is due.

Table G.1.3. Examples of themes

Theme	Examples [Appendix G.1]
Wearable Reminders	9. Smartwatch Buzzer
Location Tracking	33. Haptic Floor Tiles
Smart Home Integration	7. Smart Mirror System
Audio Reminders	13. Smart Home Voice AI
Visual Reminders	21. Baseboard LED Light Path
Haptic/Tactile Reminders	12. Haptic Doorknob

Appendix G.2: Idea Selection Process

Table G.2.1: Feasibility Check

Idea #	# of Votes	Feasible?	Justification
2 - Earpiece-like Device	2	Yes	Existing technology already - Only needs further modification
3 - Augmented Eye Glasses	5	Yes	Existing technology already - only needs further modification
11 - SPOT (Robotic Dog)	3	Not	Difficult to model/ MOS
13 - Smart Home AI	4	Yes	Existing technology already - Only needs further modification
17- Ai Pin	3	Yes	Existing technology already - Only needs further modification
19 - Digital Photo Frame	2	Yes	

23 - Gamified Task System	2	Not	
25 - Smart Whiteboard	3	Yes	Technology exists - only need modification
37 - Personal Attendant	2	Not	Ethical, Legal, Physical Reasons: Monitoring Micheal
56 - Desk Buddy (Anki Vector Robot)	2	Yes	Existing technology already - Only needs further modification
31- GPS GameBoy	2		

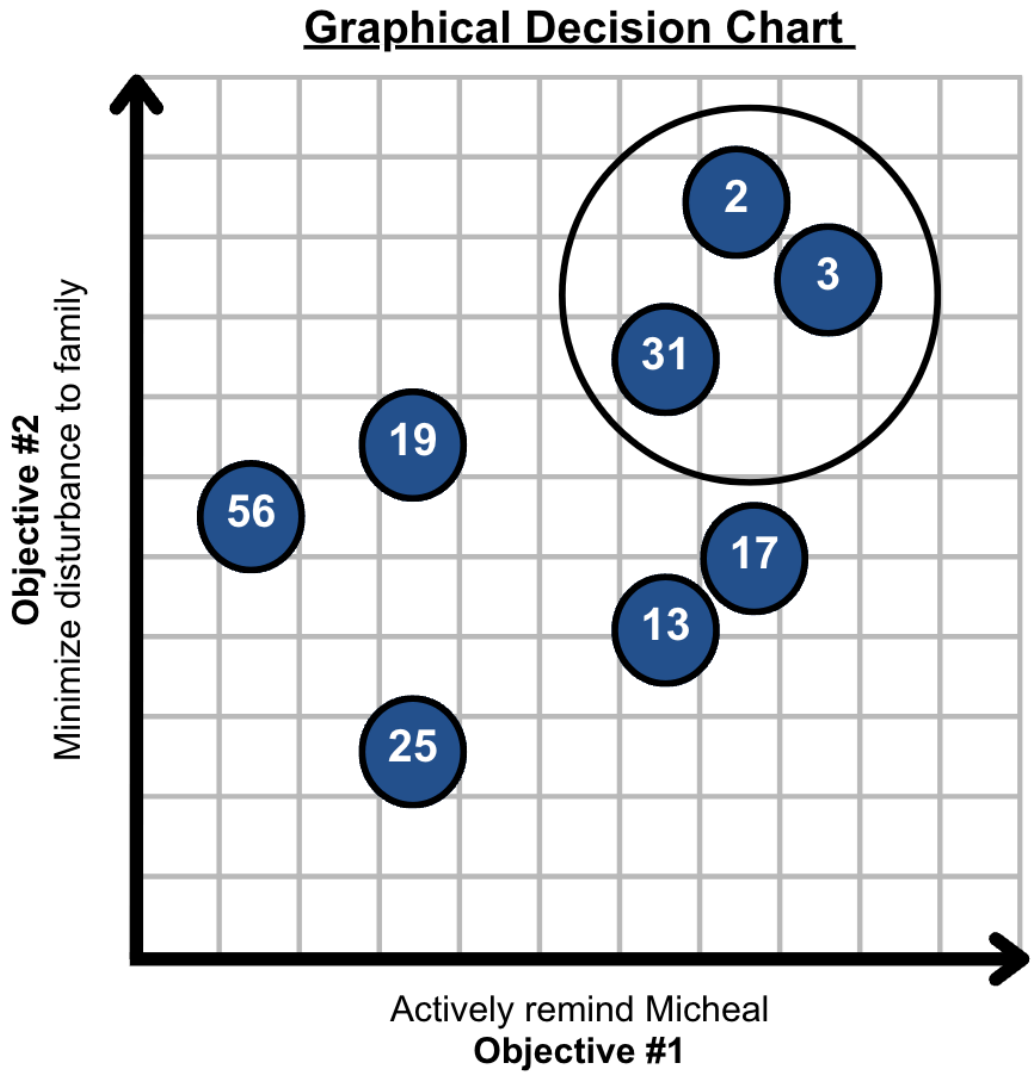

Figure G.2. Graphical Decision Chart (See Appendix G for idea descriptions)

Table G.2.2: Pugh Chart

Solution Objectives	**Datum** GPS Game Application	***Design 1*** Augmented Eyeglass	***Design 2*** Earpiece-Like Device
Actively remind Micheal	S	1	1
Minimize disturbance to his family	S	-1	0
Be adaptable to Micheal's progress	S	0	0
Store sufficient number	S	0	0

of Tasks			
Frequently notify Micheal of tasks	S	0	0
Offer multi-condition usability	S	0	1
Allow for operational uptime	S	-1	-1
Allow for minimal external maintenance	S	-1	-1
Offer multimodal presentation of information	S	-1	-1
Sum	**0**	**-3**	**-1**

Appendix G.3: Alternate Design Specifications

Appendix G.3.1: AR Glasses

Glasses follow design of Ray-Ban Meta AI Glasses: https://www.meta.com/ca/ai-glasses/?srsltid=AfmBOopZO-wERTEBpFnT_RvaTU8JwwaPzTW3hCBGls-V0do_dfkaflep

Table G.3.1. How design satisfies constraints

#	Constraint (Design must adhere to…)	How Design Satisfies Constraints
1	Child Proof Regulations	Design similar to Ray-Ban Meta AI Glasses [37] - Ray-Ban Meta AI Glasses legal in New York - Thus adhere to all regulations
2	Electricity Law	- ≤ 80% of circuit load - Operate at standard 120V [6] (Refer to Section 3.3)
3	Noise Law	- Noise level: - Maximum sound level: 76.1dB [37]
4	Data Protection	- Stored online in Google Drive, with AES-256 encryption [42]

5	ADA Compliance	- Ray-Ban Meta AI glasses (design similarity): - Weight: 48gram/ 0.105822lb - operable with one hand - Auditory cue: two built in speakers

Appendix G.3.2: JAMNS

Table G.3.2.. How design satisfies constraints

#	Constraint (Design must adhere to…)	How Design Adheres to Constraint
1	Child Proof Regulations	Design is similar to JBL Endurance Race TWS [38] - JBL Endurance Race TWS is legal in New York - Adheres to all regulations
2	Electricity Law	- ≤ 80% of circuit load - Operate at standard 120V [8] (Refer to Section 3.3)
3	Noise Law	Noise level: - Maximum sound level: 99 dB [38]
4	Data Protection	Transfer of data: - Stored online in Google Drive, with AES-256 encryption [42]
5	ADA Compliance	JBL Endurance Race TWS Specifications (since similar to design): - 12.4 grams [38] < 9kg - Average weight a male can carry - Auditory component: One speaker
6	Accordance with Brain Injury Canada	- Device must use plain language : - The complexity of communication should not exceed an 8th-grade reading level - Utilize plain, nonmedical language [30]

Appendix G.3.3: Questify: M.I.Q.E. (My Interactive Quest Engine)™

Table G.3.3. How design satisfies constraints

#	Constraint (Design must adhere to…)	How Design Adheres to Constraint
1	Child Proof Regulations	Physical portion of device: Samsung S23 - Samsung S23 is legal in New York - Adheres to all regulations
2	Electricity Law	Physical portion of device: Samsung S23

		- Samsung S23 is legal in New York - Adheres to all regulations
3	Noise Law	Noise level: - Typical ambient noise level of office: 50.8 dB [Figure G.4] - Typical notification noise level: 58.3 dB [Figure G.4]
4	Data Protection	Application protection: - User first-time sign in account requires account and unique password - Facilitator interface requires sign-in everytime it is opened Transfer of data: - Stored online in Google Drive, with AES-256 encryption [42]
5	ADA Compliance	Samsung S23 Specifications: - Touchscreen: 240Hz Touch sampling rate [56] - 168 grams [56] < 9kg - Average weight a male can carry [57] - Visual display: 6.1-Inch FHD+ [56] - Auditory component: Two Speakers [45]
6	Accordance with Brain Injury Canada	Text within application will be minimal and basic - See Figure #.

Appendix H: Proposed Design Specifications

Table G.4. Advantages and Tradeoffs of Each Design

	Advantages	**Tradeoffs**
Mike-Lens AR	Reminders will capture attention 100% of the time Streamlined notifications to Micheal reduces family disturbance Potential to expand features - Auto-polarizing feature - Eye-protection - Compatibility with corrective lenses	Susceptible to network/server malfunctions When in conditions where steam is present, glasses may become cloudy or condensation, impairing vision and detection functionalities Beginning of usage may put strain on points of contact

		Small battery life requires more charging periods Prolonged usage may cause eye strain
Earpiece-Like Device	Reminders will capture attention 100% of the time Streamlined notifications to Micheal reduces family disturbance Multifunctional (Potential to expand features) - Noise cancellation - Play entertainment - Act as hearing aid	Susceptible to network/server malfunctions Small size of design makes it easier to be forgotten or misplaced Small battery life requires more charging periods User may find wearing earpiece for entire day uncomfortable
Questify: M.I.Q.E. (My Interactive Quest Engine)	Design that offers the most interactive elements Potential for most scalability - Support for other devices (Smartwatches, iPhone…) - Incorporating more features can be done without interacting with user - Changes to features can be done without interacting with user - Cross-platform login Least interference with Micheal's life - Utilizes his phone, which he usually already carries around May serve as entertainment to Micheal Potential to scale for other/all TBI patients - Significantly less cost - Just app that supports multiple people and requires calibration	Susceptible to network/server malfunctions Capabilities are heavily dependent on chosen device If device is in a loud surrounding, auditory cues may not be heard May distract user from surroundings

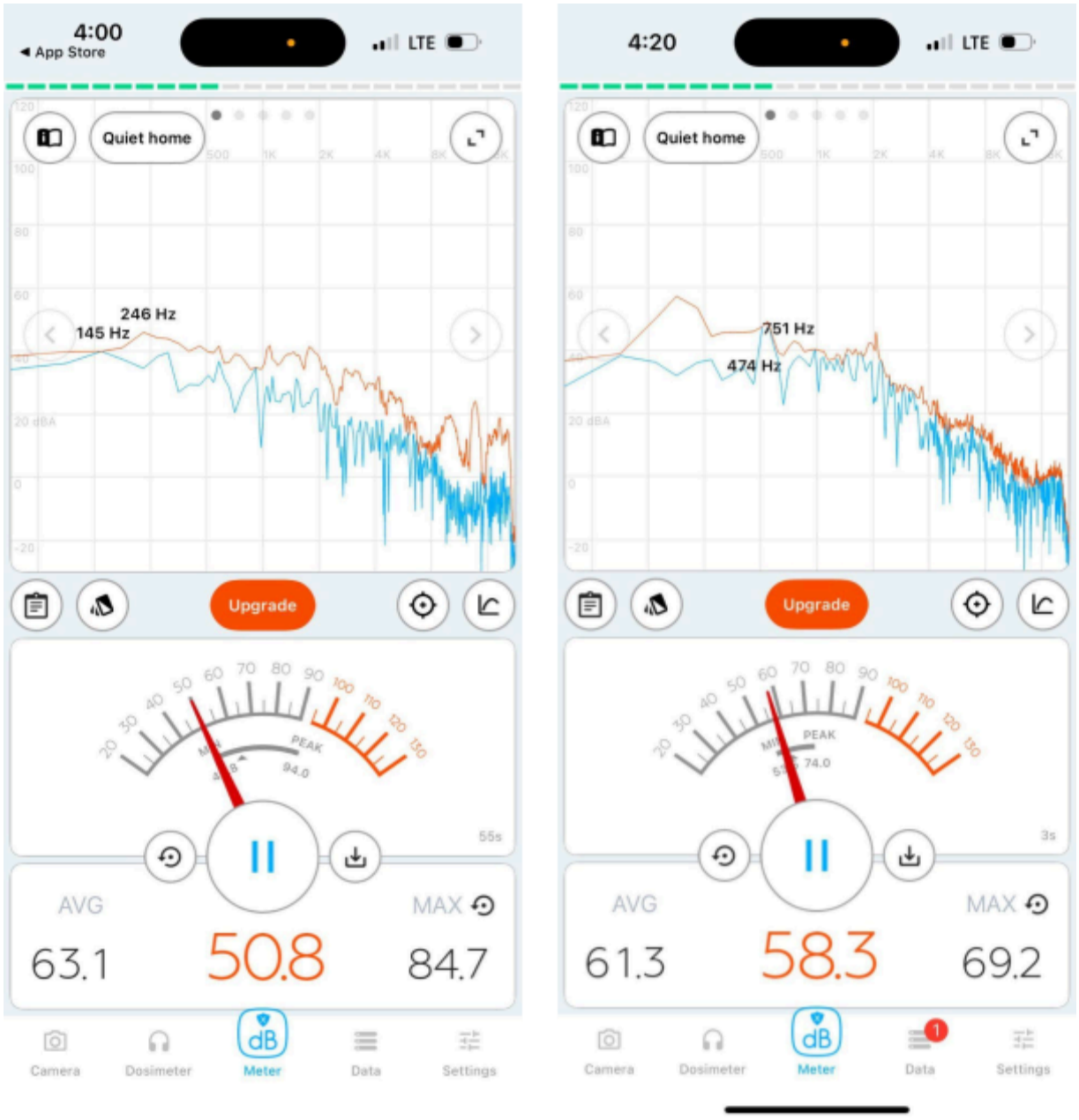

Figure G.4. Left image shows the ambient decibel level of a quiet office. Right image shows decibel level of a notification sound.

Engineering Strategies and Practice APS111-112

Attribution Table

Tutorial #: 129 Team #: 161

Assignment: Conceptual Design Specifications Date: March 21st 2025

The Attribution Table is a major resource used by your TA in determining whether there was equal contribution to the team assignment. If your TA determines that there was significant under contribution, then they may apply an individual penalty to the under contributing team members' grade. Grades lost to under contributing are simply lost. They are not redistributed to the other team members.

The Attribution Table describes the different work that each team member completed to create the submitted document. The Attribution Table should accurately reflect each team members' contribution to the document. It must be completed, signed by all team members, included as an appendix of your assignment AND uploaded to your MS Teams team channel. Be sure to keep a copy of this form for the team's records.

As a future professional engineer, you should NOT sign any document you have not read or do not agree with. The onus is on every team member to hold each other to account for accurately representing their contributions in the table.

If there are irreconcilable differences that are preventing all team members from signing the attribution table then each team member must write a letter (< one page) explaining their position on the difference and suggest a solution. These letters must be submitted to the TA.

Teams who do not submit a completed form, including those who submit an incomplete form, such as one missing a team member's signature, will have their grade withheld until team contribution has been investigated by the course.

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Section	Student Names					
	Nadira	Jaden	Adalric	Michelle	Sean	Gary
Problem Statement	ET, FP, RS11, RS12, RS13	WD, FP, ET	ET, FP	ET, FP	FP, ET	FP
Functions	ET, FP	ET, FP	ET, FP	WD, FP, ET	FP, ET	FP
Objectives	ET, FP	ET, FP	WD, RS8, RS9, FP, ET	ET, FP	FP, ET	FP
Constraints	ET, FP	ET, FP, RS14	ET, FP	ET, FP	WD, RS1, RS2, RS3, RS4, RS5, FP, ET	FP
Service Environment	WD, OR1, FP, ET	ET, FP, RS15	ET, FP	ET, FP	FP, ET	FP
Stakeholders	ET, FP	ET, FP	ET, FP	WD, FP, ET, RS10	FP, ET	FP

Introduction	ET, FP	ET, FP, RS16	ET, FP	ET, FP	WD, RS6, RS7, FP, ET	FP
Conclusion	ET, FP	ET, FP	WD, FP, ET	ET, FP	FP, ET	FP
Executive Summary	ET, FP	WD, FP, ET	ET, FP	ET, FP	FP, ET	FP
Idea Generation	ET, FP	WD, ET, FP	ET, FP	ET, FP	FP, ET	ET, FP
Idea Selection	WD, ET, FP, OR1	ET, FP	ET, FP	ET, FP	FP, ET	ET, FP
Alternate Design #1	ET, FP	ET, FP	ET, FP	ET, FP	FP, ET, OR3, OR5	WD, ET, MR, FP, RS35
Alternate Design #2	ET, FP	ET, FP, OR2	ET, FP	WD, ET, RS21, RS22, RS23	FP, OR4, OR6, ET	ET, FP
Alternate Design #3	ET, FP, OR1	ET, FP, OR2	WD, ET, RS24, RS25, RS26, RS27, RS28, RS29,	ET, FP	FP. OR7, ET	ET, FP
Proposed Design	ET, RS30, RS31, FP, OR1	ET, FP	WD, ET, RS32, RS33, RS34	ET, FP	FP, ET	ET, FP
Measures of Success	ET, FP	ET, FP	ET, FP	ET, FP	WD, FP, ET, RS17, RS18, RS19, RS20	ET, FP

Fill in abbreviations for the tasks you completed for each section of the report using the abbreviations below. You do not have to fill in every cell in the table.

RS – Research (give details below)

WD – Wrote Draft

MR – Major Revision

ET – Edited

FP – Final Proofread of COMPLETE DOCUMENT verifying for flow and consistency

AI – Used Generative AI (give details below)

OR – Other (give details below)

If you put RS (research) please add a number identifier such as RS1, RS2, etc. Give the research question below. Note: you are not limited to two research questions, add the correct number of entries below to capture your team's work.

RS1: What standards are there for accessibility in the USA?

RS2: What is the maximum electricity draw in New York City?

RS3 Are there noise regulations in New York City?

RS4 What are data protection regulations in the USA?

RS5 Are there child safety regulations for products?

RS6 What are some symptoms of TBI patients?

RS7	How severe is memory loss in TBI patients?
RS8	What is the average number of hours a person is awake?
RS9	What is the importance of having a culturally sensitive design?
RS10	What are landlords responsible for in New York City?
RS11	What are the conditions of the average New York City Apartment?
RS12	What are the standard conditions of a bathroom and kitchen?
RS13	What is the virtual environment of Manhattan, New York?
RS14	What is meant by AES-128 level encryption and what is considered better than this level?
RS15	What are the advantages and disadvantages of 5G Ultra Capacity WIFI, especially compared to 5G Ultra Wideband
RS16	What are the common memory related impacts of TBI?
RS17	What are the specifications of Samsung S23
RS18	Can sound improve notification engagement?
RS19	How does vibration and sound get the attention of a user?
RS20	Are reminder apps good for people with memory loss issues?
RS21	What are the waterproofing ratings for a typical set of wireless earphones?
RS22	How long do earbuds last?
RS23	What is the battery life of Airpods?
RS24	What is the component of a phone that emits haptics?
RS25	What are the speakers of a Samsung S23?
RS26	What are the technical specifications of a Samsung S23?
RS27	What temperatures can the Samsung S23 handle?
RS28	What are the battery capabilities of a Samsung S23?
RS29	How long can a smartphone last before replacement?
RS30	What colours are beneficial for TBI patients?

RS31	What text font/size are beneficial for TBI patients?
RS32	Does using a phone distract you from surroundings?
RS33	What are more technical specifications of a Samsung S23?
RS34	How much weight can an individual carry with one hand?
RS35	AR Glasses and the current state of art?

Some examples include: conducting site visits, identifying and reviewing articles for information, meeting with a librarian for help, etc.

If you put AI (used Generative AI) please add a number identifier such as AI1, AI2, etc. Explain how you used Generative AI in the section or document. Note: you are not limited to two AI usages, add the correct number of entries below to capture your team's work.

AI1:	
AI2:	

Some examples include: generating a draft for you to review, idea generation, editing a section you drafted, etc.

If you put OR (other) please add a number identifier such as OR1, OR2, etc. Explain what you did below. Note: you are not limited to 'other' types of work, add the correct number of entries below to capture your team's work.

OR1:	Created and integrated document figures
OR2:	Created custom app UIs for the facilitator views in Figma
OR3:	Created custom 3D CAD model for AI glasses design (Mike-lens)
OR4:	Created custom 3D CAD model for Earpiece design (JAMNS) in Canva
OR5:	Created figure to view features of AI glasses (Mike-lens) in Canva
OR6:	Created figure to view features of Earpiece design (JAMNS) in Canva
OR7:	Created figure to view features of Samsung S23 in Canva

OR covers any work you did to develop the document that is not described by writing, editing, and/or researching. Some examples include: developing figures or diagrams to support multimodality, organizing references, meeting with your CI for guidance (out of tutorial), etc.

By typing your name below to sign, you verify that you have:

- Read the attribution table and agree that it accurately reflects your contribution to the associated document.
- Written the sections of the document attributed to you as WD and that they are either entirely original, or you have included appropriate acknowledgement of AI usage.

- Accurately cited and referenced any ideas or expressions of ideas taken from other sources according to the standard specified by this course.
- Read the University of Toronto Code of Behaviour on Academic Matters and understand the definition of academic offense includes (but is not limited to) all forms of plagiarism. Additionally, you understand that if you provide another student with any part of your own or your team's work, for whatever reason, and the student having received the work uses it for the purposes of committing an academic offence, then you are considered an equal party in the offence and will be subject to academic sanctions.

Student #1 Name Nadira Barnes

Student #2 Name Michelle Bilan

Student #3 Name Adalric Tai

Student #4 Name Sean Issel Moises

Student #5 Name Xuankai Zhang

Student #6 Name Gary Geng

Student #7 Name