October 19, 2009
Dr. John Bird
School of Engineering Science
Simon Fraser University
Burnaby, British Columbia
V5A 1S6

Re: ENSC 440 Capstone Project Functional Specifications– CheckList™, Assistive Memory System by Mnemosyne Innovations Incorporated.

Dear Dr. Bird:

Please find attached the Capstone Project Functional Specifications for the product CheckList™ by our company Mnemosyne Innovations Inc. Mnemosyne Innovations is comprised of four highly motivated and talented engineering students: Priyanka Deshmukh, Rachel Cheng, Ana Namburete and Surbhi Seru.

Forgetting items is something all of us have experienced at some point or another. The product CheckList™ is precisely aimed at alleviating this problem. CheckList™ is a convenient *portable* memory aid device that enables users to confirm that all relevant items are being taken with them when they leave their surroundings.

Enclosed herewith are the functional specifications and requirements that will serve as the framework to the design of the prototype as well as the final CheckList™ device. The requirements encompass several of the areas that require careful consideration, including electrical, safety, environmental, and standard requirements to name just a few. Viewing the product from these various angles ensures that CheckList™is reliable, safe, durable and aesthetically pleasing for the end user.

If there are any questions regarding the proposal, please feel free to contact me by phone (778-995-0832) or email (pmd1@sfu.ca).

Thank you very much for your consideration.

Sincerely,

Priyanka M. Deshmukh

Priyanka Deshmukh
Chief Executive Officer, Mnemosyne Innovations Incorporated

Enclosure: *Functional Specifications for Mnemosyne Innovations' CheckList™- Assistive Memory System*

Functional Specifications

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Executive Summary

To forget is human…

In a society where everyone is constantly on the move, it is easy for anyone to forget important items at home, in a vehicle or at a public place. Mnemosyne Innovations Inc. presents the CheckList™, the only device needed to remember the most important and valuable items for the busy everyday person.

The CheckList™ system allows anyone to tag items and verify that all tagged items are with the user. The system comes with three components: the main device unit, tags for the items and a user interface. In order to use the CheckList™, the user places the tags onto the items needed, e.g. a wallet or a laptop. Next, plugging the main unit into a computer, the user can access a simple user interface where he/she can easily add, edit, or remove tags active on the device. The device is also password protected to ensure that the information stored on the CheckList™ is secure. Before leaving a location, the user merely has to press the 'Check' button located on the main unit and the LCD will display which items are absent with the user.

In future releases of the CheckList™, we wish to include software that will allow the system to prevent users from being pick-pocketed. Also, we hope to reduce the size of the tags and labels with the advancements in RFID as well as other RF technologies.

The system requirements and test plans for the first iteration prototype of the CheckList™ are outlined in following document and the Mnemosyne Innovations executives have made it their priority to deliver a device that is safe, portable, and easy to use.

Mnemosyne Innovations

Table of Contents

List of Figures

List of Acronyms

USB	Universal Serial Bus
GUI	Graphical User Interface
LCD	Liquid Crystal Display
PC	Personal Computer
RF	Radio Frequency
RFID	Radio Frequency Identification

CheckList™: Functional Specifications

1 - Introduction

The following document will outline the basic functions of the CheckList™, the user interaction with the device and the output to the user given by the device.

1.1 Scope

This document aims to describe the functional requirements of the CheckList™ - i.e. *what* the device will do. The requirements are considered for the proof-of-concept prototype as well as more stringent requirements for the final marketable product.

As noted in the executive summary, the design of the CheckList™ has changed slightly due to proximity restraints placed on the specifications of the device. In order to accommodate the desired detection range of the device, the original passive RFID tags has been replaced with an active system. Discussion into this decision will be examined in the system overview.

1.2 Intended Audience

The functional specifications are intended to be used by the entire Mnemosyne Innovations executive team. While designing, building and testing our system, we will refer to this document to ensure that all the requirements outlined are met for our prototype device. The CEO will ensure that the team reaches the desired milestones of the project with the specified requirements in mind. The hardware team, comprised of Priyanka Deshmukh and Surbhi Seru, will focus on the specifications of the detection unit and tags (Sections 3.1 and 3.2). Similarly, the software team, comprised of Rachel Cheng and Ana Namburete, will focus on the specifications of the GUI interface (Section 3.3). The entire team will integrate the design from all the requirements that meet the overall general specifications (Section 2).

1.3 Classification

To maintain a consistent numbering standard throughout the document, Mnemosyne Innovations Inc. has adopted the following convention to list the functional requirements.

[FS-#-x] 'FS' denotes a functional specification
'#' denotes the requirement number
'x' can take on a value of 'I', 'II' or 'III'
'I' - requirement for the proof-of-concept prototype only
'II' - requirement for the final commercial product only
'III' - requirement for both the prototype and the commercial product

2 - System Requirements

The System Requirements section illustrates the specification sections associated with the device in its entirety. This section outlines the physical description of the system and the general overview of how the device works from the user's point of view.

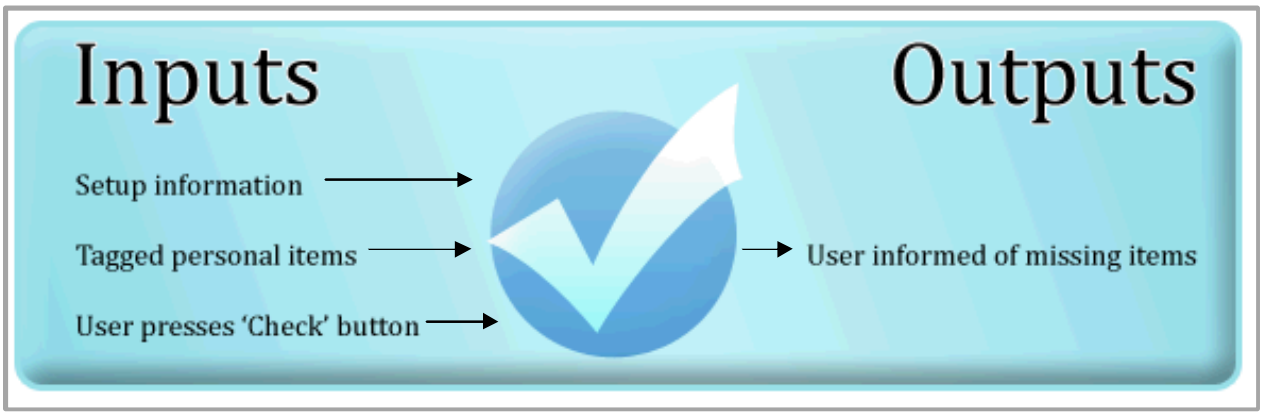

Figure 1 - System Requirements - High Level Functional Diagram

2.1 System Overview

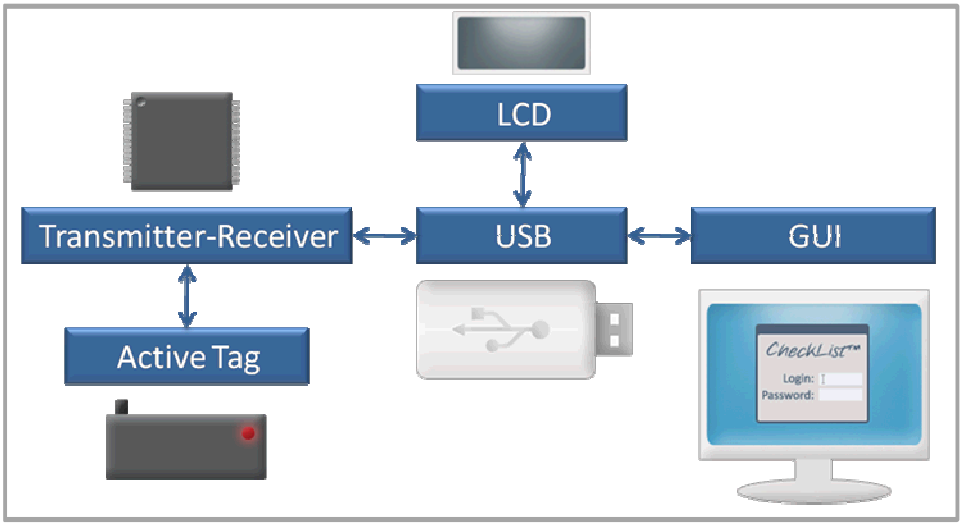

Figure 2 - System Overview - System Interface

The CheckList™ system involves three main components: the detection unit, the active tags and the GUI. The detection unit is made of three subcomponents: the USB key, LCD screen and a transmitter/receiver, as shown in Figure2. The unit interacts with the items that are tagged when the 'Check' button is pressed by the user. Information regarding which tags are currently active is stored on the detection unit which are added, edited or removed by the user via the GUI which is accessed by plugging the device into a USB port on a computer.

In our proposal, the original design of the system involved the use of passive RFID tags. However, this required a large antenna for the device to have our desired range. Therefore, we modified our design and replacedthe passive tags with active RF tags. This enables the device to reach our desired range of 1-2 metres. With the switch to active tags, batteries need to be taken into consideration. Our goal is to keep the size of the tags as small as we can by using coin cell batteries. The tags are also equipped with *"multi-read"* functionality, which will allow the user to recognize and detect multiple items. For our prototype device, we will be able to add, edit or remove five unique tags with the use of the GUI. In the commercial product we hope to have the device recognize up to ten unique tags.

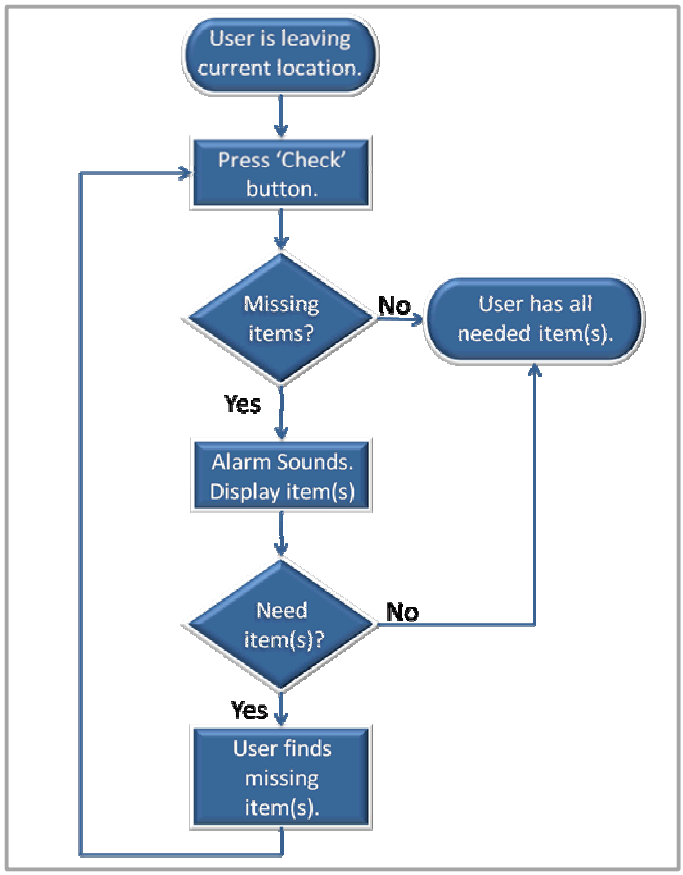

Figure 3 - System Flowchart - CheckList™ Decision Making Process

As mentioned previously, the detection device of the CheckList™ interfaceswith a computer via a USB port. When the device is connected, the GUI runs as an executable file and will be compatible in either a Windows or Mac OS-X environment. The user creates a profile with a login, password and security question (in case the password is forgotten). Once the profile is created, the GUI displaysa list of the available tags, each havingits own unique identification number that can be edited by the user through the GUI. Once the correct items are tagged, the user can edit the tag numbers with useful names (e.g. Laptop). The user can then use the GUI to activate whichever tags they wish to use. Once the desired tags are set, the user unplugs the detection device from the computer and the CheckList™ system is ready to go. The user follows the flow chart diagram in Figure 3 to use the system.

2.2 General/Overall Requirements

[FS-1-III] In an idle state, the tags shall always be transmitting a UHF signal as they are in the active mode.

[FS-2-III] In an idle state, the detection unit is powered off and only upon pressing the 'Check' pushbutton will the system activate and power on.

[FS-3-III] The detection unit shall be able to detect multiple tags during a single scan

[FS-4-III] The detection unit shall be able to detect whether or not items are in/outof the range.

[FS-5-III] The detection unit shall convey the result of a scan to the user in a clear manner.

[FS-6-III] The user shall be able to put the system in an "OFF" state, in which case no signal is sent from the access point to the target boards.

[FS-7-III] The detection unit shall interface with a computer via a USB port

[FS-8-II] The system will contain a theft prevention mode, which the user may enable when in densely populated areas to prevent pick-pocketing - this will result in a beeping sound as well as a vibratory response to alert the user.

[FS-9-I] The price of the prototype shall be under CAD$ 170.

[FS-10-II] The retail price of the product shall be underCAD$ 50.

2.3 Physical Requirements

[FS-11-III] The device shall have a 'Check' button.

[FS-12-III] The detection device shall have an LCD display.

[FS-13-III] The system shall be portable.

[FS-14-III] The system shall be lightweight.

2.4 Electrical Requirements

[FS-15-I] The prototype detection unit shall be powered by two AAA batteries.

[FS-16-I] The target boards that interact with the prototype unit shall be powered by a 3V coin cell battery.

[FS-17-II] The target boards that interact with the commercial unitshall be powered by smaller battery cells.

[FS-18-II] Commercial detection unit shall be powered by a rechargeable flat lithium ion battery.

[FS-19-II] Detection unit shall be rechargeable via a USB port and computer or adapter and an electrical outlet.

[FS-20-II] The power adapter cable shall be compatible with a supply of 110V/220V at 60Hz AC - a typical value in North America.

2.5 Environmental Requirements

[FS-21-III] The system shall be operable indoors and outdoors.

[FS-22-III] The system shall be operable in temperatures rangingbetween to .

[FS-23-III] The system shall be operable in relative humidity up to 90% (non-condensing).

[FS-24-II] The system shall produce little or no noise when in active or inactive modes.

[FS-25-III] All electrical wiring shall be enclosed in protective casing.

[FS-26-II] The system shall operate normally in the presence of and not interfere with other equipment that utilizes UHF technology.

2.6 Standards

[FS-27-II] The system shall comply with the wireless communication ISO 18000 standards. [1]

[FS-28-II] The graphical user interface shall comply with the software ergonomics ISO 14915 standards. [2]

[FS-29-II] The system shall comply with the European wireless communication IEC 62369-1 standards. [3]

2.7 Reliability

[FS-30-II] The system shall not crash from general use.

[FS-31-II] The system shall be able to withstand falls from a height of 50 centimetres.

[FS-32-II] Each tag shall be enclosed in a plastic protective coating.

[FS-33-II] Each of the tags enclosed in the protective coating shall bescratch resistant.

[FS-34-II] The covered tags shall be resistant to liquid damage, and to applied pressures.

[FS-35-I] The prototype kit shall consist of at least five (5) individual tags that can be attached and referenced to different items.

[FS-36-II] The commercial kit shall consist of at least ten (10) individual tags that can be attached and referenced to different items.

[FS-37-II] Each tag shall have more than one adhesive strip so that it can be attached onto different items.

[FS-38-III] The double-sided adhesive tags shall not melt under the operating conditions.

[FS-39-II] The electrical components in the tags and access points shall behave normally under the operating conditions.

2.8 Safety

[FS-40-II] The system shall not give the user any static shock upon contact.

[FS-41-II] The signals emitted from the system shall not interfere with any other equipment (especially the item to which it is attached).

[FS-42-II] The access point and tags shall be covered with material that is resistant to electrical shock.

[FS-43-II] The batteries powering the tags shall be held in place by a battery holder.

[FS-44-II] All sharp edges shall be enclosed within the protective coating.

[FS-45-III] All electronic components and the casings shall be made of non-lethal materials.

2.9 Performance

[FS-46-III] The LCD display shall list the missing items.

[FS-47-II] The system shall take no longer than 1.0 second to scan and display the missing items on the LCD.

[FS-48-III] The battery life for the detection unit must be comparable to other electronic devices.

[FS-49-III] The user shall be able to read the message on the LCD display in the presence and absence of environmental light.

[FS-50-III] Each character on the LCD display shall be legible to the user within the interval of clear vision (6.67cm to 20cm) [4].

[FS-51-I] The access point shall be able to read/send a signal within a range of 1-5 metres and detect the target boards within that range.

[FS-52-II] The access point shall be able to read/send a signal within a range of 1-2 metres and detect the target boards within that range.

[FS-53-II] The commercial product shall play a beeping sound when objects are found to be missing.

[FS-54-II] A product website and customer service line shall be made available if the user encounters issues with the device.

2.10 Usability

[FS-55-II] The graphical user interface shall be well mapped and intuitive to use.

[FS-56-II] The learning and uptake period for the system as a whole shall be no more than a few minutes.

[FS-57-II] The system should be easy to integrate into a person's daily life.

[FS-58-II] The system should be usable by wide age demographic.

3 - Subcomponent Requirements

The Subcomponent Requirements section aims atnarrowing down further the requirements associated with the individual components of theCheckList™ system. The requirements categories mentioned previously are provided for each of the following subcomponent areas: Detection Unit, Detection Tags and User Interface.

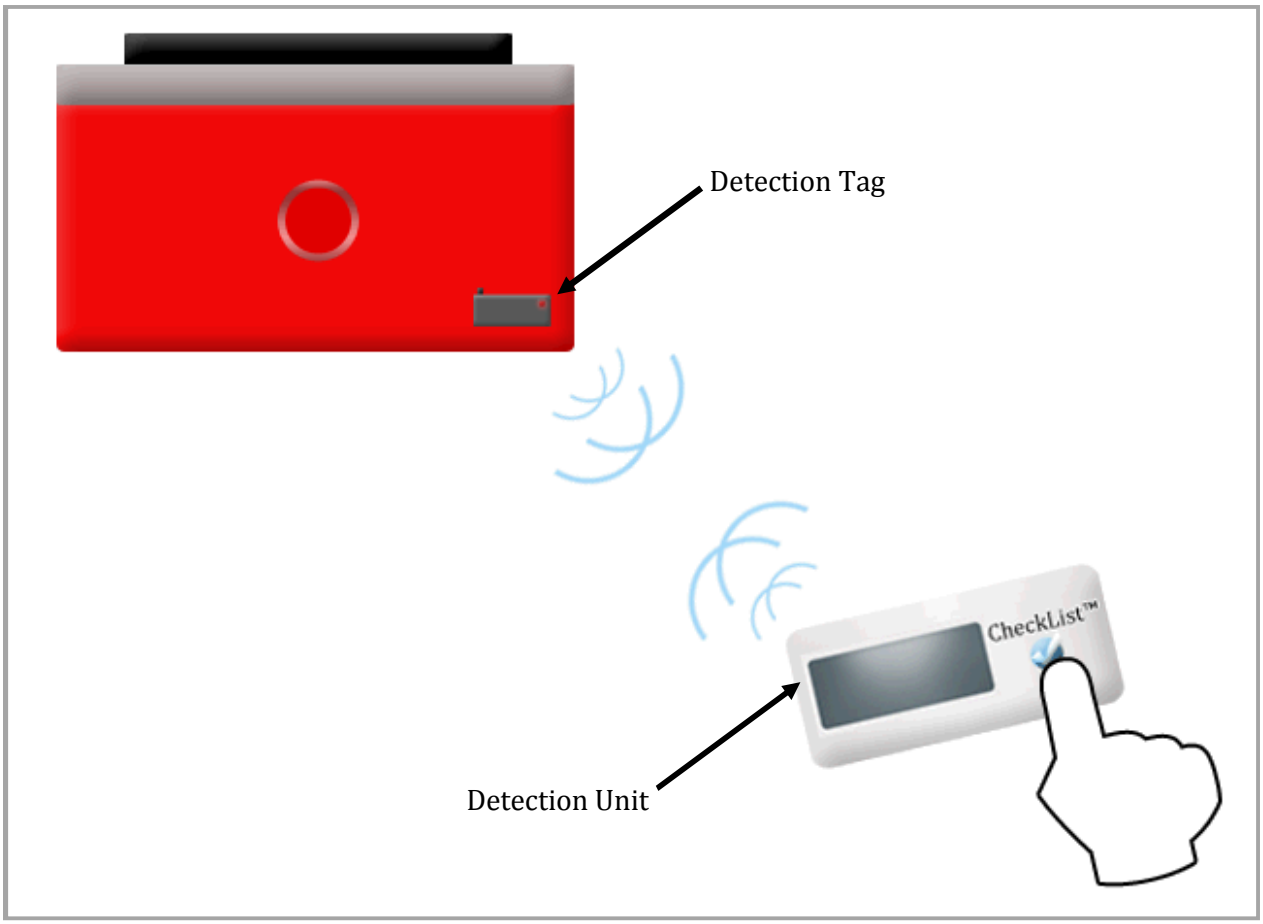

Figure 4 - CheckList™ System Components

3.1 Detection Unit

The Detection Unit is the handheld device the user interacts with in order to check whether the necessary items have not been forgotten. It includes the RF receiver and processor, Liquid Crystal Display (LCD), pushbutton, battery and USB capability.

Please note the current consumption of the detection unit according to the components being used within is as follows:

- Active mode at 1 MHz, 2.2V = 270 µA (typical) and 390µA (max)
- Standby mode = 0.7µA (typical) and 1.4 µA (max)
- Off mode with RAM retention = 0.1µA (typical) and 0.5µA (max)

3.1.1 General Requirements

[FS-59-II] The user shall be able to reset the LCD display.

[FS-60-I] The access point shall be able to read/send a signal within a range of 15 metres and detect the target boards within that range.

[FS-61-II] The access point shall be able to read/send a signal within a range of 12 metres and detect the target boards within that range.

[FS-62-III] General electronic items must not interfere with the detection of the tags.

[FS-63-I] Tag detection must be valid for multiple tags, with a limit of 5 tags being operated at any given point in time.

[FS-64-II] Tag detection must be valid for multiple tags, with a limit of 10 tags being operated at any given point in time.

[FS-65-III] Tag detection should be circularly polarized, and therefore able to detect items in the three dimensional plane.

[FS-66-III] The device must connect with a desktop or a laptop computer upon insertion into the USB port.

[FS-67-III] Components used to construct the device must be easily accessible in order to provide proper maintenance in the event that the device malfunctions.

[FS-68-II] Requests to check for items are able to be sent in succession, with a maximum waiting time of 5 seconds between individual requests.

[FS-69-II] In the instance that more than one CheckList™ systems are in use around the same environment, the detection unit of each system must only detect tags corresponding to that system (according to their ID number), and not detect tags from the other CheckList™ system.

[FS-70-III] If the system is prompted to perform a scan (by pressing the 'Check' button) while it is in the busy mode (i.e. performing a previously requested scan), the second prompt will be ignored by the system. The initial scan will first be completed and its results will be displayed to the user on the LCD.

3.1.2 Physical Requirements

[FS-71-I] The RF receiver and processor, LCD, pushbutton and battery must be enclosed in a casing of 70mm x 100mm x 50mm.

[FS-72-II] The RF receiver and processor, LCD, pushbutton and battery must be enclosed in a casing of 60mm x 70mm x 20mm.

[FS-73-I] The system shall weigh no more than 1 kilogram (2.205 lb).

[FS-74-II] The system shall weigh no more than 200 grams (0.441 lb).

[FS-75-III] The detection unit should look aesthetically pleasing to the user.

3.1.3 Performance Requirements

[FS-76-I] The battery life of the unit must be at least 5 hours.

[FS-77-II] The detection unit will function on a rechargeable flat lithium ion battery with a battery life of 5-7 hours.

3.1.4 Electrical Requirements

[FS-78-II] The power adapter cord attachable to the wall outlet should have a minimum length of 1 meter.

[FS-79-I] Key voltage nodes will be easily accessible on the detection unit for trouble shooting, testing and debugging purposes.

3.1.5 Environmental Requirements

[FS-80-III] The system must not dissipate a significant amount of heat while in use.

3.1.6 Reliability

[FS-81-III] The unit must produce valid and consistent results when detecting various items.

[FS-82-III] The material of the casing must be able to withstand shock and therefore must not easily crack.

[FS-83-II] The detection unit will contain a backup battery in order to save the stored information.

[FS-84-II] The detection unit must be able to detect the gradual drop in power from the tag, and provide the user with a warning toreplace the battery on the tag.

3.1.7 Usability

[FS-85-III] The LCD must contain a backlight so the user is able to use the device even in a dark setting (e.g. camping ground at night).

[FS-86-III] The LCD must display text in 2 two lines, and shouldhave the ability to scroll to display more text.

[FS-87-III] The detection unit must be able to detect the tagged items independently offline and without interfacing with a computer.

3.1.8 Safety

[FS-88-III] All the necessary parts of the components mustbe securely affixed inside the casing.

[FS-89-III] The LCD must be mounted on top within a safe distance from the main microprocessor board to ensure the components are not in contact.

3.2 Detection 'Tags'

The Detection Tags consist of the target board that continuously transmits an RF signal so as to enable detection by the detection unit. In addition, it consists of the battery that is used to power the tag.

3.2.1 General Requirements

[FS-90-III] Multiple tags should not interfere with the signals emitted from other tags.

3.2.2 Physical Requirements

[FS-91-III] The tags must be enclosed in a protective, malleable, heat resistant casing.

[FS-92-I] The tags (including casing) should have a maximum area of 12cm^2.

[FS-93-II] The tags (including casing) should have a maximum area of 6cm^2.

[FS-94-III] The tags must be light in weight so as to enable attaching them to a small item.

[FS-95-II] The tags will consist of an LED visible from the casing– to indicate low battery (see 3.2.6 for more details).

3.2.3 Performance Requirements

[FS-96-III] The battery life for the tags must be comparable to other electronic components that require similar power consumption. (Please note, an experiment will be conducted with the present target boards i.e tags, to determine the battery life. More details on this area will be provided in the Design Specifications document).

3.2.4 Electrical Requirements

[FS-97-III] The tags must operate using a small 3V disposable cell battery.

[FS-98-II] The tags will consist of a mechanism that will be built alongside the target board to enable energy conservation during idle mode.

3.2.5 Environmental Requirements

[FS-99-II] The tags must be able to withstand humidity up to 90%.

3.2.6 Reliability

[FS-100-II] Upon a reaching a low battery level (i.e. battery power below a certain threshold), the LED on the tag must turn on as an indicator of low battery.

3.2.7 Usability

[FS-#-III] The casing of the tags must contain a portion with double sided adhesive tape attached to the underside, in order for the tags to be attached to items.

3.3 User Interface

The two modules that form the user interface are the Handheld Detection Device Interface and the Graphical User Interface.

3.3.1 Handheld Detection Device Interface

The Handheld Detection Device Interface shall comprise of a pushbutton as an input and an LCD as an output.

3.3.1.1 General Requirements

[FS-101-III] The primary form of user input is through a single pushbutton that will activate the RF signal transmitter.

[FS-102-III] The primary form of output to the user is through an LCD

3.3.1.2 Physical Requirements

[FS-103-III] The unit shall have an LCD.

[FS-104-III] The unit shall have a pushbutton.

3.3.1.3 Performance Requirements

[FS-105-II] The LCD shall display status indicators to indicate low battery.

[FS-106-III] The LCD shall list the missing items once the button is pushed.

[FS-107-II] The unit shall play a beeping sound when objects are found to be missing.

[FS-108-III] Each character on the LCD shall be legible to the user within the interval of clear vision (6.67cm to 20cm) [4].

3.3.1.4 Environmental Requirements

[FS-109-III] The user shall be able to read the message on the LCD in the presence and absence of environmental light.

[FS-110-III] The unit shall be operable indoors and outdoors.

[FS-111-II] All electrical wiring shall be enclosed in protective casing.

3.3.1.5 Reliability

[FS-112-II] The user interface shall not crash from general use.

[FS-113-III] The pushbutton shall be able to withstand user forces for the lifetime of the product.

3.3.1.6 Usability

[FS-114-I] The unit shall have a pushbutton that is easily activated with a user's touch.

[FS-115-II] The unit shall have a pushbutton that is easily activated with a user's touch but not while inside the user's pocket or bag.

3.3.2 Graphical User Interface

The Graphical User Interface (GUI) shall comprise of a set of screen modules that enable the user to configure the use of the product.

3.3.2.1 General Requirements

[FS-116-III] The primary function of the GUI is to enable the user to configure the device settings.

[FS-117-III] The primary form of the user input is through a computer mouse and keyboard.

[FS-118-III] The primary form of the output to the user is through the on-screen modules.

3.3.2.2 Performance Requirements

[FS-119-I] The user shall be able to display the GUI through opening the USB device once the USB is connected to the PC.

[FS-120-II] The GUI shall pop up once the USB is connected tothe PC.

[FS-121-III] The GUI shall be password-protected.

3.3.2.3 Environmental Requirements

[FS-122-III] The user shall be able to operate the GUI using a Windows operating system.

[FS-123-II] The user shall be able to operate the GUI using a Windowsand Mac OS-X operating system.

3.3.2.4 Standards

[FS-124-II] The graphical user interface shall comply with the software ergonomics ISO 14915 standards. [2]

3.3.2.5 Reliability

[FS-125-II] The GUI shall not crash from general use.

3.3.2.6 Usability

[FS-126-II] The GUI shall be user-friendly and intuitive to use.

4 - Documentation

[FS-127-II] The primary form of user documentation shall be the Setup Guide for the device, which shall outline the basic steps for setup and usage of the product.

[FS-128-II] User documentation shall include a website with general product information and contact information for technical support

[FS-129-II] User documentation shall also include a written user manual included with each product, written in English, French, and Spanish.

[FS-130-II] As the product expands to the international market, the user manual shall be available in the major language(s) ofthe target countries.

[FS-131-II] The written user manual shall be written for an audience with minimal technical knowledge.

5 - System Test Plan

The CheckList™ device proof-of-concept prototype will undergo three stages of testing. The initial stage will involve testing of each of the individual components. Once this testing is complete, we will integrate related components together and test the combined modules. Finally, we will assemble the complete product and conduct holistic testing.

5.1 Component Testing

Detection Unit

- Ability to power the unit using AAA batteries
- Ability to detect one RF Tag

Target Board Tags

- Ability to power the tags using a cell battery
- Ability to transmit RF signals when powered

LCD

- Ability to display characters as programmed

Graphical User Interface

- Ability to display and interact with user commands as programmed
- Intuitivism of design

USB

- Ability to establish a connection with the PC

5.2 Module Testing

Detection Unit and Tags

- Demonstrate several tags being detected bythe detection unit within a 1-5 m radius

Handheld Detection Device Interface

- Ability to respond to pushbutton “Check” request by displaying characters on LCD.

Graphical User Interface

- Ability to display upon connection of the USB
- Ability to save changes to device

5.3 Holistic Testing

We will conduct thorough software and hardware tests to ensure that all modules have been integrated properly. We will confirm that all connections comply with our requirements listed in sections 2 and 3 of this document. In addition, we will simulate the Typical Usage Scenario, outlined below, which mimics the intended use of the device by the end-user. During our holistic testing, we will ensure that each step of the Typical Usage Scenario is functioning as required.

Typical Usage Scenario

1. User inserts batteries into tags and tags begin transmitting RF signals
2. User inserts the USB into PC and the GUI is displayed on the screen
3. The simple and intuitive GUI takes the user through the device set-up process
4. Once the user clicks “Save” in the GUI, the settings are saved onto the Handheld Detection Device through the USB
5. When the user presses the “Check” button on the Handheld Detection Device, the LCD informs the user of which tags aremissing
6. When the user does not need to use the device, they are able to switch the device off.
7. If the user wants to reconfigure all settings, they are able to reset the device to factory settings.

6 - Conclusion

Mnemosyne Innovation believes the CheckList™ is a product that would be used in every household by individuals of all age groups. Its practicality, reliability, safety and usability in particular contribute to its sound functioning.

The Functional Specifications mentioned in this document will provide Mnemosyne Innovation with a guideline of the requirements during the product design, development and testing stages. It is important to note that the specifications mentioned here have been considered not only from the company's standpoint but also from the user's point of view, to therefore produce a product that is highly marketable.

All you need to remember is your CheckList™.

7 - References

[1] ISO/IEC, "Information Technology – Radio Frequency Identification for Item Management – Part 2: Parameters for Air Interface Communications below 135kHz", [Online]. Available: http://webstore.iec.ch/preview/info_isoiec18000-2%7Bed2.0%7Den.pdf. [Accessed: 7 October, 2009]

[2] Usability Net, "International Standards for HCI and Usability", [Online]. Available: http://www.usabilitynet.org/tools/r_international.htm. [Accessed: 13 October, 2009]

[3] IEC, "Project: IEC 62369-1 Ed. 1.0" [Online]. Available: http://www.iec.ch/cgi-bin/procgi.pl/www/iecwww.p?wwwlang=english&wwwprog=pro-det.p&progdb=db1&He=IEC&Pu=62369&Pa=1&Se=&Am=&Fr=&TR=&Ed=1. [Accessed: 17 October, 2009]

[4] Wilkinson, M.E. ,"Essential Optics Review for the Boards". Coralville: F.E.P. International Inc., 2006, pp. 54