

February 20, 2006

Dr. Andrew Rawicz
School of Engineering Science
Simon Fraser University
Burnaby, BC, V5A 1S6

Re: Functional Specification for a Sensory Balance Assistance Device

Dear Dr. Rawicz:

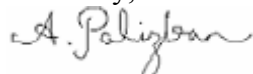
Attached, please find the document describing the Functional Specification for a Sensory Balance Assistive Device.

We are designing and implementing a portable device, called *Equilibra*, to assist people prone to falling as a result of balance disorders. The device, which will be attached to the belt, would send auditory and vibratory signals when the individual leans in any of the four directions, thereby helping people maintain their balance and carry out their day to day activities with greater ease.

The functional specification presents requirements, parameters, and criteria that *Equilibra* will meet for the deadline set in second week of April 2006. In addition, this document outlines the set of specifications to be implemented in the future development.

NewBalance Technologies consists of four team members: Siavosh Jalili, Sakshi Nagalia, Atefeh Palizban, Yang Yu. Should you have any question or concern, please contact us at ensc440-newbalance@sfu.ca. You may also reach our contact person, Siavosh Jalili, at 778-895-5920.

Sincerely,

A handwritten signature in cursive script that reads "A. Palizban".

Atefeh Palizban
President and CEO
NewBalance Technologies

Enclosure: Functional Specification for a Sensory Balance Assistive Device



Functional Specification for a
Sensory Balance Assistance Device

Project Team: Siavosh Jalili
Sakshi Nagalia
Atefeh Palizban
Yang (Jerry) Yu

Contact Person: Siavosh Jalili
ensc440-newbalance@sfu.ca

Submitted to: Dr. Andrew Rawicz ENSC 440
Steve Whitmore ENSC 305
School of Engineering Science
Simon Fraser University

Issued date: February 20, 2006

Revision: 1.5

Executive Summary

As many as 50,000 Canadians live with balance disorders. Our proposal to develop a sensory balance assistive device is presented after considering the importance of balance, also dubbed the “*sixth sense*”, the cost incurred by individuals and government for caring, and the compromise of the independence of people living with balance disorders, and the subsequent negative impact it has on their quality of life. NewBalance Technologies proposes a device, called *Equilibra*, attached to a belt that would send auditory and vibratory signals when the individual leans in any direction. The more the individual leans, and the more they are outside their centre of mass, the louder or stronger the signal becomes. This would help the individual to correct his/her posture and thus prevent a potential fall.

We divided our development process into two phases: the first phase will see through the completion of a functioning proof of concept device with main features as follows:

1. A Central Unit detects and analyzes inclinations in all directions
2. Auditory notification via earphones that are connected to the Central Unit will warn the user of a potentially dangerous position
3. Sensory warning via vibrators that are connected to the Central Unit will notify the user of the potentially unsafe posture

The second phase will be the production phase in which some more complex and advanced features are added to the *Equilibra* for better performance and usability. Such features are summarized below:

1. Central unit and vibrators are connected and mounted on a belt that is worn by the user
2. A more efficient power delivery system
3. The use of some wireless technology enabling wireless communication between the Central Unit and the vibrators and earphones
4. Implementation of a 3D surround sound system for a more intuitive position notification scheme

The completion of the first phase of the development of *Equilibra* is scheduled to be April 2006.

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1. INTRODUCTION

The *Equilibra* is an iPod like device that is attached to the belt and would inform an individual when (s)he is assuming a potentially dangerous posture. This notification is possible through the use of both sensory and audio signals that are generated by the system. The user will be able to sense and hear their current state of posture in case of an inclination in any direction via earphones and vibrators that are attached to the belt. The auditory signal varies in tone depending on the user's direction and level of inclination. With the help of *Equilibra*, the person corrects his/her posture, thus preventing a potential hazardous fall. The development of *Equilibra* will take place in two phases. The first phase will consist of the completion of a proof of concept device aimed to be achieved by April 2006. The second phase will finalize the development of a more advanced design more suitable for commercial production.

1.1 Scope

The scope of this document encompasses the requirements and parameters that have to be met by a functioning *Equilibra* device. These requirements are outlined for both the proof of concept and production phases as predicted to be applicable at this time. Requirements of the production phase may change as the design process progresses and potential problems are encountered.

1.2 Intended Audience

The functional specification is intended for use by our team members in developing different aspects of the device. The CEO will use the requirements as a reference to ensure compliance. VP Technical will enlist the help of this document to verify and adhere to desired functional goals.

The CFO and VP Business Planning and Strategy will use this document for advertising and promoting the product as well as setting a competitive market price. The content of this document can also be used in preparing a user manual.

1.3 Objectives

The following convention is used throughout this document to denote functional requirements:

[R#] A functional requirement [n]

To denote the priority of each functional requirement, and a number n that will take one of the following numbers to distinguish between those requirements specific to concept device and those for the production device:

- [i]** A functional requirement for both the prototype device and the production device.
- [ii]** A functional requirement for only the proof of concept (prototype) device.
- [iii]** A functional requirement for only the production device.

2. SYSTEM REQUIREMENTS

2.1 System Overview

Equilibra, a Sensory Balance Assistance Device, comprises of the Central Unit and vibrators attached to the belt along with earphones. Figure 1 below shows an example of the application of *Equilibra*, in preventing a potential fall due to loss of balance. Different components of the device along with their location are also illustrated.

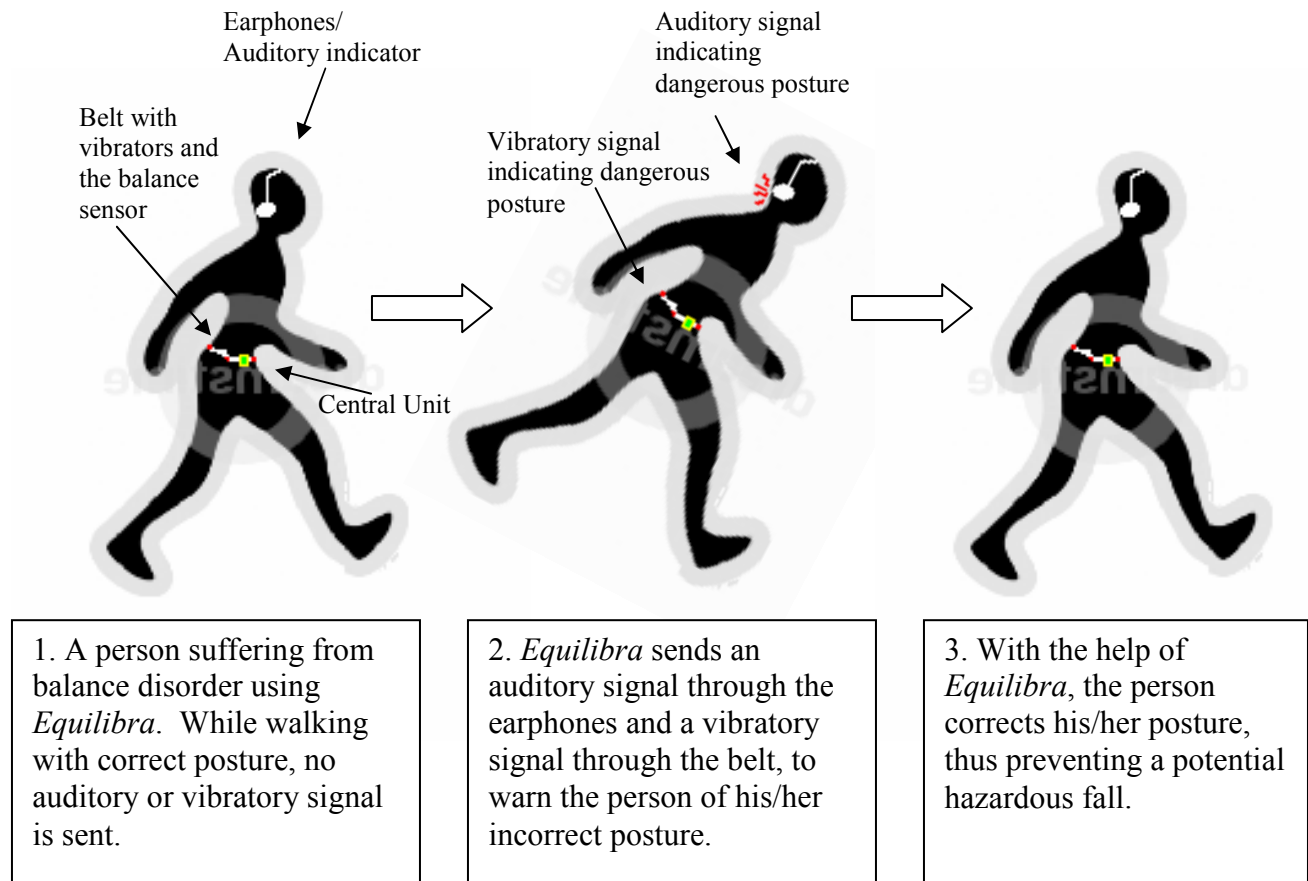


Figure 1: Overview of *Equilibra*

2.2 General Requirements

- [R1] *Equilibra* consists of a belt with vibrators, a Central Unit and headphone. The Central Unit and vibrators are integrated to the belt such that the user can easily put on and take off the belt without dislocating any components. [i]
- [R2] The Central Unit of *Equilibra* will be the size of a belt buckle. [iii]
- [R3] *Equilibra* shall not weigh over 75 grams. This includes the weight of the Central Unit, headphones, and the vibrators. [iii]
- [R4] The geometry of the Central Unit of *Equilibra* will provide the user with maximum flexibility in that it will not interfere with the daily activities of the user. [iii]
- [R5] The unit's heat dissipation shall be such that the exterior of the unit will not be more than 30°C. [iii]
- [R6] The case of the Central Unit will be well insulated and waterproof. [iii]
- [R7] The materials used in the box will be durable in that it will withstand the force of impact, and flexible in that it will not cause injury or discomfort to the user. [iii]

2.2.1 Environmental Requirements

- [R8] The unit will operate in temperatures ranging from -40°C to +125°C. [iii]
- [R9] *Equilibra* will be operational in 0% - 100% humidity and pressures ranging from 259.5 mmHg to about 900 mmHg. [iii]

2.3 Performance Requirements

2.3.1 Accuracy Requirements

- [R10] The detection of motion with this system will be sufficient in providing information to correctly analyze user's position. [i]
- [R11] The 3D auditory signalling will indicate the exact direction of inclination by employing advanced features of surround sound technology. [iii]
- [R12] The relative accuracy of the angle of inclination measurements is within ± 0.5 degrees. [i]

[R13] The reaction time between a physical user inclination and the generation of a notification signal will be small enough to invoke corrective balancing motion by the user as the inclination is occurring. [i]

2.4 Reliability and Serviceability Requirements

[R14] The fully charged system must be able to operate without failing for at least 3 days. [iii]

[R15] The system must be able to recover from failure by cycling the power. [i]

[R16] The battery must be able to be recharged at least 1000 number of times. [iii]

[R17] The buttons located on the Central Unit must have a duty cycle of at least 1,000,000. [i]

[R18] The signal noise generated by the vibrators of *Equilibra* will not interfere with the auditory signals. [i]

2.5 Component Requirements

2.5.1 Central Unit

[R19] The system must be able to store the data related to the user's position on an external memory card. [i]

[R20] This data will be analyzed by special software to for studying the level of balance disorder being experienced by an individual. [iii]

2.5.2 Belt with vibrators

[R21] The vibrators will be mounted on the front, back, left and right sides of the belt to provide signaling in the direction of inclination. [i]

[R22] The vibrators are connected to the Central Unit via wires inserted into the belt. Future improvements will implement a wireless connection. [ii]

[R23] The user will be able to adjust the level of vibratory signal. There will be different levels of vibration from Mute (Minimum) to Maximum. [iii]

2.5.3 Auditory Signal

- [R24] The production device will employ a 3-dimensional surround sound system that will produce a tone simulation generated from the direction of inclination, thereby enabling users to distinctly identify the direction in which they are leaning. [iii]
- [R25] Behind-the-ear attaching ear phones will ensure that the earphones remain in place at all times. [i]
- [R26] The earphones are connected to the Central Unit. [i]
- [R27] The intensity of the audio signal produced is within an appropriate range to avoid damage to the ear. [i]
- [R28] The intensity of the audio signal will vary corresponding to the degree of inclination from the upright position; the larger degree of inclination, the more intensity of audio signal will be. [i]
- [R29] The mono-tone audio signal generated in each of the right and left earphones will be indicative of the direction of inclination either to the right or left respectively. Also, inclination to the front will result in a lower pitch tone and an inclination to the back will produce a higher pitch tone [ii]

2.6 Power Management

- [R30] Rechargeable battery pack will be used to ensure longer lasting and reliable power supply for the system. [iii]
- [R31] For added convenience, *Equilibra* will include a car charger and power adapter interface. [iii]
- [R32] The prototype is powered by an external power source [ii]
- [R33] Auto sleep/awake mode feature of the system will allow low power consumption. [i]

2.7 User Interface

- [R34] Power button and volume scroll will be designed on the Central Unit such that it will not be activated accidentally. [iii]
- [R35] The power on/off status is shown on the Central Unit by an indicator. [i]
- [R36] The battery status is shown on the Central Unit by a color indicator. [iii]
- [R37] There will be buttons on the Central Unit enabling the users to choose between auditory signal, vibratory signal and both. [iii]

3 DOCUMENTATION AND USER TRAINING

Equilibra's market targets a very wide range of population of all ages, guilds, and abilities. *Equilibra* will be as user friendly as possible, and will not need expertise or extensive training to operate.

- [R38] All the documentation provided in junction with the device shall be clear and free of ambiguity. Use of Jargons in the documentation will be minimal.
- [R39] Documentation for the production version of the device will consists of a user manual in English. [iii]
- [R40] There will be also electronic version of the user manuals available on the website in English, French, Spanish, Mandarin, and Japanese. [iii]
- [R41] The language used in the user manual will be appropriate for an audience that has limited knowledge of and experience with electronic devices. [iii]
- [R42] The user manual will cover functional features as well as operational conditions. It will, in addition, include a troubleshooting and safety section. [iii]
- [R43] *Equilibra* will be user-friendly. The training required for using this device will be minimal. [iii]
- [R44] Users of the prototype will be instructed by the project team members. [ii]

4 REGULATORY REQUIREMENTS

[R45] *Equilibra*, as a biomedical assistance device, will meet all related standards laid out by Canadian Standard Association (CSA) and Underwriters Laboratories Inc. A list of these standards and regulation is presented in the following table. The list is not exclusive. [iii]

Table 1: List of Related Standards for *Equilibra*

Source	Standard	Title
UL	94	Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL	969	Standard for Marking and Labeling Systems
UL	248	Low-Voltage Fuses
UL	813	Standard for Commercial Audio Equipment
UL	1439	Standard for Tests for Sharpness of Edges on Equipment
UL	1492	Audio-Video Products and Accessories
CSA	C22.2 NO. 60065-03	Audio, Video and Similar Electronic Apparatus – Safety Requirements
CSA	C108.1.1-1977 (R2003):	Electromagnetic Interference Measuring Instrument
CAN/CSA	C22.2 NO. 61010-1-04	Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use - Part 1: General Requirements (Adopted IEC 61010-1:2001, MOD) (Tri-National standard, with UL 61010-1 and ISA 82.02.01)

[R46] *Equilibra* will also meet all other CSA and the U.S. Federal Communication Commission (FCC) safety requirements and regulations pertaining to electromagnetic radiations.[iii]

5 CONCLUSION

The Functional Specification outlines, as elaborately as possible, the requirements and parameters that are to be met in an *Equilibra* unit device. The requirements were classified based on whether they will be implemented in the prototype device or in the production device. The device meeting the requirements denoted by [i] and/or [ii] will be completed by April 5, 2006. Parameters indicated by [iii] shall be implemented in the future developments of *Equilibra*.

6 REFERENCE

1. The American Institute of Balance, accessed 5 February, 2006 <www.dizzy.com>
2. Analog Device, *ADIS16201 - Programmable Dual Axis Inclinator / Accelerometer*, accessed 18 February, 2006 <<http://www.analog.com/en/prod/0,2877,ADIS16201,00.html>>
3. Canadian Standard Association, *Canadian Electrical Code*, accessed 18 February 2006 <<http://www.csa-intl.org/onlinestore/GetCatalogDrillDown.asp?Parent=3654>>
4. Underwriters Laboratories Inc., *UL Standards*, accessed 18 February 2006 <<http://www.comm-2000.com/catalog.aspx?sendingPageType=BigBrowser&CatalogID=Standards>>