February 15, 2009

Patrick Leung
School of Engineering Science
Simon Fraser University
Burnaby, British Columbia
V5A 1S6

Re: ENSC 440 –StandStation System Functional Specification

Dear Mr. Leung:

The following document, StandStation System Functional Specification, gives an overview of features that will be included upon the completion of our ENSC 440 (Capstone Engineering Science Project) project. Our project's objective is to help those with limited use of their body by providing a way for them to stand up. The ability to stand up will ease the discomfort that comes from sitting on a wheelchair for an extended period of time, and also it will provide a way for a disabled person to use the standing urinal. An additional feature we are considering to include is a convenient way to transport the person in and out of a wheelchair.

Through interviews with Dr. Peter Borwein and a physiotherapist working at GF Strong Rehabilitation Center, along with our own research, we were able to come up with set of requirements that our StandStation System must satisfy. The purpose of this document is to outlines the requirement of our project, and to ensure our StandStation System is designed to fulfill the needs of its users.

New Step Innovations consists of four motivated and talented fifth-year Engineering Science students: Wayne Chan, Gavin Wu, Edward Chan, and Kyuho Cha. We each come from different fields of engineering to provide a diverse expertise, and to bring different insight on to the table. We are committed to our project and will work diligently to accomplish our goals. We will be happy to answer any questions you might have concerning our Functional Specification. I can be reached by phone at 778-241-0709 or by email at wyc3@sfu.ca.

Sincerely,

Wayne Chan
President and CEO
New Step Innovations

Enclosure: StandStation System Functional Specification

StandStation System Functional Spec

Project Team:

Wayne Chen
Gavin Wu
Kyuho Cha
Edward Chan

Contact:

wyc3@sfu.ca

Submitted To:

Patrick Leung
Steve Whitmore
School of Engineering Science
Simon Fraser University

Date:

February 15, 2009

Version:

1.0

Executive Summary

For the disabled, being bounded to a wheelchair means many different inconveniences and challenges. The ability to stand being a major challenge to all wheelchair users. NewStep Innovations believes that with the StandStation, we will be able to overcome this major challenge posed. A prototype model of the StandStation model will be built to demonstrate and facilitate the proposed solution. The prototype model is scheduled for completion on April 2009 and will contain the main features:

- StandStation will allow a secure assistive method to stand upright. When in the upright position, it will allow users to use standing urinals, and place pressure on the legs.
- StandStation consists of an array of controls to enable and disable different functions.
- StandStation will provide functionality comparable to competitive products at a fraction of a cost.

A detailed discussion of the functional specification will be thoroughly discussed in this document.

Table of Contents

1. Introduction

StandStation offers wheelchair users the ability to stand up with a simple click. With the use of a mini electric car-jack combining with a well designed chair frame, *StandStation* is able to provide a safe and swift motion that elevates user to a comfortable standing position. Prolonged sitting can cause insufficient blood circulation to the lower body, causing muscle sore and tissue damage. *StandStation* can reduce the risk of muscle sore and tissue damage by assisting the user to stand up, just like a "Standar", which is a huge standing machines used by patients in GF strong rehabilitation center.

StandStation, over the long term, provides users with effective pressure relief and blood circulation to the lower body. More over, the ability to stand up will further improve users' quality of life in terms of the ability to reach objects and for men, the ability to urinate with ease. Figure 1.1 illustrates some of the potential benefits from using *StandStation*.

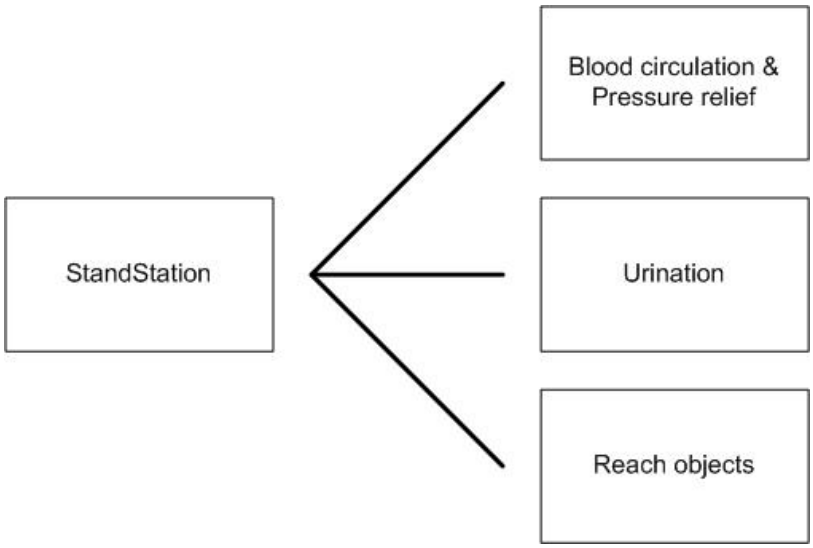

Fig1.1 StandStation's functions

StandStation is a simple add-on to a standard electric wheelchair base; those with the standard base can easily upgrade to a standing wheelchair without the need to spend 20-30 thousand dollars. *StandStation* focuses on using simple design instead of complex integrated design we see on the standing wheelchairs on the market, which yields less cost for the consumer and manufacturer.

The development of *StandStation* is separated into two stages; the proof of concept stage and production model stage. Proof of concept stage will stretch from January 10th until the completion of the project prototype on April 6th. Production model stage will start upon the completion of the proof of concept stage.

1.1 Scope

This document describes the functional requirements *StandStation* must satisfy. Safety, functionality, and other requirements listed all came from meetings with Dr. Peter Borwein (Wheelchair user), Patrick Leung (Senior lecturer), and Ian from GF strong rehabilitation center. The functional specifications listed in this document describe the proof of concept model and also provide a guideline for production model, which will later be modified according to the market demands and customer feedbacks.

1.2 Intended audience

This functional specification is intended for use by New Step Innovations members. This document shall serve as a guideline for the development of *StandStation*. Members who use this document include designers, engineers, testers, and project manager within New Step Innovations.

1.3 Classification

The following convention will be used to classify functional requirements:

[Rn-x] A functional requirement

Where **n** is the functional requirement number and **x** is the applicable development cycle.

The development cycle index:

I: Requirement for proof of concept
II: Requirement for production model

[TPm-z] A test plan

Where **m** is the test plan number and **z** is the applicable development cycle (I, II, or III).

2. System Overview

Since our system is meant to fit the needs of people with many different body types we will provide two different options for standing process. First option will be fully automated and will straighten the wheelchair fully with a push of a button. For the second option we will provide the user with the maximum control over the standing process, this will allow the user to select a position that provides most comfort for them. To fulfill the above requirements we will need to take input from the user and the position of the chair to safely change the orientation of the wheelchair to the desired position. Figure 2.1 outlines how the system will operate.

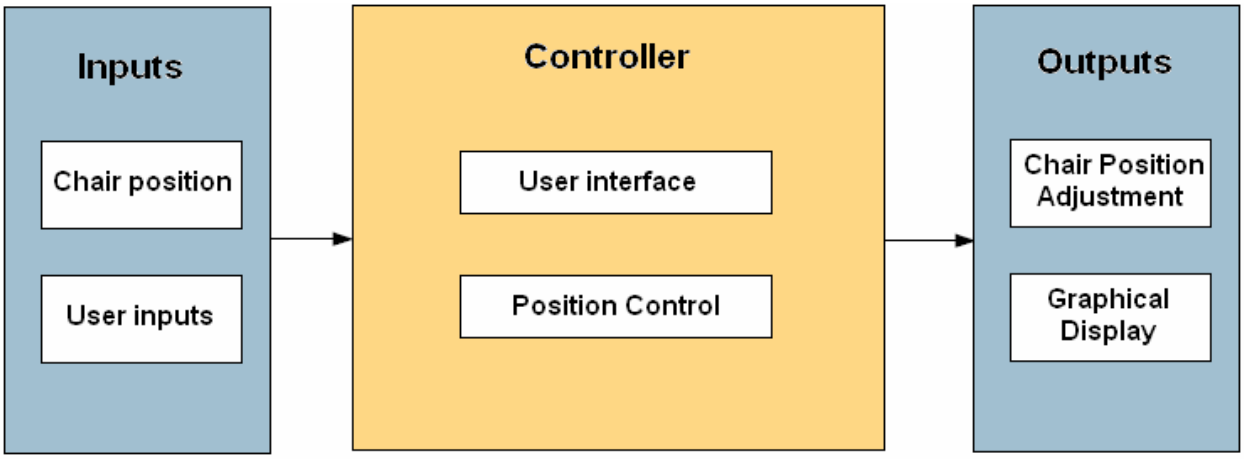

Fig 2.1

To ensure our wheelchair is capable of dealing with any combination of the user input, we carefully studied all the possible combination of user input and decided their appropriate outcome for each case. Figure x.x illustrates flow diagram of StandStation System.

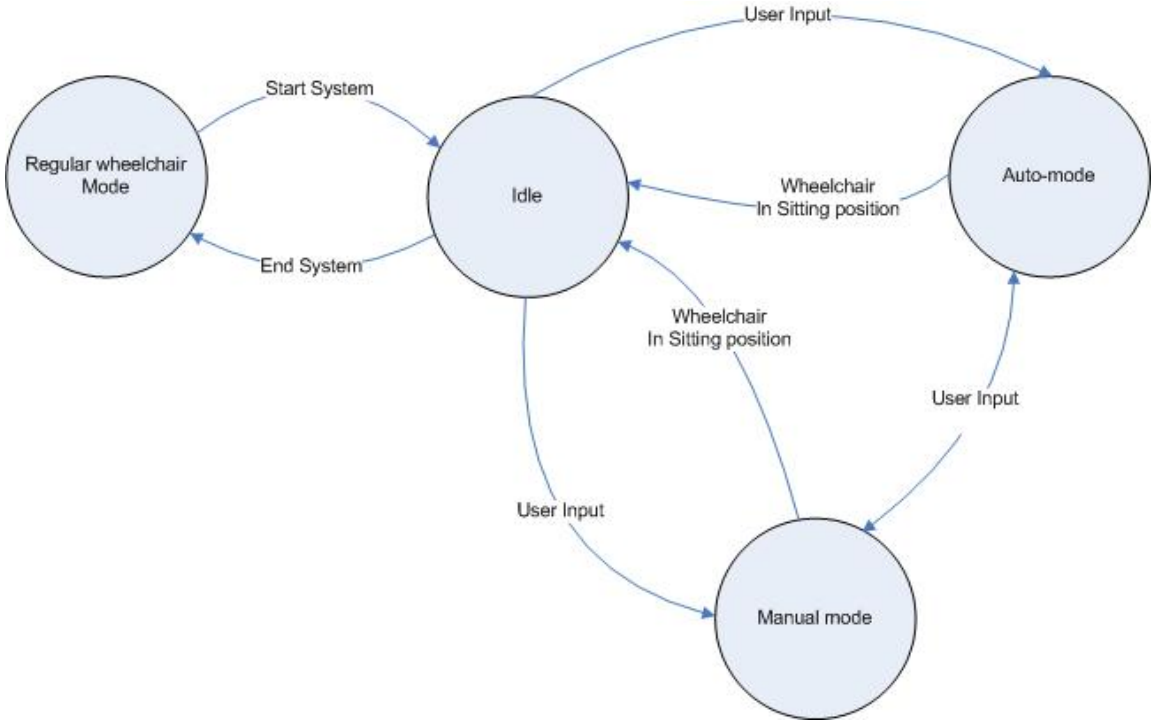

Fig: 2.2

Because we place great importance on the safety of the user we limit the use of our system during when the wheelchair is in motion. The only way for the user to get back to wheelchair mode is by bending the wheelchair in the sitting position. Also, we allow the user to switch between Auto-mode and Manual mode with ease to prevent the chair from causing any discomfort when it is on the Auto-mode.

3. System Requirements

3.1 Mechanical

[R1-I] The structure and added components should not weight more than 15kg.
[R2-I] The structure will not interfere with the basic functions of a wheelchair
[R3-II] The mechanical components should be easy to replace and maintenance.
[R4-II] The materials for the structure will have enough fatigue strength to undergo 3000 load cycles.
[R5-I] The materials for the structure will have a high yield strength that supports a 150kg patient.
[R6-II] The system will be reliable from -10 to 45 degrees Celsius
[R7-I] The mechanical components will not be physically obtrusive.

3.2 Electrical

[R8-I] The system will share the same power supply as the wheelchair
[R9-II] The electrical components will be reliable from -10 to 45 degrees Celsius.
[R10-I] The power consumption will be kept at minimum when the system is in idle.

3.3 Safety

[R11-I] The system will follow the requirements for wheelchair seating listed in ISO 16840-3:2006, wheelchair tie-down, and occupant-restraint system in ISO 10542-2:2001
[R12-I] The failures of electrical components will not endanger the user.
[R13-II] Warning to possible failures of system components will be given prior to the operation of the system.
[R14-I] The system will not cause bodily harm to the user during the operation.
[R15-II] The system will not respond to improper use (System will not respond if safety harnesses are not worn).
[R16-II] The system will give warnings and will not respond upon detecting insufficient power supply.
[R17-II] The system will disable the regular wheelchair functions (moving forward/backward) during the sitting-to-standing (STS) transition.

3.4 User

[R18-I] The system will not cause any discomfort when it is inactive.
[R19-I] The system will respond to the user input immediately.
[R20-I] The user shall be able to halt/resume the system during the transition phase.
[R21-I] The user will be able to manually control the STS transition.
[R22-I] The operation of the system will be intuitive and easy to learn.
[R23-II] The system will display relevant information to the user via the graphical user interface.

3.5 Operation

Figure 3.1 shows the chair movement during STS transition.

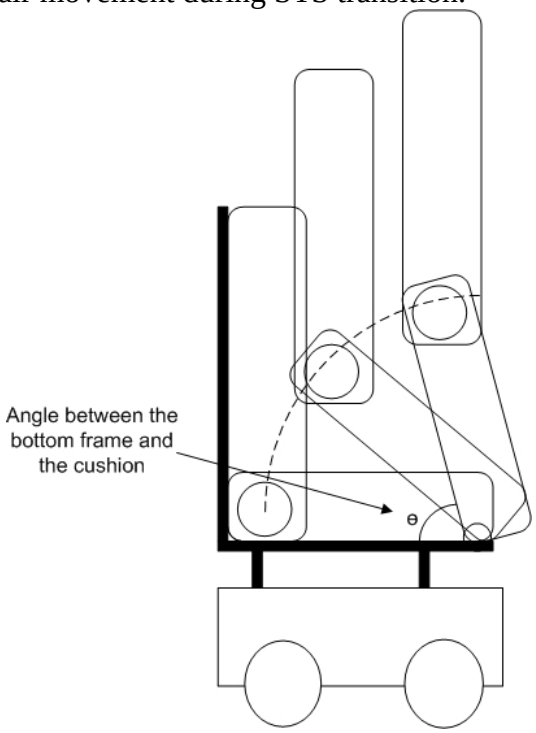

Fig 3.1

[R24-I] The STS transition will not take longer than 15 seconds.
[R25-I] The system will monitor the angle Θ (Refer to figure 3.5.1) during the operation.
[R26-I] The speed of the movement will not cause discomfort to the user.

3.6 Cost

[R27-II] The overall cost for adding the system will be less than $3000

3.7 Environmental

[R28-I] The system should be silent when idling.
[R29-II] Noise produced during operation will be minimized and below 50dB.
[R30-I] The system will operate on a rechargeable power source.
[R31-I] All components will be “Restriction of Hazardous Substances” compliant.

4. Test plan

Mechanical

[TP1-II] Test the mechanical structure of the chair with a body weight of 100-200kg for large number of cycles, and then look for visible or micro fractures.
[TP2-I] Test the strength of the safety harness.
[TP3-II] Test the fatigue strength of the mechanical power source (Electric car-jack).

Electronics components
[TP4-I] Test the robustness of the coding on the board.
[TP5-II] Test the board under extreme conditions (High/low temperature).
[TP6-I] Test the response time of the electronics.
[TP7-I] Test the integration of the micro-controller and sensor.

System performance
[TP8-I] Test the trajectory of the major joints according to our design.
[TP9-I] Test the power efficiency of the added system.
[TP10-I] Test the consistency of the transition time (Time from sitting to standing).
[TP11-I] Test the robustness of the overall system.

5. Conclusion

For the functional requirements explained in this document, the StandStation system have been discussed thoroughly with industry professionals and future interested users. The set of specification will be organized and developed with safety in mind and following all major standards.

New Step Innovations final goal will be to provide a user friendly product that offers the disabled to stand and benefit from the position. For those forced to sit in a wheelchair for prolonged periods of time, this change of position will allow a whole new realm of mobility and ease. A prototype of the product will be available by April 2009 with requirements labeled [RN-I]. All requirements composed in this document will be demonstrated upon successful completion of our prototype model.

6. References

[1]
http://publib.upol.cz/~obd/fulltext/Gymnica33-1/gymnica8.pdf

[2]
http://www.thestandingcompany.com/benefits/index.php