Re: ENSC 440 - Project Proposal for a Wheelchair Stability and Pressure Relief System

Dear Mr. Leung:

The enclosed document, *Proposal for a Wheelchair Stability and Pressure Relief System*, outlines our project for ENSC440 (Capstone Engineering Science Project). The goal of our team is to design a system that has the ability to move the body sideways and out of danger in a tipping situation and provides substantial and effective controlled pressure relief for disabled people with limited upper body movement ability.

This proposal will provide an overall view of our product. It includes information regarding the design consideration, possible solutions and their weaknesses, our sources of information and funding, a tentative project budget, project schedule, and description of the company and its members.

Safe Sense Technologies consists of three highly motivated, innovative and hard working fifth-year engineering science students: Jamie Westell, Arash Jamalian, and Shadi Agha Kazem Shirazi. We are extremely passionate about our proposed design and willing to work as hard as we can to achieve our goals. Please feel free to contact me with any questions or concerns regarding our project proposal. I can be contacted by phone at (778)889-2310 or by email at saghakaz@sfu.ca. Our team can also be contacted via email at ensc440-spring08-safesense@sfu.ca.

Sincerely,

Shadi A.K Shirazi  
President and CEO  
Safe Sense Technologies
PROPOSAL FOR A WHEELCHAIR STABILITY AND PRESSURE RELIEF SYSTEM

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Submitted to: Patrick Leung  
Steve Whitmore  
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Date: January 21st, 2008

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EXECUTIVE SUMMARY

Wheelchair bound, inhibited by a totally unresponsive body, Laura is unable to stop the tipping accident caused by a sudden turn and a lurch over the sidewalk curb. Also her body fails to relay to her when excessive pressure results, and horrendous body sores develop. Is Laura doomed to an existence filled with both trepidation and acceptance of an unacceptable reality? Not if she had a system like Equipoise.

Equipoise is a self-adjusting system which has the ability to move the inert body sideways and out of danger in a tipping situation. It is common for wheelchair users to be involved in tips and falls. Tipping occurs when navigating over sidewalk curbs, when meeting an immovable obstacle, when the user is reaching awkwardly and when the user suffers from sudden muscle spasms. In any one of these circumstances, the individual is rendered helpless and the accident inevitably follows. Equipoise has the facility to reduce these innate dangers by electronically moving the person in the opposite direction of the tip and in so doing, help prevent the fall.

Equipoise, over the longer term, provides substantial and effective, controlled pressure relief. Pressure relief comes naturally to able bodied individuals. If one were to sit, like William Shakespeare, on a hard school bench for 8 long hours, one would anticipate a squirming and a shifting to move one’s weight and relieve the pressure on the sore buttocks. The disabled person does not feel the sensation of this discomfort, nor the ensuing signal to the brain to shift. Ignorance, in this case, is not bliss, and the development of a pressure sore is the unpleasant and painful consequence. Equipoise can, by moving the helpless individual’s body, very gently, from side to side, help prevent skin break down, as well as keep the skin tissue healthy.

SafeSense Technologies is comprised of three enthusiastic and dedicated engineering science students in their fifth year of studies, whose combined knowledge and expertise has caused them to develop the Equipoise model. They were particularly inspired by the wise advice given them by Ian Dennison, therapist and equipment evaluator at GF Strong Rehabilitation Centre, who indicated that the pressure relief exercises currently in use are not as effective as our proposed Equipoise system.

Equipoise expects the project timeline to extend over a 13-week period, beginning on 9th of January 2008, with April 6th, 2008 as the scheduled completion date for an operational prototype. The entire project is tentatively budgeted at $1,728, and the funding will come from a variety of sources.
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1. INTRODUCTION
Stability and pressure ulcer are two vital issues wheelchair users are dealing with everyday. In 2003, more than 100,000 wheelchair-related injuries were treated in emergency departments in the US. 65-80% of these accidents were due to tips and falls [2]. On the other hand, people who do not have enough upper body strength or can not sense their upper body are not allowed to sit on a wheelchair for more than two or three hours. The reason is that they do not change their sitting posture to relieve the pressure and develop skin sores. To address these issues, we need a system like Equipoise which is able to move the user’s body sideways in a controlled manner.

There have been several attempts to prevent wheelchair tipping automatically such as self-adjusting seats or active suspension systems, but none of these systems have been marketed successfully due to high cost and manufacturing problems. In GF strong, British Columbia’s largest rehabilitation centre, there is not even a single wheelchair with an automated tilt prevention mechanism (Gayton & Dennison, 2008).

In this project our focus will be on the lateral tipping of the wheelchair. Lateral tipping often happens due to sidewalk curbs or user’s spasm attacks. When the wheelchair gets tilted, our self-adjusting system, Equipoise, is able to sense the danger and move the body in the opposite direction to a safer position. Most disabled people do not have enough upper body strength to react and move their body when the wheelchair gets tilted. As a result, the body’s centre of mass can easily go outside the wheelchair footprint and cause instability. In more dangerous situations, the centre of mass of the whole system (person’s body and the wheelchair) goes outside of the wheelchair footprint and causes the person to fall out of the wheelchair.

Our project will also have vital therapeutic benefits. Equipoise has the ability to move the body sideways in slow fashion overtime for pressure relief. Right now, there is no effective mechanism available to do effective pressure relief. The physiotherapists teach users to lift one side of the body for a short amount of time, but this method is not effective and sometimes has the opposite effect due to sudden blood flow to areas under pressure (Gayton & Dennison, 2008). Also using the tilt recline system for pressure relief has a lot of disadvantages such as raising the level of chair from ground, consuming more power, and discomfort for users. Due to ability of Equipoise to change body’s sitting postures, it is also very useful for people with postural disorder (bended spine), and for people who have trouble swallowing in certain postures.

This proposal describes the overall system design, potential design solutions, and the sources of information and funding available for the project. It also includes a timeline for various stages of the project.

2. SYSTEM OVERVIEW
In the design of Equipoise, the safety and comfort of the user is of great importance. When the wheelchair is on a flat surface, the system does not impose any restrictions to the user. When the wheelchair is travelling over an unlevel surface however, the system will engage if a certain level of danger is present. Figure 1 shows an example of a typical sidewalk corner where a wheelchair must travel over several portions of uneven pavement.
In situations when the wheelchair gets tilted, the system is able to sense the position of the user’s upper body with respect to the wheelchair and the tilt angle of the wheelchair from ground and move the body sideways to a safer position to avoid the center of mass to go outside of the wheelchair footprint. Figure 2 shows a typical position of a wheelchair and user during a dangerous tilt situation. The arrow represents the force that our self-adjusting system will impose on the user to move their body to a safer position.

The system has three main components: sensing, control, and actuation. The following block diagram illustrates the overall structure.
In addition, *Equipoise* can be effectively used for pressure relief. When the wheelchair is on flat surface, the actuators move the body in very slow fashion from side to side to relieve pressure on the seat of the person. This results in enhanced blood flow and a greater level of comfort. The following block diagram illustrates the algorithm of the system in the pressure relief mode.
3. POSSIBLE DESIGN SOLUTIONS

A balance between effectiveness, unobtrusiveness, and safety is crucial in developing a product that the user is willing to accept. In order to determine when the user of the wheelchair is in danger, two pieces of information must be gathered: the lateral tilt angle of the wheelchair and the position of the center of gravity of the user. The tilt angle information may be gathered by an inclinometer. This device outputs the angle of lateral inclination of the wheelchair to a microcontroller for processing. The position of the user’s body relative to the chair (and hence the center of gravity) is much more difficult to obtain. Three possible solutions for gathering this crucial piece of information are discussed below along with actuation solutions for correcting the body position accordingly.

3.1 SEAT ACTUATION BASED ON TILT AND FORCE DISTRIBUTION ON SEAT

The position of the upper body may be estimated from the force distribution on the seat. For instance, if the user is applying more force to the right side of the seat than to the left side, a reasonable estimate can be made that the user is leaning to the right. Based on the complete force distribution and calibration techniques that would provide information of extreme left and extreme right positions, the position of the center of gravity of the user can be estimated.

When the tilt angle of the wheelchair is at a critical falling value based on the tilt sensor output and the seat pressure distribution, the body position could be corrected by actuating motors under the seat that
would tilt the seat away from the fall so to keep the user as vertical as possible. Hydraulics strong enough with a fast response time is required for the implementation of this design.

Some of the key issues with this design deal with the cost of the solution, the processing power required, and the safety of the user. In order to obtain the force distribution of the seat, an array of pressure sensors would be needed. Currently these arrays are custom made for specialty applications and cost several thousands of dollars. Also, the processing of the outputs of these arrays is similar to image processing in the way that they both output a proportional value for each sensor (similar to how a grayscale image outputs a brightness value for each pixel). Processing this output in real-time at a fast enough sampling rate that would provide a fast enough reaction to avoid danger is very costly in resources and price of components. Lastly, we believe that a shift in the seat attitude in response to the dangerous situation may not be effective enough to avoid the danger in the case that the wheelchair does tip. Also, in this design solution the user’s comfort level may be reduced knowing that the seat may shift rapidly in response to a tilt in the road or a bump on the sidewalk.

3.2 Chair Actuation Based on Tilt and Force Interpolation on the Seat

Improving on the pitfalls of the first design solution, this solution works to correct the problems with the first. To reduce the processing speed and cost of the body sensing apparatus, a less dense array of force sensors may be placed under the seat and an estimate of the body position may be made based on an interpolation of the force sensors’ response. One possible arrangement would be to have four force sensors located near each corner of the seat. Based on the position of the body, some sensors will respond with a greater output while others will have a lesser output. Based on the four outputs, a location may be interpolated. This solution to body sensing is much less expensive both in terms of dollars and cents as well as processing power.

An alternative solution to adjusting the body of the user would be to control hydraulics located in the wheel base or suspension of the entire chair. For instance, if a critical fall value is reached based on the tilt sensor and the interpolated body position, the hydraulic actuators on one side of the wheelchair may extend to place the entire wheelchair in a more vertical position. Much stronger hydraulics capable of lifting the combined mass of the user plus chair would be required for this implementation.

Again, with this solution we find significant drawbacks and safety concerns. The method for estimating the position of the center of gravity of the user is not accurate enough to base such critical actuation decisions on. Two possibly significant errors are introduced during this calculation. First, the interpolation of the maximum force location based on the response of the four force sensors introduces some interpolation error from the sensors and material used to mount the sensors. Second, the estimation of center of gravity based on the maximum force location introduces error due to the body type of the user. The compounding of these two errors may be too great for this implementation to be effective. Regarding the actuation of the chair instead of the seat, we would require very strong hydraulic actuators as mentioned above. Although these actuators exist in industrial applications, they are very expensive. More importantly, implementing hydraulic actuators such as these would require a great amount of mass to be adjusted at a very high speed. This results in a significant amount of momentum from the chair and user. Considering the user’s safety and comfort level, this may not be the most appealing solution for the user.

3.3 Body Movement Based on Tilt and Body Positioning

A more accurate method of sensing which position the upper body is in with respect to the wheelchair is to place the sensing device higher up on the body. Instead of an estimation based on the pressure
profile in the seat, this design places an apparatus on the outside of the user’s shoulders which is free to move with the movement of the user. The position of the apparatus provides a measurement of the position of the body. A possible design of this apparatus would have a revolute joint on the back of the chair with a link rising vertical above the back of the chair and extending to either side of the user’s shoulders.

Based on the tilt angle provided by the tilt sensor and the position information from the apparatus discussed above, an actuator is connected to this same apparatus which is used to move the user left or right away from the danger. For instance, if the user is leaning to the right, the apparatus moves with the user to the right and so the body position is sensed. When the tilt angle reaches a critical fall value, the apparatus would then move to the left, away from danger, while moving the body with it.

The drawback of this design is that it requires a large apparatus to be attached to the wheelchair. One of the concerns of wheelchair users is the accessibility of facilities. Because of this, wheelchairs are made as small as possible so as to fit in to as many doors, hallways, etc. as possible. Connecting this apparatus to the wheelchair would increase the silhouette of the wheelchair which may be undesirable to the user. Additionally, the user may feel restrained with the apparatus contacting their shoulders at all times. A less obtrusive device would be more desirable.

4. PROPOSED DESIGN SOLUTION

Taking in to account the advantages and disadvantages of each of the possible design solutions, SafeSense Technologies has arrived at a safe, effective, and unobtrusive solution which we call *Equipoise*.

In order to sense the position of the upper body most accurately, an adjustable and comfortable band is placed around the chest of the user. Attached to this band is a very thin but very strong rope on either side. These ropes are connected to retractable rope sensors at the back and to either side of the wheelchair which sense how much rope is retracted on each side. With this information, a precise value may be resolved for the location of the upper body.

When a dangerous situation is sensed based on the tilt angle of the wheelchair along with the body position of the user, actuators mounted on the retractable rope sensors would retract the rope on the side of the user that is away from the danger. As a result, the pulling force in the rope is transmitted to the user’s body which in turn is pulled away from the dangerous position.

This design is the least obtrusive and most effective at moving the user away from danger. If the user is in a situation where there is no danger of tipping (i.e. stationary, travelling slowly, etc.) they can simply take off their safety band around their chest. In cases of increased danger (i.e. moving fast, uneven ground, travelling near curbs, etc.) the user may put on the band for an increased sense of safety. This sense of safety comes from knowing that if the user does happen to tip, or come close to tipping, this system will pull them away from the fall, keeping them in a more vertical position.

The natural reaction of able-bodied people is to keep the upper body in a vertical position. When someone with considerable core strength feels that the chair they are sitting in is tipping right, for instance, they will flex their left core muscles to pull their body to the left in order to counter the fall. Disabled users, who commonly have reduced core strength, would not be able to correct their body position well enough or fast enough. *Equipoise* mimics the core muscles of the able-bodied person by reactively pulling the body away from danger in a safe, effective, and unobtrusive manner.
With this proposed design solution, we are also able to incorporate a pressure relief system which is in high demand by wheelchair users. With the rope actuation system on either side of the user, an optional pressure relief setting may be selected on the user interface which slowly adjusts the user’s seat pressure distribution from side to side. Based on research in the field of wheelchair seating we will use an optimized algorithm which increases and decreases pulling force on alternate sides of the user over a long period of time. The benefits of this feature enhance blood flow to the areas of the user’s backside which are in contact with the seat. *Equipoise* provides a reduced risk of developing pressure ulcers and an increased comfort level for the user over time.

5. Sources of Information

Our goal in this project is to find a practical solution to better the lives of disabled people. This requires counseling and feedback from faculty members, physiotherapists, and the wheelchair users. Every key decision in the design process has to take into consideration the engineering, therapeutic, and user perspective.

To truly understand the issues which disabled people are dealing with, we managed to find several contacts in GF strong rehabilitation centre (GFS). Ian Dennison, physiotherapist and equipment evaluator, will be our main source for the therapeutic counseling in this project. In our meeting on Thursday Jan 17th, he brought a pressure relief mat and showed us the pressure distribution when you move the upper body sideways. It was quite amazing to watch how effective this method is for pressure relief. He thinks that our project has crucial applications for people who have limited upper body strength or no sense in their upper body. In addition, we contacted Walt Lawrence, spine peer mentor, who has been parallelized in a diving accident around 30 years ago. He has some upper body movement but is not able to get help from his hands and uses a sip-n-puff system to drive its powered wheelchair. He is willing to get us some user feedback through different stages of the project. We have also planned to participate in GF strong Solutions event which is an annual assistive device and health technologies design exposition. This year’s event will be held on April 17th. Doug Gayton, assistive technology practitioner, is available to review our design for this event.

For this project, our most valuable source will be Dr. Andrew Rawicz in the school of engineering science. His knowledge and expertise in biomedical engineering will be our best resource for decision making and implementation of the design. In addition, to get the required background knowledge about wheelchair stability and pressure relief, we have found several online journals and articles in SFU library data base. These articles will help us view the problem from different angles and choose a practical solution in different stages of the project. In addition, to become familiar with latest technologies and developments in industry, Doug Gayton is willing to introduce us to some of the wheelchair companies which might have interest in our project.
6. BUDGET & FUNDING

Table 1 is an approximate budget for the research and development of the Wheelchair stability and pressure relief system. As we are currently engaging in the design stages, the amount of budget may vary as the development progresses. Consequently, and estimated of 15% contingency fund has been considered for unexpected expenses.

<table>
<thead>
<tr>
<th>ITEM</th>
<th>Estimated Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microcontroller</td>
<td>$38</td>
</tr>
<tr>
<td>Ropes</td>
<td>$50</td>
</tr>
<tr>
<td>Actuators</td>
<td>$600</td>
</tr>
<tr>
<td>Inclinometer sensor</td>
<td>$65</td>
</tr>
<tr>
<td>Mechanical Parts</td>
<td>$200</td>
</tr>
<tr>
<td>Linear displacement sensor</td>
<td>$500</td>
</tr>
<tr>
<td>Equipment and Tools</td>
<td>$50</td>
</tr>
<tr>
<td>Miscellaneous (15%)</td>
<td>$225</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$1,728</strong></td>
</tr>
</tbody>
</table>

Funding is an important factor for ensuring successful completion of our project. $50 per group has been allocated by the SFU Engineering Science department. SafeSense Technologies is currently applying for various organizations which provide research funding such as Wighton Engineering Development Fund and Engineering Science Student Endowment Fund (ESSEF). We are also looking into possibility of funding from outside resources such as GF Strong Rehabilitation Centre.

In addition each team member is willing to contribute to cover the difference between the actual budget and granted funds.
7. TIMELINE

The schedule of tasks to be completed over the course of our project is showed in the following tables. Table 2 is a Gantt chart which describes the approximate time frame allocated for each task. Table 3 is a Milestone Chart which depicts dates at which certain items will be completed. We will be following these time schedules to ensure our project will be completed professionally and on time.

**TABLE 2 GANTT CHART**

<table>
<thead>
<tr>
<th>ID</th>
<th>Task Name</th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Research</td>
<td>30</td>
<td>6</td>
<td>E3</td>
<td>70</td>
</tr>
<tr>
<td>2</td>
<td>Proposal</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>3</td>
<td>Functional Specification</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Design Specification</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Assembly of Modules</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Integration/Prototype Testing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Documentation/Website</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Process Report</td>
<td></td>
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</tr>
</tbody>
</table>

**TABLE 3 MILESTONE CHART**

<table>
<thead>
<tr>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
</tr>
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<tbody>
<tr>
<td>21th</td>
<td>4th</td>
<td>17th</td>
<td></td>
</tr>
<tr>
<td>1st Progress Report Completed</td>
<td>Functional specification Completed</td>
<td>Assembly of Modules Completed</td>
<td>Working Prototype Completed</td>
</tr>
<tr>
<td>1st</td>
<td>15th</td>
<td>29th</td>
<td>1st</td>
</tr>
<tr>
<td>Design Specification Completed</td>
<td>Website and Documentation Completed</td>
<td>Final Progress Report Completed</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
8. TEAM ORGANIZATION

SafeSense Technologies consists of four dedicated and creative fifth year engineering students: Arash Jamalian, Jamie Westell, and Shadi A.K Shirazi. Diversity of our backgrounds, interests, and technical experiences will assist us in finding creative and ingenious approaches to the challenges and problems we are facing. A summary of skills and experiences offered by each member is provided in Company Profile section of this document.

Given the scale of the project and the tight deadlines, a great deal of the work will be shared and allotted among team members. To achieve highest efficiency and performance, task assignment will be based on individual’s strengths and weaknesses.

Shadi A.K. Shirazi, President and Chief Executive Officer (CEO), will oversee the overall progress of the project, assess inter-group communication, resolve organizational conflicts, evaluate project performance and ensure that the project flow is heading toward a positive direction.

Arash Jamalian serves double duty as Chief Technology Officer (CTO) and Chief Financial Officer (CFO). As CTO, he will examine the development of the product responsible for the technical operations and solving all issues that may arise. As CFO he will manage the budget and resolve financial issues towards the completion of this project.

Jamie Westell, Chief Design Officer (CDO), is responsible for evaluating the drawbacks of existing design ideas and lead the team to achieve unique and efficient design solutions.

To ensure timely completion of the project, the team has designated a meeting time once every week to discuss the progress of the project and individual tasks. The duration of each meeting will be 30 minutes to 1 hour depending on the agenda. Team members missing during the meeting can access the meeting’s minutes through a Microsoft Groove workspace which is used among the group to share files and post discussion topics. To verify that our project is on the right track and our product confirms with requirement, some meetings will also be held with Dr. Andrew Rawicz, a biomedical professor at SFU engineering science department and Ian Dennison, a physiotherapist at GF Strong Rehabilitation Centre. SafeSense Technologies is confident that the project will be successfully finished on time as the team does not lack the required skills and most importantly, each member has a great interest in the project.
8. TEAM PROFILE

SHADI AGHA KAZEM SHIRAZI (CHIEF EXECUTIVE OFFICER)
Shadi is a fifth year Systems Engineering student at Simon Fraser University with two Co-op work term at Chevron Canada Ltd as an IT Helpdesk and one co-op work term experience at Super Active manufacturing company In Iran as an Instrument engineer assistant. She has technical skills relating to both hardware and software. Previous work experience and course work have exposed her to programming languages such as C++, java, VHDL and Assembly language. She is familiar with the operation of different kinds of sensors, actuators, motors and generators. As a systems engineer student, she has also become familiar with feedback control systems. She enjoys utilizing Computer Aided Design software such as solid works to create various design modules and has experience with manufacturing design CAD designs using rapid prototyping machines. She believes her organizational and communication skills are valuable assets to the company and will lead SafeSense Technologies in achieving all its goals.

ARASH JAMALIAN (CHIEF TECHNOLOGY OFFICER, CHIEF FINANCIAL OFFICER)
Arash is a fifth year Systems Engineering student at Simon Fraser University. He has done three coop terms at Broadcom where he worked as test engineer and software developer. He has experience in C, Tcl, Assembly and Java programming. He also has experience working with analog circuits, sensors, electrical motors, hydraulic and pneumatic actuators, feedback control systems, and microcontrollers. Besides his engineering skills, he has the certificate of Aluminum welding (both Tig and Mig welding) from BCIT. His hands on experience and excellent team work will be helpful assets for SafeSense Technologies.

JAMIE WESTELL (CHIEF DESIGN OFFICER)
Jamie is a fifth year engineering student at Simon Fraser University. He is focused on the Systems stream within the School of Engineering and has a special interest in sensors and actuators. Jamie brings plenty of experience from his previous work term at the Mercedes Technology Centre in Stuttgart, Germany where he designed safety control systems. His experience in design, his well organized approach to problem solving, and his strong motivation are an excellent addition to this team.
9. CONCLUSION

Many experts and scientist are convinced that the human balance system is our true sixth sense. Most people do not give their sense of equilibrium a second thought, but without balance, it is almost impossible either to get around or to live in an independent fashion. SafeSense Technologies is confident that Equipoise can assist wheel chair users who are prone to falling as a result of impaired upper body balance. As well, we believe that Equipoise has the facility to alleviate the development of pressure sores. Equipoise will provide its users a higher degree of comfort and security, and allow incapacitated individuals to engage in their day to day activities with a greater sense of comfort and liberation.

Equipoise requires less power than products currently on the market which are designed on the tilt and interpolation of the chair itself. The latter are large and heavy and require an excessive use of power. Equipoise simply moves the body rather than the chair and therefore does not consume as much electricity as its rival designs. The Equipoise apparatus is much smaller and lighter than any other present design; as a consequence, Equipoise has proven to be far more cost effective for both the manufacturer and the consumer. SafeSense Technologies believe that Equipoise is a truly revolutionary device which will dramatically change the lives of all wheelchair users.

We are committed to the production of Equipoise by our scheduled date, April 6th, 2008. We are excited to watch the development of in product in which we all completely believe. Equipoise is a major break through in the lives of all those people who are forced to spend their days in a wheelchair and we anticipate that Equipoise will make a significant difference in the lives of people who endure limited mobility.
10. REFERENCES


