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January 18, 2010

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

Re: ENSC 440 Project Proposal for Rolada , Rollator with Controlled Braking System

Dear Dr. Rawicz:

The attached document, *Proposal for Rolada, Rollator with Controlled Braking System*, outlines our project for ENSC 440 (Engineering Science Project). Our objective is to design and build a rollator which produces controlled variable braking resistance on the wheels when going down a steep slope to provide the user with a stable support, reducing stress on the knees. The design also attempts to address issues such as difficulty opening doors and the conflict of space of the seat with the users' legs while walking through a new frame construction. Furthermore, safety features such as obstacle sensing as well as nighttime visibility augmentation are equipped.

This proposal presents a summary of the aforementioned product, an overview of the design analysis, an estimated budget breakdown, and an expected project timeline. An assessment of the market potential of the product by investigating similar alternative products is also presented.

Xotro is composed of five enthusiastic, creative and resourceful Engineering students: Henry Kam, Jeff Ip, Nathaniel Seung, Chuck Lee and Benjamin Chen. Should any inquiries or concerns arise, please do not hesitate to contact me at (778) 865-8859 or by email at xotro-440@sfu.ca.

Sincerely,

Henry Kam
President and CEO
Xotro

Enclosure: *Rolada, Rollator with Controlled Braking System*

PROPOSAL FOR

ROLADA
ROLLATOR WITH CONTROLLED BRAKING SYSTEM

Project Team: Henry Kam
Jeff Ip
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Submitted to: Dr. Andrew Rawicz – ENSC 440
Steve Whitmore – ENSC 305
School of Engineering Science
Simon Fraser University

Issued date: January 16, 2010
Revision: 1.1

Executive Summary

"This is COPD," the doctor said after looking over John's data. John was confused and said jokingly, "Yes, I'm in the Central Ontario Police Department, hold up your hand or I'll shoot you."
The doctor laughed for a while and repeated in a calm voice. "COPD refers to people like you who have limited exercise tolerance compared with normal people. They find it hard to walk without assistance, so I'm prescribing for you a rollator." Without knowing what a rollator is, John's family bought him a rollator from a local shop. The next day, John decided to try out the rollator. He kept kicking the seat of the rollator as he tries to walk out of his house. Of course he wasn't kicking the seat because he was angry at the rollator, but the seat of the rollator was in his way. With a bruised leg, he finally got out. Unfortunately, his house was located on a steep hill, so the rollator suddenly sped downwards, and John fell after losing control of the rollator. He cried out, "God! I want the Xotro team to successfully make a better rollator!"

If you have been to a shopping mall, park or any places where the senior people are populated, you probably have seen some of them with baby strollers that contain no babies. Those strollers are what we call 'rollators'. Doctors prescribe rollators to patients to help improve their quality of life and their exercise capacity. It will support and assist the elderly to walk comfortably as they are able to support their body weight. However, the current rollators in the market do not fully serve this purpose.

From our recent survey, we confirmed the numerous inconveniences that arose from using the rollator. The elderly legs were kicking the seat while they were walking. They have problems opening the door because the door handle is not within reach. The rollator was also inconvenient when going downhill. While the rollator aid seniors with their quality of life, it also provides distress to their daily activities.

This document proposes a new design of the rollator with additional features that traditional rollators do not have. The design we propose contains the following solutions:

- § foldable seat to prevent the elderly from kicking it
- § handle on the front part of the rollator for easy access to the door knob
- § push-through roller after opening the door
- § automatic brake control system when going downhill
- § lighting system for other people to see them in dark
- § IR sensor for obstacle recognition near the rollator

Xotro consists of two fifth year engineering and three fourth year engineering students experienced in various engineering fields such as analog/digital system design, mechanical analysis/design and software. We propose the engineering cycle will be carried through by research, frame design, mechanical system design, electronics system design and integration. The cycle span is expected to be 11-week period with a prototype completion date of April 5th, 2010. The total budget is estimated to be between $871 and $976.40. Our budgets will be funded by ESSEF or by the company asset.

Contents

1. Introduction

There is a significant population aging prospect in Canada. Statistics Canada expects that the number of people aged 80 or over will increase 43% from 2001 to 2011, while children aged 4 and under will decline to approximately 1.6 million due to a declining fertility rate. Furthermore, the median age of the working-age population is projected to be 43.7 by 2011[1]. These figures raise real concerns about the impact of population aging to society as there will be an ever-increasing need for the elderly to take care of themselves in the near future.

As age progresses, problems in basic mobility may be inevitable due to arthritis, illness or muscular weakness. For individuals with a severe mobility problem, wheelchairs, scooters, or other assistive aids may be necessary for travel or exercise. Short-term studies showed marked benefit in the exercise outcomes of persons with chronic obstructive pulmonary disease who have severe breathing difficulties[2]. However, for mature individuals with minor mobility problems, a walker or rollator can be invaluable for safer and more comfortable walking. Many existing walkers have been developed for this purpose.

Our project goal is to create a safe rollator which provides a controlled automatic braking mechanism when going down a steep surface. This helps to support the user descend the slope safely and steadily without putting excessive strain on the knees or the back. The braking will also reduce the accelerating force if the acceleration is detected to be higher than safety limits. Users of current rollators complain about the current frame design being clumsy and inconvenient. In an interview with Josh Yang, an industrial design student in Emily Carr who has talked with many elderly users of rollators, issues such as accidentally kicking the seat or wheel due to its placement and difficulty opening doors are raised. Our frame design addresses these issues while maintaining a strong and lightweight support.

In addition, we realized that the elderly may not be able to see or avoid small obstacles or curbs in front of a rollator while walking, due to vision problems or slower response time. An audible cue in response to the detection of an obstacle will be implemented in the design. To increase visibility at night, we will also integrate flashing LEDs into the frame which activate when it is dark. Optionally, a Global Positioning System can be mounted onto the rollator for navigation.

This document provides an outline of our project, addressing the design plan and providing information on funding, projected schedule, and our team profile. Other existing rollator designs are briefly discussed. The estimated timeline and milestone charts as well as budget breakdown are provided.

2. System Overview

The rollator system is illustrated in Figure 1 and 2, showing the basic functions and feature of the product. The back wheels of the rollator will have a braking system to control the speed of the rollator and the front wheels will have a sensor to measure the speed. Hence it allows the speed controlling brakes to activate when the acceleration or speed value is large or when slope gradient is high. Sensors on the front of the frame are used to detect any obstacles in front of the rollator. The user is notified through an audio device. To increase night visibility of the rollator, flashing LED will be added to increase awareness of surrounding pedestrians and drivers. Please note that figure 1 is meant to depict a general outline of the functions of the device. The final design may differ from the diagram shown.

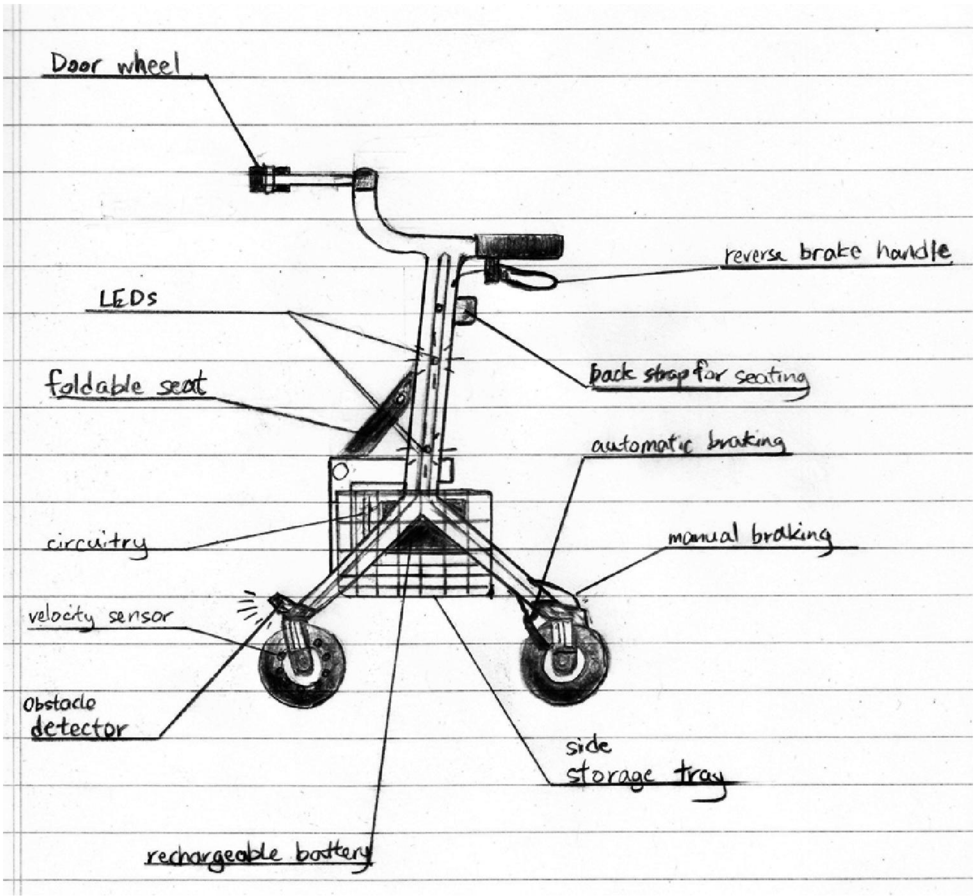

Figure 1 - Rollator concept design showing various features

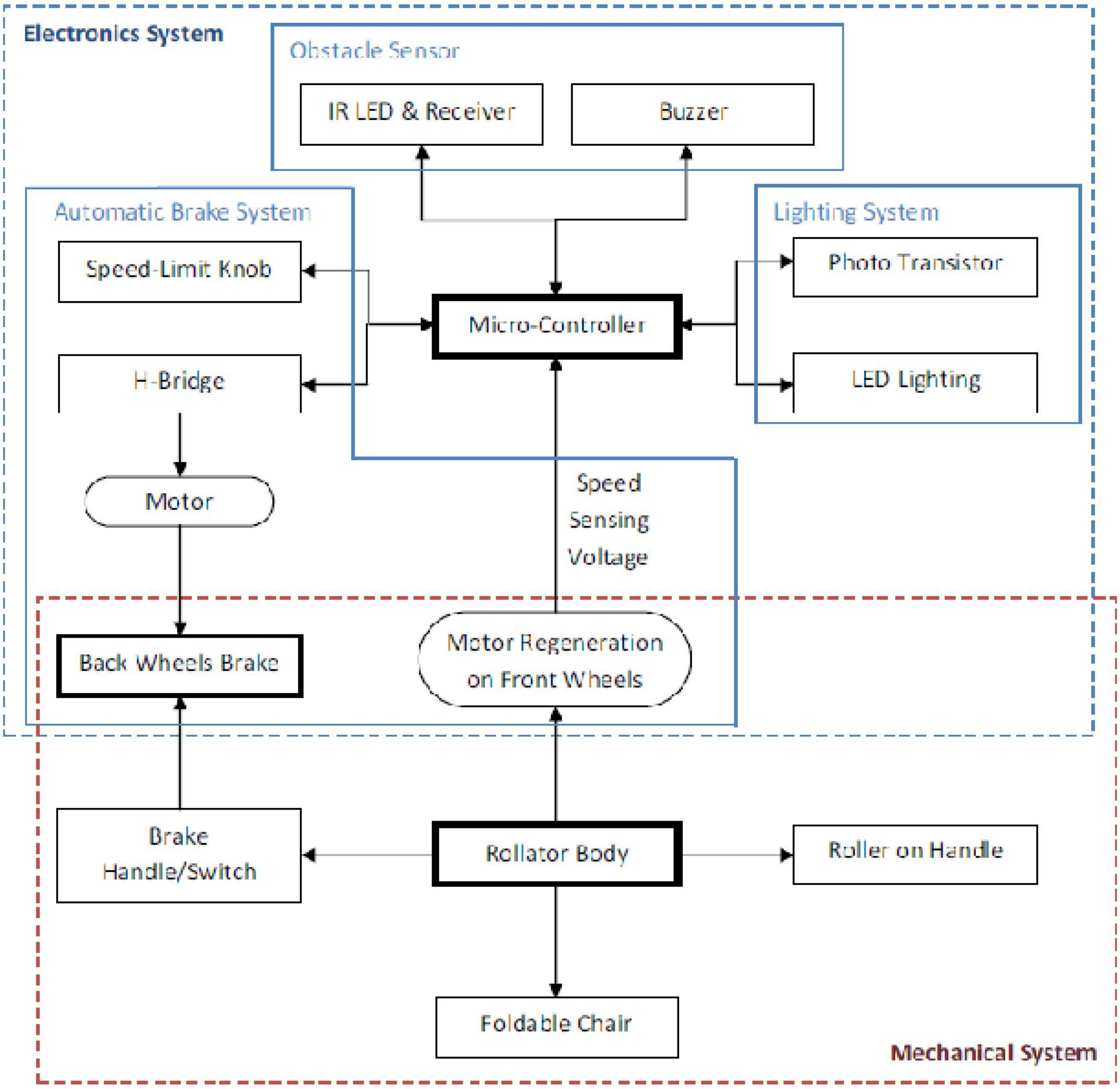

Figure 2 - Electrical and mechanical system outline

3. Existing Designs

Existing Rollators provide a promising solution for the elderly that requires walking support. Rollators are currently very affordable as their prices can be as low as $150 USD. Most Rollator models offered now are robust in design and nearly maintenance free. They may include ergonomic brakes that provide excellent braking as well as comfortable handles for elderly. Each unit has varied functionalities that may include baskets, height adjustments and fold ability and the pricing ranges anywhere from $150-$300 USD. The Rollator models now in the market are standardized in which the designs must meet certain specifications set by law.

However, the current existing solutions for walkers such as the Rollators only meet the minimal requirements for elders, which is to provide them with support while walking. As a result, there is significant room for improvement in the current designs of Rollators. Some individuals complain about a problem with their legs constantly kicking the seat panels of existing Rollator designs. Many existing models do not address this problem. Most, if not all, Rollators in the market do not include lighting to increase visibility in dark areas. Current Rollators do not offer collision detection which can alert elders before they collide with obstacles.

There are at least four types of braking mechanism for standard rollators, which are the “push-down brake”, “loop brake”, “reverse brake”, and “slow-down brake.” The “push-down” braking mechanism depends on the user’s weight. When the user leans on the rollator, applying pressure to it, the motion of the back wheels is obstructed. This braking mechanism fails if the user does not provide enough pressure to halt the back wheels, or if the user provides too much pressure and continuously stall the back wheels, preventing any movement for the rollator.

The “loop” braking mechanism is similar to bicycle brakes which requires the user to squeeze the brake handle in order to apply the brake. However, this braking mechanism will stop the back wheels almost instantly when the brake handles are squeezed, preventing any “slowing” transition between locking and unlocking the back wheels. Another flaw from “loop” braking is if the user loses control of the rollators handles on an inclined slope, the rollator will continue to roll down the incline.

The “reverse” braking mechanism is the “loop” braking mechanism, but with the reverse operation when using the brake handles. Instead of squeezing the brake handles to apply the brake, the back wheels are locked whenever the brake handles are released, whereas squeezing the brake handles will allow the back wheels to move freely. This braking mechanism intuitively solves the “free-run” on an inclined slope problem for the “loop” braking mechanism. However, the “slowing” transition between locking and unlocking the back wheels has yet to be solved.

Finally, the “slow-down brake” rollator allows the user to adjust the freedom of movement of the back wheels, allowing for resistance when, for example, a user walks down a slope. However, when travelling uphill or on a flat road, the user would have to manually adjust the resistance to a lower level. This could be a significant annoyance to the elderly.

4. Proposed Design Solution

Our main goal in this project is to ensure safety and satisfaction for people with very limited exercise ability while maintaining a reasonable cost. To achieve this, our design will be re-engineered to make the users feel at ease and comfortable while using the rollator. For additional safety, our design has an automatic braking system, an obstacle sensor and a lighting system.

The design we propose in this project will have an automatic braking system which varies in resistance according to the gradient of the slope and the angular velocity of the wheels. This is very useful for travelling down a long hill as the rollator can maintain a counterforce for leaning, which will reduce the stress on the knees and back. As a safety feature, the brakes are also applied if the velocity is beyond a safe threshold. The user can change the desire speed limit by manually adjusting a knob.

The new rollator will emit an audible cue when the obstacle sensor detects an immediate obstruction. This feature will notify users of obstacles such as curbs or large rocks to help avoid potentially dangerous collisions. To increase visibility in the dark, the rollator will also detect the level of ambient light and turn on flashing LEDs as necessary. The design will have a seat which can be folded upwards when walking, which will prevent injury to the user by accidentally kicking it. Furthermore, the new frame will make it easier for users to open or close doors due to its compact design which enhances proximity to door knobs. An integrated door wheel allows for easily moving through a partially opened door, or a door which automatically closes.

Given the quantity of work required to develop electronic, electrical and mechanical designs, and the very limited amount of time available for this project, we are expecting to build a simplified model of the proposed rollator. If we had more resources and time for development, we would be able to build a lighter model which would be more energy efficient and refined.

5. Sources of Information

The project can be divided into two main technical areas: mechanical and electronics. Mechanical area is related to all the mechanical aspect from researching and surveying the purpose of the rollator to frame work and mechanical analysis of the new rollator design. Electronics area is related to all the electronics aspect from system design to PCB assembly.

The mechanical team will obtain information from the Internet, elderly individuals using rollators, kinesiology and engineering professors, mechanical and bioengineering textbooks and expert machinists. The Internet will be able to provide information on the most of the mechanical issues. Seniors can shed light on the inconveniences and inadequacies they encounter with the current rollators. Professors can assist by guiding us towards practical solutions in implementation, and textbooks can help us gain deeper knowledge on mechanical analysis. Professional machinists can aid us with the frame manufacturing in the new design.

The electronics team will seek knowledge from the Internet, engineering professors, engineering textbooks and application notes from semiconductor companies. The Internet will provide many reference materials such as a practical system design using similar components. Professors and textbooks can give us direction and greater knowledge to solve any problems that we might encounter during the system design. Application notes will provide basic design method using the component in the application notes for various applications. Lastly, software such as PSpice and Solidworks will be used to simulate and confirm the system design.

6. Finances

6.1. Budget Breakdown

Table 1 - Budget overview

Part Name	Overestimated (120%) Unit Price Range
triple-axis accelerometer	$30.00 – $53.00
hall-effect sensor	$24.00 – $50.00
magnets and coils	$20.40
H-bridge	$3.60
high speed diode	$0.40 x 15 = $6.00
voltage regulator	$2.40 x 5 = $12.00
gear motor	$24.00 x 4 = $96.00
IR LED and receiver	$2.40 x 4 = $9.60
buzzer	$1.20
microcontroller	$4.80 - $61.20
LED	$1.00 x 5 = $5.00
phototransistor	$1.20
reflective vinyl tape	$6.00
leather chair	$36.00
handle grip	$6.00 x 2 = $12.00
wheels	$103.20
custom aluminum fabrication	$500.00
Total	**$871.00 – $976.40**

The total above is overestimated by 20% to accommodate for shipping and any other unforeseen costs.

6.2. Funding

The expenditure required of building an initial model will be higher than the actual costs of the resulting product. Development costs are involved in any prototype design without completely finalized detail. Some spare parts may be required in case of defects or damage during assembly.

Since the projected sum is considerably large, Xotro has considered many options in funding. We are in the process of applying for support from The Engineering Science Student Endowment Fund. The Wighton Development Fund is also being considered as a possible source of subsidy. The SFU Engineering Science Department is also willing to provide $50 towards electronics costs.

Despite financial support from the aforementioned organizations dedicated in aiding student developments, it may not be sufficient to sustain the entire cost of the project. Should such a circumstance arise, Xotro will divide the remaining costs evenly among its team members.

7. Projected Timeline

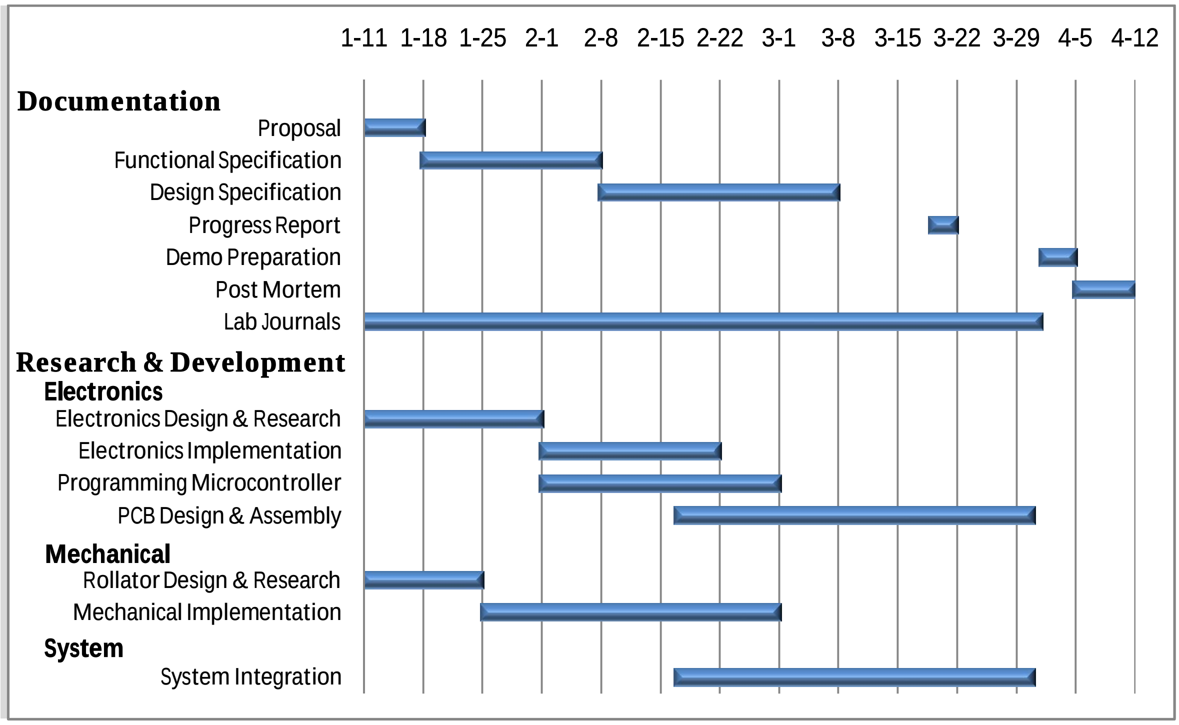

Figure 3 – Project Gantt chart

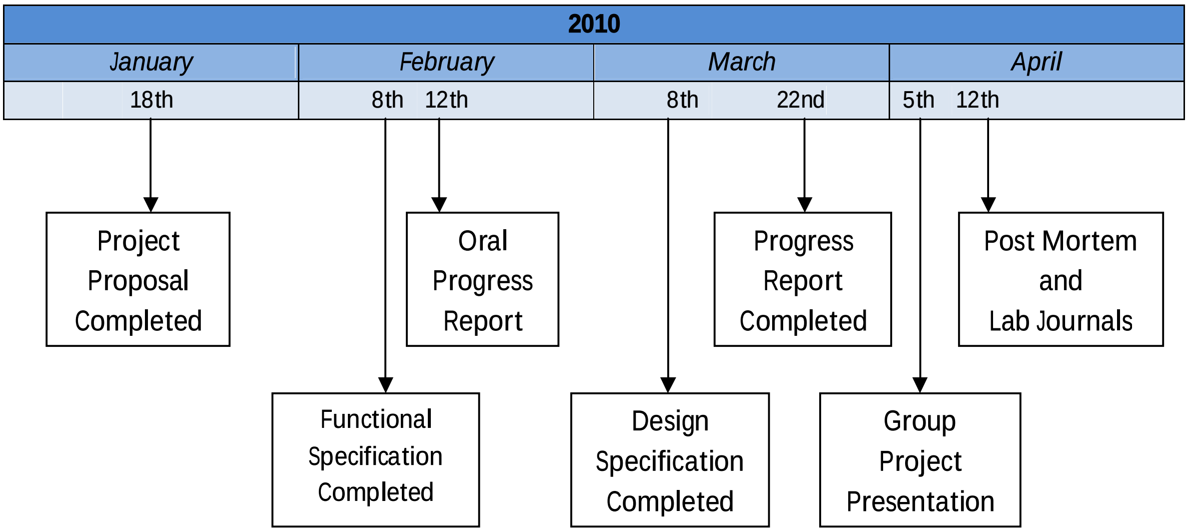

Figure 4 - Milestone timeline

8. Team Organization

The company XOTRO was founded early spring 2010 by five engineers: Henry Kam, Chuck Lee, Nathaniel Seung, Jeff Ip, and Benjamin Chen. All members are either fourth-year or fifth-year engineering undergrad students that are specializing in Systems or Electronic Engineering. Each member brings diverse experience and unique skill set that will prove invaluable towards the project.

Xotro corporate structure is created to recognize each member key attributes as well as to designate each member to a specified position within the organization. Henry Kam, President and Chief Executive Officer (CEO) will be overseeing the progress of the project and will provide resolution to any group conflict that may arise. Acting as Chief Operating Officer (COO) is Chuck Lee. He is in charge of day-to-day management, research and analysis of hardware components. Chuck also will be cooperating with Nathaniel in designing the product and any technical aspects. Nathaniel Seung, Chief Technical Officer (CTO), is lead hardware designer of the product. He is responsible for hardware specification and resolving any technical issues. Jeff Ip, Chief Creative Officer (CCO), will be the lead software designer of the product. He is responsible for software development and marketing of the product. Benjamin Chen, Chief Financial Officer (CFO), is in charge of the budget and ordering of hardware component. He will be cooperating with Jeff Ip on software development.

Due to time constraint, we are on a tight schedule to complete the project. Therefore the key emphasis is team cohesiveness and collaboration. In order to do this, Xotro is implementing several collaborative techniques. Each member will share their ideas and work through a dedicated ftp server or through email on a bi-daily basis. Microsoft Outlook is use to schedule meetings and share our availability times. Short meetings can be conducted through windows live messenger. In case of emergency or critical decision, all team members have each other's cell phone number to contact each other.

For formal group meetings, the members will meet three times a week. During the meeting, each group member will update their progress to the rest of the members. The meetings will address complication and question about the project. For each meeting there will be a designated leader. The designated leader responsibility is to prepare goals and objective before the meeting. He is also accountable for recording the group journal and organizing the proceedings. This method allows each member to develop and practice their leadership skill.

Dealing with a project of this magnitude, members will be divided into two teams that will be either categorized as mechanical or electronics. Integration and testing between the two teams will be done frequently and conducted by the entire group. Jeff and Chuck will be focus on the mechanical issues such as frame work design of the rollator and physics aspects during situations. Nathaniel and Benjamin will be focus on circuit analysis and hardware components. Henry will be working in both teams providing insight and resolving any complication.

9. Company Profile

Figure 5 - Team Xotro

Henry Heung Wing Kam – *Chief Executive Officer (CEO)*

Henry is a fifth year Systems Engineering student at Simon Fraser University. He has gathered a substantial programming skill set from his studies and from his co-op experience in Polycom, being familiar with many languages such as C, C++, Java, Perl, JavaScript, and Matlab. In terms of hardware, he is familiar with circuit design using VHDL. Being a senior Systems student, he has knowledge of modern control systems implementation using a state-space formulation. Throughout university, he has learned important communication and problem-solving skills. In addition, his positive attitude and critical thinking are equally valuable in a team environment.

Jeffrey Jia Hui Ip - *Chief Creative Officer (CCO)*

Jeffrey is a fourth year Systems Engineering student at Simon Fraser University with experience in both design and implementation of software and hardware aspects of various projects. Being an experienced website and graphics designer, he has developed strong skills in programs that include Adobe Flash, Adobe Photoshop, Adobe Illustrator, and Dreamweaver. His web development experience include the usage of PHP, MySQL, HTML, JavaScript, Actionscript to write server sided websites. He has familiarity with a wide number of programming languages such as C++, C, Java, Perl, Python and Visual Basic, and also embedded systems programming using assembly language. In terms of hardware, he is knowledgeable in electronic PCB design using Eagle and is experienced in 3D modeling using Solidworks.

Nathaniel Homin Seung – *Chief Technical Officer (CTO)*

Nathaniel is a fifth year Electronics Engineering student at Simon Fraser University. He has previous co-op experience in various places such as Analytic Systems, Simon Fraser University Engineering (under Dr. Menon) and Ubukata Industries in Nagoya, Japan. Throughout his co-ops, he has gained valuable experience in PCB design, assembly code programming and debugging. In his co-op at SFU, he had designed systems of measuring devices on a spider robot using analog and digital circuits, such as the Cyclone 2 FPGA. Furthermore, he had gained much knowledge in international standards such as UL (Underwriters Laboratories) as well as valuable skills in patent research while at Ubukata Industries.

Benjamin Jian Sung Chen – *Chief Financial Officer (CFO)*

Benjamin is a fourth year Electronic Engineering at Simon Fraser University with co-op experience on real time embedded systems using QNX while working under Professor Patrick Leung (Simon Fraser University Engineering). He has a strong background on software programming languages such as C, C++, MATLAB, and VHDL. He has also done projects on image processing and compression using MATLAB and Embedded Systems design using QNX.

Chuck Loong Lee – *Chief Operating Officer (COO)*

Chuck is a fourth year Systems Engineering student in Simon Fraser University. His studies has allowed him to accumulate practical experience in modeling and analyzing both feedback and non-feedback systems, as well as selecting actuators, sensors and transducers for system designs, and simulating system implementations using MATLAB and PSpice. He is familiar with several different levels of programming languages, including MATLAB, C, C++ and Assembly. Recently, under the concept of real time and embedded systems design, Chuck has implemented a block detection algorithm on the QNX operating platform using C language. Outside of his studies, he has an interest in visual arts and is familiar with Adobe Photoshop, Adobe Illustrator and Corel Painter. Most importantly, his experience gives him the flexibility to excel at both collaborative and individual tasks.

10. Conclusion

Xotro is a company envisioning a better quality of life for individuals with mobility problems. Dedicated to improving ergonomics and safety, Xotro commits itself to alleviating the problems frequently encountered by rollator users.

Our proposed project will provide solutions to numerous complaints raised by current rollator users considering uncomfortable leg movement and limited accessibility to the door knobs.
By incorporating common sensors and actuators, Xotro hopes to offer our customers a Rollator that is innovative and affordable. The automatic braking system will allow a safer and more comfortable walk when walking down inclines, reducing knee and back stress. Furthermore, this project will provide enhanced safety by increasing the visibility of the rollator for other people, and by controlling the speed of the rollator. Xotro believes that *Rolada* is valuable to improving the lives of those who require a Rollator.

In this proposal, we have stated our motivation and goal for undertaking this project. A summary of our research and source of information had been included, as well as the financial outline illustrating our costs and potential sources of funding. Finally, the projected schedule had been presented through the Gantt chart and milestone timeline.

11. References

[1] Statistics Canada, "2001 Census: Age and Sex Profile: Canada," *Statistics Canada*, 2001. [Online]. Available: http://www12.statcan.ca/english/census01/Products/Analytic/companion/age/canada.cfm. [Accessed Jan. 10, 2010].

[2] R. B. Gupta et al, "Effect of Rollator Use on Health-Related Quality of Life in Individuals With COPD," *CHEST*, 2006. [Online]. Available: http://chestjournal.chestpubs.org/content/130/4/1089.full.html. [Accessed Jan 9, 2010].

[3] Chee et al, "Determinants of Safe Mobility In Older Adults Who Use Assistive Mobility Devices: Objectively Assessing Foot Placement During Rollator Use," *Sunnybrook Health Sciences Centre*, 2009. [Online]. Available: http://sunnybrook.ca/uploads/sri_csia_fmn_2009_chee.pdf. [Accessed Jan 10, 2010].

[4] Bindependent, "Rollator (wheeled walker) features," [Online]. Available: http://www.bindependent.com/hompg/bi/bindep/store/aisles/s-needs/mobility/walkers.htm. [Accessed: January 14th, 2010].

