Monarch Technologies Inc.
1234 Boundary Road, Burnaby, BC, V5A 4R9
Email: support@monarch.ca

January 19, 2009

Mr. Patrick Leung
School of Engineering Science
Simon Fraser University
8888 University Drive
Burnaby, British Columbia
V5A 1S6

Re: ENSC 440 Project Proposal for a Motorcycle Racer Training Device

Dear Mr. Leung:

Monarch Technologies is committed to designing a motorcycle racer training device that will aid in improving racers' skills on the track and act as an informative device off the track. The enclosed document, Proposal for a Motorcycle Racer Training Device, outlines the high and low level aspects of our design solution, alternative solutions, financial and budget plans, target timeline for a prototype by April 2009, marketability, and provides a description of our very capable project team.

Our goal is to create a light, robust, and rider friendly device that will detect and display the lean angle of a turn and track the position of the motorcycle which will be transmitted wirelessly to a base PC concurrently. This device will be a small mountable product with a set of LCD and LED displays to show the lean angle of the motorcycle and some keys to power the device and select modes.

Monarch Technologies is a new engineering firm operating in Vancouver, BC. Our staff has a wide variety of experience ranging from software and hardware programming, and mechanical and electric circuit design. We trust that the quality of this proposal will reflect our competence and breadth of experience.

We will complete the duties associated with this project with the same diligence, competence and pride of workmanship as we have displayed on projects we have undertaken previously. We look forward to working with you on this project. Please do not hesitate to contact us with any questions.

Sincerely,

Ted Meredith	*Dan Carter*	*Freya Santos*	*Helia Sharif*
Ted Meredith	Dan Carter	Freya Santos	Helia Sharif
Chief Executive Officer	Chief Technical Officer	Chief Marketing Officer	Chief Financial Officer

Enclosure: *Proposal for a Motorcycle Racer Training Device*

Proposal for a Motorcycle Lean Detection System

Project Team:

Ted Meredith
Freya Santos
Helia Sharif
Daniel Carter

Contact Person:

Ted Meredith
ted.meredith@gmail.com

Submitted to:

Patrick Leung
Steve Whitmore
School of Engineering Science
Simon Fraser University

Issue Date:

Monday, January 19, 2009

Revision:

1.7

Monarch Technologies Inc.
1234 Boundary Road, Burnaby, BC, V5A 4R9
Email: support@monarch.ca

Executive Summary

My name is Ted Meredith and I am an avid motorcyclist. I have been riding ever since getting on a friend's Honda CR50 when I was a boy and the enthusiasm for riding hasn't waned. I've owned my share of motorcycles, both off-road and street, from my humble days on a Kawasaki YZ80 dirtbike over 25 years ago, to a Kawasaki LTD440 cruiser 15 years ago, to my current ride, a Honda CBR1100 sportbike. I got my first taste of real motorcycling power when I took my Yamaha Virago 750 in for a tune-up and some work and the shop only had a Suzuki Katana to loan me while they worked on my bike. Going from a two cylinder 750cc cruiser to a four cylinder 1100cc sport-tourer is like going from a Tercel to a Ferrari (I'm guessing here, as I've never driven a Ferrari). Once this sport bug bit, I was hooked, and its nothing but tight twist's ever since.

Approaching any turn on a motorcycle, a good rider will do a few things. One, they'll scan the turn ahead to make sure it's clear of obstructions that could potentially cause an accident. Two, they'll distribute their weight on the bike to optimize balance for the upcoming turn. Three, they'll apply a bit of throttle halfway through the turn to maintain grip and, on exiting the turn, they may wonder, "How far did I go over that time?" With our project, we'll provide an answer to that question.

The design of our system will come in two varieties. For the enthusiast rider, the system will be a sensor for detecting lean angles and a display system for showing sensor output. The display system will comprise a two-digit numeric LED display and a pair of light bars. For the advanced rider like motorcycle racers, expanded functionality will allow GPS position information to be coupled with lean information and transmitted wirelessly to a PC, where this information will be displayed in real-time within a software application. This information will allow a rider to analyze their lean angle and track time and position and determine where to make improvements to their technique.

It's important that this system come in two user levels: motorcycle race teams and general motorcycle consumers. There are about 1000 race teams in the world and consumer sales statistics show that in the year 2005, roughly 1 million motorcycles and scooter units were sold in the United States. In addition, Honda projects 10.5 million motorcycle sales worldwide for 2009. With this larger consumer market in mind, we can effectively target our product to meet the requirements of a consumer product through ease of use, and cost effectiveness, while still designing a model to meet the higher requirements of the specialized race market.

We believe that we can accomplish the design, prototyping and testing of a unit within the tight timeframe required and keep this project on a budget of $1000.

Monarch Technologies Inc.
1234 Boundary Road, Burnaby, BC, V5A 4R9
Email: support@monarch.ca

Table of Contents

List of Figures

Monarch Technologies Inc.
1234 Boundary Road, Burnaby, BC, V5A 4R9
Email: support@monarch.ca

1. Introduction

To date, there are no devices in the motorcycle market that assist the rider in providing lean information. Our product is uniquely situated to exploit with oversight and provide motorcyclists with this information. Our device will assist the enthusiast rider, providing information in real-time on rider performance. For the race rider, a more sophisticated version of the device will couple GPS tracking capability with lean information and transmit that data to software running on a PC, providing real-time information to a race crew. The crew can then analyze this information to make improvements to machine and rider and better their chances at achieving victory on the circuit.

In this proposal, we will highlight our vision for our product, define timelines, deliverables and project budgets, and discuss our team and how we believe we are uniquely qualified to accomplish the goals of this project.

2. System Overview

Figure 1 shows how the different components of our system will function. The lean detector module, with a digital display, and GPS module will be mounted on the dashboard. The lean angle data and position on the race track will be sent wirelessly to the base station PC where the data will be displayed for analysis.

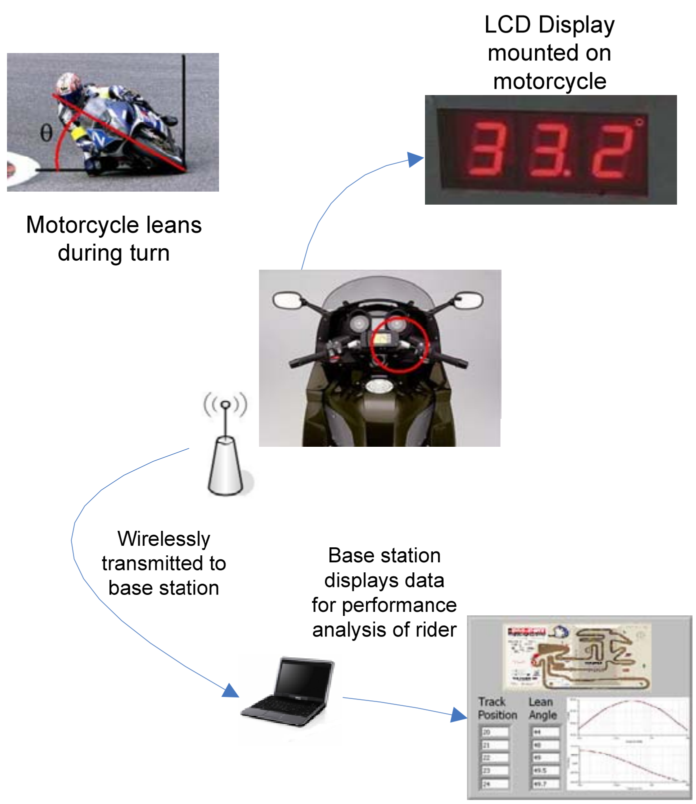

Figure 1 - Conceptual Overview [1][2][3]

Monarch Technologies Inc.
1234 Boundary Road, Burnaby, BC, V5A 4R9
Email: support@monarch.ca

Figure 2 shows the system block diagram. The section in the dotted line is what we propose to build and mount on the motorcycle. The data will be sent to the PC, processed, and displayed in a meaningful way to the rider and his team.

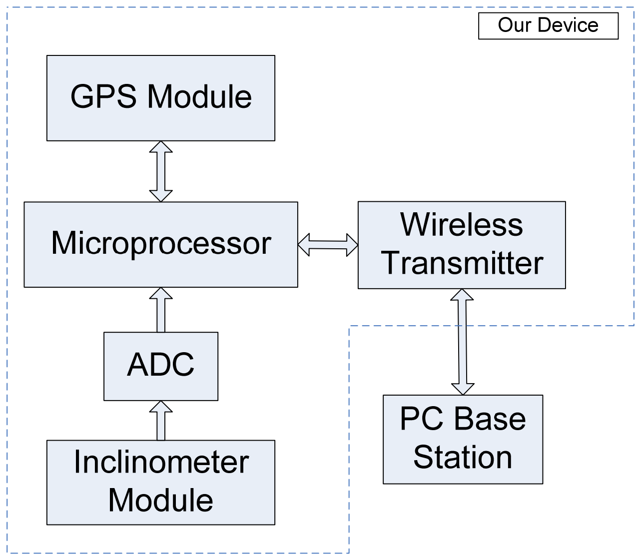

Figure 2 - System Block Diagram

3. Possible Design Solutions

Currently there are few ways to accurately determine the lean angle during a motorcycle turn. The methods that do exist are either not accurate enough or not practical for performance analysis and improvement. There is a need for a systematic approach to determining lean angle to analyze a motorcycle racer's performance on any given turn that involves the bike undergoing a significant lean angle. Some methods currently used are outlined below.

3.1 Video

This method may be practical in a very controlled practice environment. Cameras can be set up around the track near a critical turn occurs. The videos can then be analyzed and a system devised to calculate the lean angle. The downfalls of this method are a lack of accuracy from determine lean angle from a picture, and the time needed to analyze video for 10 or 20 laps makes it very impractical.

3.2 Lean Sensor

Some Honda bikes are equipped with a simple lean sensor used for rider safety. If the bike leans too far over, the bike motor is forced to shut off. The lean angle is not displayed to the rider in any way nor is it converted to digital format for data transmission.

3.3 Pressure on knee pads

Riders commonly have pads on the side of their knees which protect them from contacting the ground during very tight turns. It is common for riders to judge how tight they are taking a turn by the pressure

Monarch Technologies Inc.
1234 Boundary Road, Burnaby, BC, V5A 4R9
Email: support@monarch.ca

they feel on these pads. This technique is useful for determining if the rider is pushing too hard into the turn, but it doesn't give a recorded value of the lean angle to be used for post-race or post-practice performance analysis.

3.4 Wires mounted on bike

A concern facing commercial bike owners is their muffler scraping the ground if they take a turn too tightly. Some have remedied this by mounting cheap wires on their bike which make a loud scraping noise if they take too tight a turn [4] [5]. This signals them to ease off on the turn. This technique is useful for its purpose, but again, its lack of accuracy and angle recording capability renders it useless for our purposes.

3.5 GPS SD card logging

After some research on current GPS projects, we found that there have been many attempts at making a miniature GPS data tracker. These utilize a SD card for storage that the user will read via a PC, along with Mapquest or Google Maps, to determine their position [6]. This is a sufficient solution for storing and receiving the data but it does not provide real-time monitoring like a wireless solution would.

4. Proposed Design Solution

Our proposed solution is to build a detector and display unit which would be mounted on the bike that transmits lean angle and position data wirelessly to a PC base station. This data will be used by the rider's team to analyze their performance in practice or race situations. Based on this data, the team can determine how best the rider can improve their performance and whether they can push harder around turns.

Lean sensors have been introduced as a safety feature on some Honda bikes, but our research has shown they do not display or record the lean angle for any meaningful analysis. Our device would appeal to professional motorcycle racers for its ability to make precise measurements of their lean angle during a turn. It also may appeal to the casual rider for the simple ability to see how far one is leaning into a turn. It is foreseeable that a major bike manufacturer could incorporate our sensor into their bike design.

The main constraint on this project will be the tight timeline. We have thirteen weeks to complete the design, assembly, and testing of a prototype. We will do some simple tests to make sure the device functions properly, but more testing with an actual race motorcycle would be ideal. We are not equipped to do exhaustive testing, as our timeline does not allow for this.

Another constraint on the device is that our prototype will not be designed to interface with current bike electronics or computers. We will need to work with a bike manufacturer team to integrate the systems together, since most bikes have built in computers or microprocessor units; hence our concept would have to be integrated into a current design.

Monarch Technologies Inc.
1234 Boundary Road, Burnaby, BC, V5A 4R9
Email: support@monarch.ca

5. Sources of Information

This project requires knowledge from many different areas. We will need to program a microprocessor to interface with a GPS module, a wireless transmitter, and an analog sensor. In solving our problem we will obtain information from textbooks, fellow students, professors at SFU, the internet, and actual motorcycle racers.

We have initiated contacting students who have taken ENSC 440 before as a resource. Although they have done completely different projects, they have used similar components such as GPS or wireless technology. This is a project involving many different peripheral devices and learning from those who have experience is an asset. One group from ENSC 440 2007 did a similar project that adjusted the headlights as a motorcycle goes into a turn, while another used a GPS module in a traffic controller prototype last year. The internet is a vital resource for research and parts ordering and we already found several projects that interface a GPS module with a microprocessor.

Our CEO, Ted Meredith, has been a motorcyclist for most of his life. His knowledge, experience, and contacts in this area will be a helpful resource. One of the keys to the research and design process will be looking at the device from the point of view of the user. Ted has used a motorcycle extensively so he has a unique viewpoint to aid in our usability design and we plan to interview motorcycle racers for more information.

6. Team Organization

Monarch Technologies consists of four capable and innovative engineers: Freya Santos, Helia Sharif, Ted Meredith, and Daniel Carter. All members are within a year of graduating and have completed 3 or more co-op terms. We have a wealth of academic and industry experience backing our endeavour.

We have organized our company by giving each member a specific role that conforms as best as possible to their strengths. Freya Santos, Chief Marketing Officer, is in charge of project management. Helia Sharif, Chief Financial Officer, will put together our budget and assist in researching components that we will need to purchase. Ted Meredith, Chief Executive Officer, will lead the team with his expertise and passion for motorcycles. He will also develop the analog circuitry for the sensor circuit. Daniel Carter, Chief Technical Officer, will be in charge of software and peripheral integration.

To ensure we progress smoothly and efficiently towards our goal, Freya has defined our schedules and organized weekly team meetings to update each other and discuss any issues we are having. At each meeting we designate one member to take minutes and email all pertinent information and action items to members for later review. This will ensure that everyone knows all the important deadlines and all issues are tracked.

7. Project Schedule

To meet our goal of completing a prototype by April 2009, we intend to follow the project schedule and technical development outlined in the Milestone Gantt charts. The first Gantt chart (Figure 3) focuses on project management tasks and displays the amount of time we expect each task will take to complete. The technical milestones are shown in the second Gantt chart (Figure 4); note that the technical

Monarch Technologies Inc.
1234 Boundary Road, Burnaby, BC, V5A 4R9
Email: support@monarch.ca

milestones are based on the assumption that parts are available by end of January. The list of milestones is summarized in Table 1.

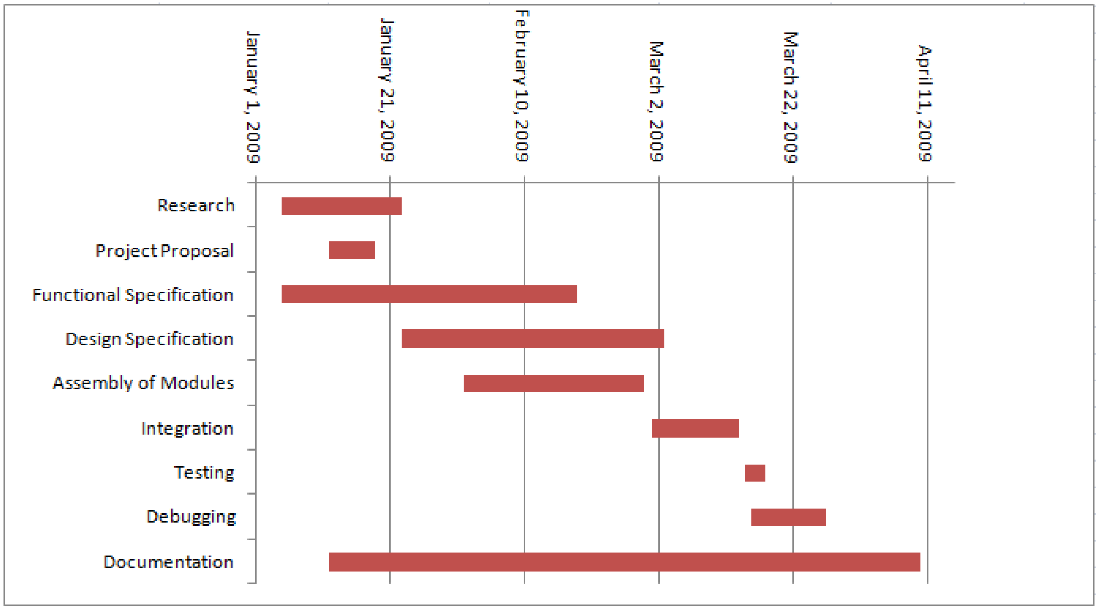

Figure 3 - Project Gantt Chart

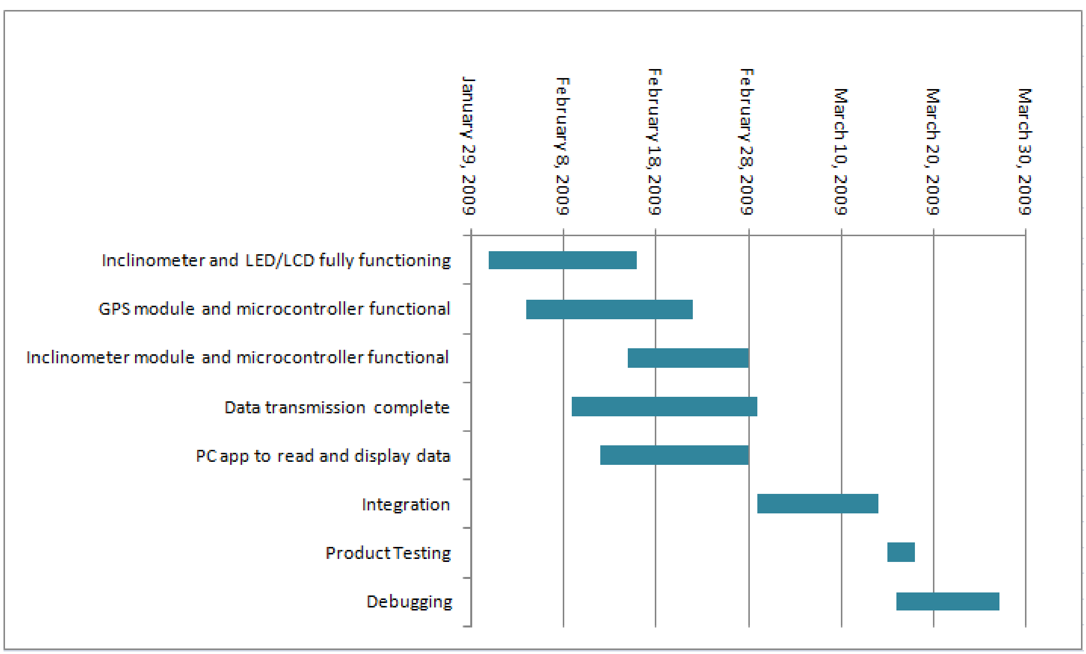

Figure 4 - Technical Development Gantt Chart

Monarch Technologies Inc.
1234 Boundary Road, Burnaby, BC, V5A 4R9
Email: support@monarch.ca

Table 1 - List of Project Milestones

Milestone	Target Date of Completion
Project Proposal	January 19, 2009
First Progress Report	February 4, 2009
Functional Specification	February 18, 2009
Design Specification	March 3, 2009
Inclinometer and LED/LCD fully functioning	February 15, 2009
GPS module and microcontroller functional	February 22, 2009
Inclinometer module and microcontroller functional	February 28, 2009
Data transmission complete	March 1, 2009
PC app to read and display data	February 28, 2009
Integration	March 14, 2009
Product Testing	March 18, 2009
Debugging	March 27, 2009

8. Budget and Funding

8.1 Cost Analysis

The estimated cost for the prototype is broken down in Table 2. Once the proof of concept model has been completed, the team plans reduce the costs by purchasing the parts in bulk for mass production purposes.

Table 2 - Cost of Material Breakdown

Part	Cost	Description
VTI inclinometer x 2	$150	To measure the lean angle while turning
Accelerometer circuit	$150	Various electronic parts
Microcontroller	$100	
GPS module	$250	For position tracking
Wireless controller (transmitter and receiver)	$300	Transmitting data to base PC
Mounting brackets	$50	Mounting the device on motorcycle
Total	**$1000**	

Note that costs are approximated within ±10% and minor electrical components such as resistors, capacitors, etc. are not included in the estimates above.

8.2 Sources of Funding

The school funding provided for this project is broken down into three sources: a) the Engineering Student Endowment Fund (ESSEF) provided by the Engineering Undergraduate Student Society, b) the Department of Engineering Science and c) the Wighton Development Fund.

Aside from the funding found through school, we're also approaching the automotive industry, riding schools, and insurance companies. Once the prototype is completed, we are confident that it will be play a key role in the new generation of vehicles for the motorcycle industry. Some of the corporations which we plan to approach about our innovative product are: Kawasaki, Ducati, BMW, Suzuki, Yamaha and Honda.

The insurance companies and riding schools are the target audience, as they will be interested in products that will reduce accidents and enhance the safety of individuals. Some of these companies include ICBC, TD Canada Trust Insurance, Ontario Motorcycle Insurance, Pacific Riding School Inc, Action Motorcycle School, and many more.

Throughout the next three months, we will also approach some of the motorcycle organizations such as: Canadian Motorcycle Association, CMG On Line, Cycle City Riders Club, Gold Wing Road Riders Association, Harley-Davidson Owners Group, Ontario Motorcycle Association, Southern Cruisers Riding Club, Sturgess Cycle Riders Club, the Motorcycle and Moped Industry Council, and the B.C. Coalition of Motorcyclists.

In the end, any outstanding costs will be covered evenly amongst the teammates.

9. Marketability

The market for this device among race teams is limited to roughly 1000 race teams worldwide [7]. Although this may appear like a restricted market, combined with the consumer market which shows that sales of motorcycles and scooters was roughly 1 million units in the United States alone for 2005, and that Honda estimates 10.5 million worldwide sales in 2009 [8][9]. While we could not find sources online to explicitly define the size of the market, extrapolating data from a number of sources online indicates that the worldwide, yearly unit sales figures for all manufacturers is around 30 million [9][10][11].

Current motorcycle training devices were found to be focused on safety, such as the Honda Riding Trainer, or focused on the reaction time of a rider at the start of a race, like the United States Patent Application 20040076929, *Training device for motorcycle racing*. The Honda Riding Trainer contains a TV screen that simulates a virtual environment and faces the user, who sits on a bike structure with handle bars, foot and brake control, and saddle [12]. Overall the Honda Riding Trainer teaches novice riders and improves avid bikers' skills through simulation only. On the other hand, the patented training device samples the reaction time of a rider which is only imperative at the beginning of a race [13]. Our proposed product is unique from these two devices because it collects and transmits the turn incline and position data real time as the rider is riding around the track and improving how fast one turns in a track can enable a rider to place his or herself in a preferred position.

Monarch Technologies Inc.
1234 Boundary Road, Burnaby, BC, V5A 4R9
Email: support@monarch.ca

The lean detection and GPS tracking system of this device makes it an ideal training product for motorcycle racers because of the real time data update on the racer's incline measurement and tracking of position on the track. However, enthusiasts can also utilize this device recreationally and not necessarily with both the GPS and incline detector functions simultaneously. With the inclinometer module only, the rider is notified his/her degree of incline after a turn, whereas the GPS module can track and display the global position via a PC. This training tool is merely a stepping stone to other types of applications! As a safety device, the inclinometer module can be modified to sense dangerous lean angles and alert the rider; or if the inclinometer senses an unfinished turn (e.g. user leans but doesn't go back to an upright position), the tracked position can automatically be routed to the local police. The GPS tracking can be optimized to work in dense areas such as woodlands, resulting in new markets such as off-road dirt bikers. In addition, if the inclinometer system is updated to measure a full 360 degrees and multiple axes, then this gadget can be used for bicycle motocross fanatics to measure flips and corresponding speeds.

10. Description of the Team

10.1 Ted Meredith – Chief Executive Officer, Circuit Design Team Lead

Ted is a fifth year Systems Engineering student at Simon Fraser University. Ted has a previous degree from SFU, a Bachelor of Arts, and a wealth of experience in the Print Industry, most recently as a project manager at Creo (now Kodak). His tenure at Creo, coupled with his fascination in understanding how systems work, are what inspired him to return to university and pursue a degree in Engineering. This experience and drive will help him guide this team to completing the goals of this project in the short time this group has.

10.2 Helia Sharif – Chief Financial Officer, Wireless Team Lead

Helia is a fourth year Systems Engineering student at Simon Fraser University. In one of her recent employments, Helia had the opportunity to work as the Field Support Engineer for NASA. During her contract in the Arctic, she offered assistance in maintaining the satellite and advanced wireless networking systems in place, support users in field traverse requirements, and gained experience in expedition camping. Her expertise in wireless networking will play an essential role in Monarch Technologies as the Wireless Team Lead. Her current experience serving as the President and Financial Advisor of Women In Engineering Group at SFU will help the team maintain a stable financial state.

10.3 Freya Santos – Chief Marketing Officer, GPS Team Lead

Freya is a 5th year Systems Engineer student at Simon Fraser University with theoretical and practical experience in a variety of engineering areas like software and hardware programming, mechanical design, and digital and analog circuit design and analysis. Her preference lies in mechanical design, hardware programming and fabrication, and digital circuit analysis. She has prototyping experience from working within a hardware team during a co-op with the Community Security Establishment, and further developed her management, leadership and communication skills as a Software Project Coordinator at Research in Motion last year. Her project management skills contribute greatly in running the marketing division and combined with her technical knowledge and experience, she is an asset to the GPS team.

Monarch Technologies Inc.
1234 Boundary Road, Burnaby, BC, V5A 4R9
Email: support@monarch.ca

10.4 Dan Carter – Chief Technical Officer, Microcontroller Team Lead

Dan is a seventh year Electronics Engineering student at Simon Fraser University. He has had 2 8-month co-op terms at Wavemakers (now QNX Software systems), and Yokogawa Electric in Tokyo, Japan. His experience lies predominantly in software and peripheral interfacing. I have written low level graphics drivers so I know the perils and pitfalls associated with integrating many components together and controller them with software.

11. Conclusion

As we have shown in this proposal, Monarch Technologies is poised to exploit an undeveloped market. By introducing this product to motorcyclists, our company can pioneer a new experience for all motorcyclists, enthusiasts and racers alike. We believe we have the knowledge and vision to achieve the goal of bringing this prototype to market under a very tight deadline.

12. References and Sources

[1] Bode plot, [Online picture – cited January 12, 2009], Available: http://www.zen22142.zen.co.uk/Circuits/rf/bode.gif

[2] Leaning motorcycle, [Online picture – cited January 12, 2009], Available: http://static.howstuffworks.com/gif/motorcycle-pictures-1.jpg

[3] LED display, [Online picture – cited January 12, 2009], Available: http://us1.webpublications.com.au/static/images/articles/i30/3032_3lo.jpg

[4] Honda lean sensor, [Online picture – cited January 12, 2009], Available: http://www.fireblades.org/forums/

[5] Wire method, [Online picture – cited January 12, 2009], Available: http://www.triumphrat.net/biker-hang-out/

[6] OHARARP LLC, "How to assemble an SMD GPS Device," [Online document], 2008, [cited January 16 2009], Available: http://www.ohararp.com/products

[7] "List of Grand Prix motorcycle racers", [Online document], 2008 Decmeber 12, [cited January 14, 2009], Available: http://en.wikipedia.org/wiki/List_of_Grand_Prix_motorcycle_racers

[8] Rich K., "Motorcycle Sales Statistics – 2005", [Online document], 2005, [cited January 14, 2009], Available: http://www.webbikeworld.com/Motorcycle-news/2005-motorcycle-sales.htm

[9] HONDA, "Honda's Cumulative Worldwide Motorcycle Production Reaches 150 Million Units", [Online document], 2005 May 9, [cited January 14, 2009], Available: http://world.honda.com/news/2005/2050509.html

Monarch Technologies Inc.
1234 Boundary Road, Burnaby, BC, V5A 4R9
Email: support@monarch.ca

[10] M. Hinchliffe, "Motorcycle sales surge amid slumping car market.", [Online document], 2009 January 11, [cited January 14, 2009], Available: http://www.news.com.au/couriermail/story/0,23739,24898528-953,00.html

[11] S. Carpenter, "Bumpy road ahead for industry?", [Online document], 2008 January 23, [cited January 14, 2009], Available: http://www.latimes.com/classified/automotive/highway1/la-hy-throttle23jan23,1,5521492.story

[12] T. Groussin, "Honda Riding Trainer", [Online document], 2006 Jun 5, [cited January 16, 2009], Available: http://www.viamichelin.com/viamichelin/gbr/tpl/mag5/art20060601/htm/route-simulateur-conduite-honda.htm

[13] A.L. Gerkey, "Training device for motorcycle racing", [Online document], 2004 Apr 22, [cited January 16, 2009], Available: http://www.freepatentsonline.com/y2004/0076929.html.