DESIGN OUTLAWS

September 18, 2001

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

Re: ENSC 340 Project Proposal for Electric Bicycle Technology Development

Dear Dr. Rawicz:

The attached document, *Proposal for Design and Implementation of Electric Bicycle Technologies*, highlights the initiatives of Design Outlaws, a group of four Simon Fraser University Engineering Science students.

Our project involves the development of an electric bicycle, equipped with a speed control mechanism and other unique features, aimed at urban commuters. This technology, we feel, will be a great boon to increase bicycle attractiveness, accessibility, and convenience for contemporary business people, students, and other commuters.

Our goal is to create a prototype firstly for demonstration, in order to create public awareness of emerging electric vehicle options and to publicize the field of engineering along with the work that is being accomplished at SFU. Secondly, we will develop new electric vehicle technology that may be incorporated into established vehicle development. We will develop a system that is affordable, fun, safe, and compliant with existing regulations across North America.

Our proposal further outlines our intended project. A timeline, budget, and possible sources of funding are included, along with a discussion of the members of Design Outlaws and their roles in this exciting undertaking. Should you have any questions or concerns, please feel free to contact me via e-mail at acoppin@sfu.ca.

Sincerely,

Rhiannon Coppin
Project Manager
Design Outlaws

Enclosure: *Proposal for Design and Implementation of Electric Bicycle Technologies*

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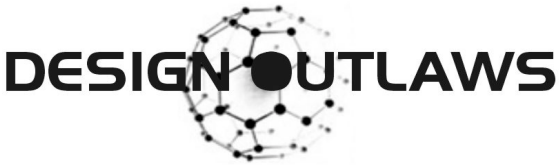

PROPOSAL FOR DESIGN AND IMPLEMENTATION OF ELECTRIC BICYCLE TECHNOLOGIES

Project Team *Design Outlaws*
Rhiannon Coppin
Eric Hennessey
Samuel Hu
Eric Keung

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Submitted to Dr. Andrew Rawicz, Steve Whitmore
School of Engineering Science
Simon Fraser University

Date Issued September 18, 2001

Revision 2.0

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Mission Statement

Our mission is to create a breakthrough in electric vehicle technology, which will enhance the marketability of the electric vehicle movement as a whole.

Our logo is the Buckyball, named after R. Buckminster Fuller, proselytizer of the geodesic dome whose shape mimics the Carbon-60 molecule, in recognition that the vision of some allows others to go further.

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Executive Summary

A visionary of the twentieth century, sometimes called a 'maverick inventor' and 'futurist philosopher', R. Buckminster Fuller (1895-1983) called the innovators who explore beyond the frontier "design outlaws".

As such, Design Outlaws is a company aiming to engineer a better mode of transportation: the *Ranger.* The *Ranger* will be an electrically powered bicycle with programmable speed control and an ease-of-use that will provide an attractive commuting alternative to cars. This technology will be of great importance in urban districts such as Greater Vancouver, where the members of this team reside, through the many benefits electric vehicles have over alternative forms of transportation.

The form of electric bicycles in the market today are either motor-only (pedals are removed), have a distracting manual motor control, or boast non-intuitive features such as pedal-motor matching. None of the models currently have what we feel is an important feature: automatic speed control.

Our invention will allow the user to pre-set a desired speed and then pedal at will. The motor will engage only when necessary to maintain the selected speed. Additionally, the models being marketed today have limited output to comply with maximum speed regulations; our model will have a maximum speed, but with a greater range of output, allowing the user to maintain a higher speed even on taxing inclines.

Our model will comply with the leading-edge electric bicycle legislation of the State of California and State of Washington.

The team creating this vision consists of talented, experienced, and highly-motivated hardware, systems, and software engineers. The members of this team are:

Rhiannon Coppin, Project Manager, acoppin@sfu.ca
Eric Hennessey, Technical Lead & Marketing Manager, eth@sfu.ca
Samuel Hu, Lead Software Engineer, shua@sfu.ca
Eric Keung, Head of R&D, eykeung@sfu.ca

Our expected cost of materials is $1450, which we hope to obtain through sponsorship from individuals and corporations within the community who are concerned for the health of the environment and of the population.

In November 2001, Design Outlaws will have a prototype ready for demonstration, incorporating all required safety features. We plan to demonstrate this project in industry, high schools, student competitions, and for other groups at Simon Fraser University and in the community upon request.

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DESIGN OUTLAWS

Background

"*Like an infection that grows more and more virulent, the continent-size hole in Earth's ozone layer keeps getting bigger and bigger*."[1]

This statement, backed up by such trends as displayed in Figure 1 from the National Academies, illustrates the far reaching effects humans have on this planet and clearly demonstrates that we as a species must place utmost importance on the care of our environment.

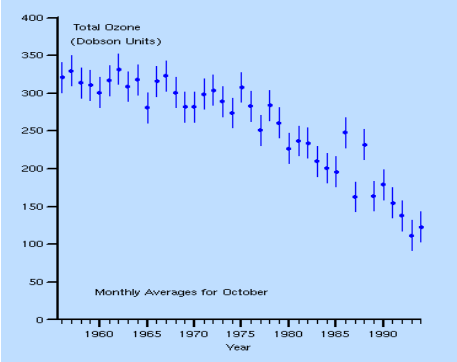

Figure 1 - Levels of Ozone above the Antarctic

Coupled with this is the fastest growing issue in North America: the affordability and increasing need for health care. The crippling increases in costs associated with hospitalization of people suffering from heart disease, as shown in Figure 2, has generated great concern not only for the health, but also for the overall productivity, of North Americans.

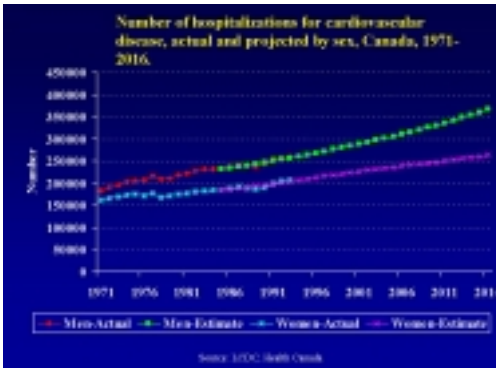

Figure 2 - Number of Hospitalizations for Heart Disease[2]

[1] http://www.nationalacademies.org/
[2] http://www.atm.ch.cam.ac.uk/tour/part2.html

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DESIGN OUTLAWS

Introduction

We at Design Outlaws believe strongly that the two issues at hand must be addressed to improve the quality of life for people today, and to enhance the possibilities for longevity of the human species for tomorrow. Hence, we propose the research and development of the *Ranger* bicycle, which we strongly believe will prove to be a viable and attractive alternative means of transportation for people.

Conventional bicycles rely solely on manpower propulsion. Unfortunately this deters many individuals from using their bicycles as a means of transportation. A low level of physical fitness or the presence of extremely hilly terrain quite often compels people to utilize 'traditional' modes of transportation, such as internal combustion vehicles, to travel between their destinations.

Electric vehicles are a superior form of transportation for many reasons. They have no emissions, excepting those produced at the electric generation plant, they tend to be lightweight and therefore more energy efficient, they are cheaper and more robust, and they have simpler engines and are thus easier to repair. However, this technology, which has been in existence almost since the birth of the first Ford, is one that is very slow to be adopted.

In response to greater congestion, longer and more intense 'smog' seasons, and lack of parking spaces, cities are looking to encourage their citizens to use alternate forms of transportation such as bus, rail, or bicycle. Of these, the bicycle is the cheapest form -- for the commuter as well as the city -- with the most health benefits for the commuter. Unfortunately, regular commuting ridership in North America remains the lowest of the globe. North Americans give the following reasons commonly for choosing a car over a bike: they do not feel they are fit enough for a bicycle commute, especially if the commute involves hills, and they do not feel safe when they cannot maintain a competitive speed on the roadways.

Enter the *Ranger*. This “power assisted” bicycle will be designed and implemented by the research and development team of Design Outlaws and, when complete, the *Ranger* will prove to be an environmentally- and user-friendly means of transportation.

For those who do not feel that they possess the physical fitness required to travel to and from their destinations, the *Ranger* will provide assistance as they develop the necessary strength, endurance, and self-confidence. For those who choose not to cycle because of the challenging terrain they would encounter on their path, the *Ranger* will provide the extra energy required to traverse these obstacles.

Design Outlaws strongly believes that we as humans are all responsible for taking care of the world we live in. We also believe that "healthy people are happy people". Therefore, with the development of the *Ranger* bicycle, we believe that we can create an alternative mode of transportation that will contribute to the health of the world.

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DESIGN OUTLAWS

Current State of Technology

The development of the *Ranger* will not mean the end of research into alternative modes of transportation. Rather, Design Outlaws believes that all companies and organizations that care about our environment and personal health must work together to provide the world with comprehensive solutions to the issues at hand.

The following is a brief summary of alternative modes of transportation already available to the public.

Dinamotor Electronic Superbike - Ing. Vincenzo Fittipaldi[3]

The Dinamotor is the brainchild of Vincenzo Fittipaldi; an Italian inventor who has patented this electronic bicycle to assist the elderly and physically challenged. The Dinamotor features an automatic battery recharging system that eliminates the worries of the bicycle running out of power at the end of the day. Furthermore the motor is controlled by the speed at which one is travelling.

LaFree Ebikes[4]

LaFree's motor is activated by your pedal pressure and will increase output power as you exert more force. When you go up a hill (in the same gear), the motor senses the need for more power and automatically delivers. ($995US)

SlipStream Electric Bicycle[5]

This modified bicycle has the pedals removed and is therefore motor-only. Power control is achieved through a throttle with an ON/OFF killswitch. Instead of regenerative braking, the SlipStream uses a freewheel mechanism to maximize power usage. Assembly weight is 80lbs, including a 1hp motor, achieving a top speed of 30mph.

OZ E-bike Commuter[6]

The Speed Controller on this model is mounted on the handlebar, in a traditional motorcycle twist-control. The speed regulator employs pulse width modulation for transmission levels, and apparently has "infinite speed".

Summary

The homemade and commercially available models of electric bicycles currently on the market are non-system comprehensive, non-intuitive, or require more manual intervention than we feel is necessary. Most also employ no acceleration-from-start aid, and none allow the user to specify a target speed.

[3] http://web.tiscali.it/dinamotor/Home-english.html
[4] http://www.electricvehiclesnw.com/main/lafree.htm
[5] http://www.econvergence.net/specs.htm
[6] http://www.geocities.com/ozebike/commuterspecs.htm

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System Overview

Our prototype will follow standard HMH (Human-Motor-Hybrid) electric bicycle construction, consisting of the following main components, visible in Figure 3 (courtesy of PedElec). The main components are:

1) The motor,
2) The chain and gears,
3) The motor controller,
4) The handlebar mounted digital controls/display and
5) The battery.

Figure 3: Basic Modified Electric Bicycle

Our system will build on this typical design by incorporating the following features:

1) Digital pre-settable speed control, operating on flat and hilly terrain
2) Automatic brake-sensing motor shutoff
3) Automatic motor kick-in and incremental acceleration from stopping position
4) AC wall outlet interface and charge control for battery recharging
5) Battery health indicator

One additional feature we hope to incorporate into the first model, but may appear in subsequent releases, is automatic recharging, using the motor as a generator down long or steep slopes, and during braking.

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The system envisioned is shown in Figure 4.

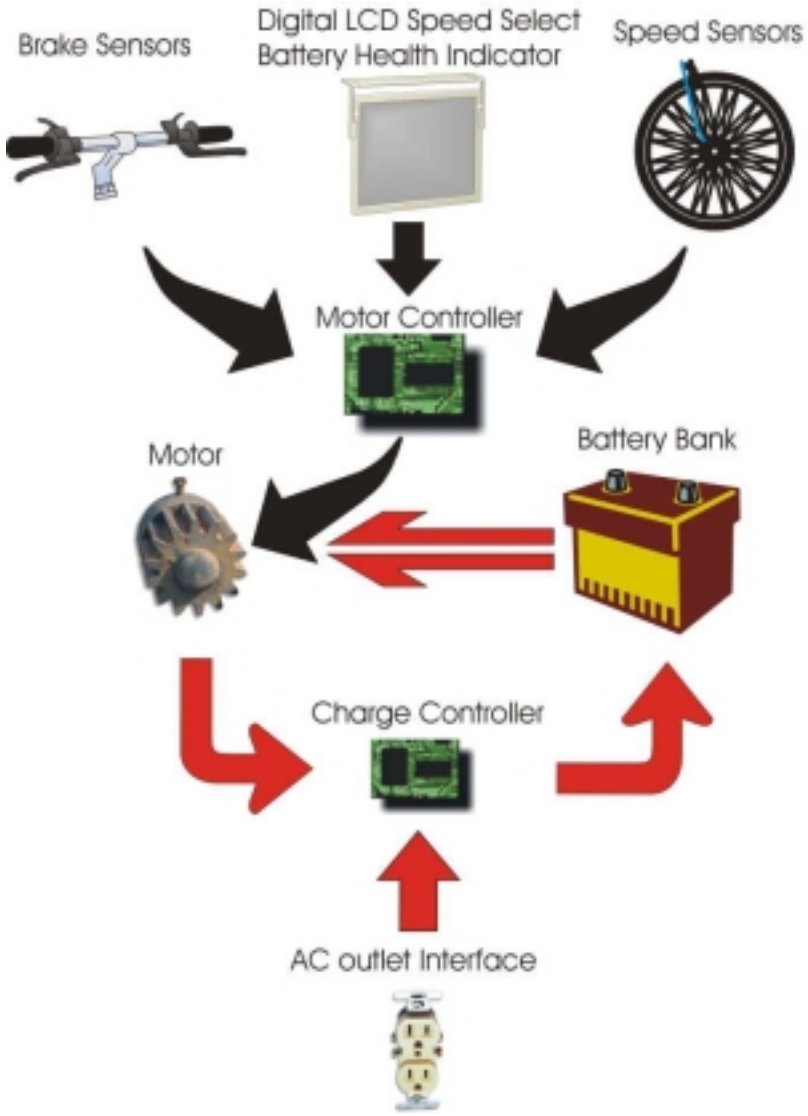

Figure 4 - Electric Bicycle System Diagram

Note that the Red arrows indicate a flow of power, while the black arrows indicate a flow of information.

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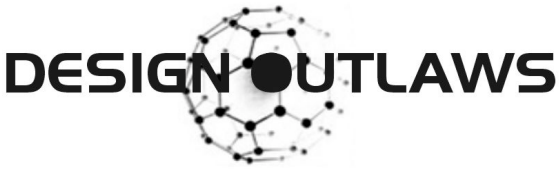

System Components

The four system areas are described below.

Drive System

The *Ranger* bicycle will utilize an electrically powered motor to deliver power to the rear wheel. This motor will enable riders to travel greater distances in a shorter time period and allow the riders to easily ascend any inclines they may face on their journeys. Batteries that have a long life and that can easily be recharged will provide the electricity.

Control System

The *Ranger* bicycle will boast a speed and power control system never seen before. Upon accepting user input specifying a desired speed of travel, the *Ranger's* electronic system will analyze the current speed of travel and vary the motor's power output accordingly. This advanced control system serves a duel purpose. Using only as much of the motor power as is necessary will maximize the range of the bicycle. Furthermore, the control system will also allow the user to work as hard as desired before providing motor assistance, thereby maximizing the improvement of the user's physical fitness.

Display System

The *Ranger* bicycle will be equipped with a state of the art display that will relay pertinent information to the user. The user will have the option of displaying several statistics including the current speed of travel, the distance traveled, and the available battery life. The user will also use the display to instruct the *Ranger* as to the desired speed of travel.

Safety System

The *Ranger* will employ brake sensors, automatic motor-assisted speed limitation (to comply with regulations), and incremental acceleration-from-stop features to maximize utility and safety.

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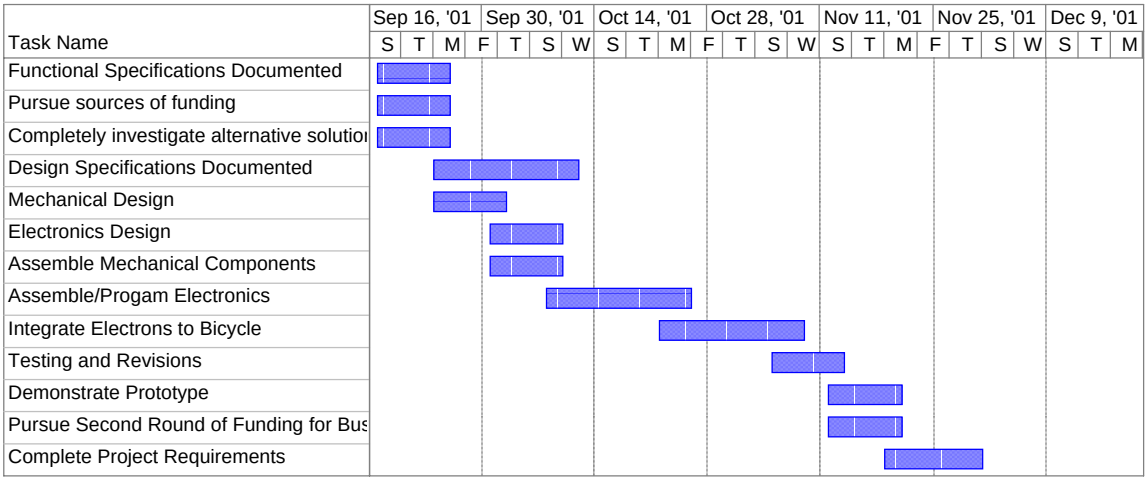
DESIGN OUTLAWS

Project Timeline and Milestones

The following chart outlines the tasks that we intend to undertake during the next twelve weeks of research and development.



Milestones

The following is a list of deliverables and their deadlines:

- Functional Specifications – September 21, 2001
- Design Specifications – October 5, 2001
- Functional power assisted bicycle assembled – October 12, 2001
- Prototype tested and revised accordingly – November 23, 2001
- Final Documentation Completed – November 30, 2001

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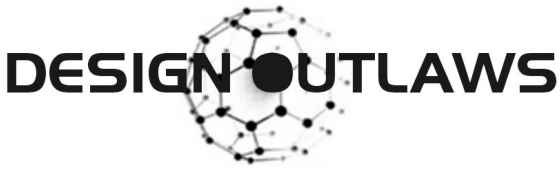

Financing

Table 1 lists the expected costs we will incur during the research and development of the *Ranger* bicycle.

Components	Expected Costs
Bicycle	250
Motor	300
Battery	200
Wiring, Fixtures, and Housing	100
Electronic Hardware	150
Microcontroller board	300
Sensors	100
Literature	50
Total	**$1450**

Table 1 - Expected Cost for Research and Development

Sources of Funding

The *Ranger* is a product designed for both the health of humans and the health of the environment. As such, the Ranger has a wide range of applicability and will generate much interest in the community.

The sponsorships and funding we hope to receive will facilitate the research and development of our product. Furthermore, the sponsorships will demonstrate to the community the seriousness of the issues we are addressing.

In return for funding, our sponsors will actively be part of our exciting and environmentally focused project. More tangibly, we will provide our sponsors public exposure through acknowledgments in the media and in functions at which the *Ranger* will be demonstrated. Upon completion of our working prototype in November, we will be participating in technology fairs, high school demonstrations, and competitions, demonstrating to the public and the youth the field of engineering, and the road to a cleaner, healthier life.

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Specifically, we intend to demo at the following events:

- Western Engineering Conference 2002
- Canadian Engineering Conference 2002
- Simon Fraser University during National Engineering Week (Feb. 2002)
- Local High Schools, related to the field of engineering and energy efficiency
- ASI (Advanced Systems Institute) Exchange, March 2002
- Other functions as requested

We hope that the following individuals and organizations will see the utility of our endeavor and provide us with some of the funding required to complete the *Ranger*.

- Engineering Undergraduate Student Society Endowment Fund
- Wighton Development Fund; Managed by Dr. Andrew Rawicz
- APEGBC student project funding program
- BC Hydro Corporate and Regional Donation Outreach Program
- DynaMotive Technologies
- Solar Energy Limited
- Northwest Public Power Association
- Blak Dog Bikes, Coquitlam, BC
- Cambie Cycles, Vancouver, BC
- Simon's Bike Shop, Vancouver, BC
- Cycle BC Rentals
- Individuals concerned with both the environment and with education

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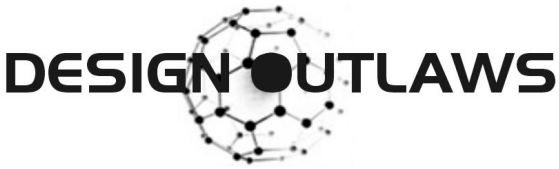

Design Team

Design Outlaws is a synthesis of four senior year Engineering Science students at Simon Fraser University. Each member of the team has a broad experience in design, combined with specific specialties that taken together result in a diverse, fully functional project team.

The entire group will take part in the high-level design and development stages, and in prototype construction. Decisions will be made in concert, with opportunities for each group member to contribute their knowledge and opinions.

This method of design will require intensive cooperation and frequent group discussions, but will ensure that each member has a firm understanding of the entire project scope and interrelations. Particular design tasks will be assigned based on member workload, interest, and talent; for example, Sam Hu is especially interested and talented in the area of software design, and Eric Keung in hardware design.

Roles outside of design will be assigned to specific members; Eric Hennessey will handle external public relations, and Rhiannon Coppin will handle group coordination. A description of each member's qualifications follows.

Rhiannon Coppin – Project Manager

Rhiannon Coppin is experienced in business, marketing, web design, mechanical design, and hardware design. Her schooling and career have brought her to England, where she gained experience in mechanical engineering and industrial automation, and to Silicon Valley, where she learned foremost about design and launching new ideas. Her experiences range from working in industry with design groups ranging from three members to thirty. As project manager for Design Outlaws, Rhiannon brings maturity, experience, and a dedication to upholding vision.

Eric Hennessey – Technical Lead and Marketing Manager

Eric Hennessey brings to his position extensive experience in the engineering industry, both from a design and a public relations perspective. Eric has demonstrated his capabilities as a marketing manager through the successful establishment of Sage Computing Services, through which Eric created a software package that he successfully marketed within the public school system. Eric was also a key contact in the significant media attention that focused on him and his group when the Canadian Space Agency selected their experiment to be conducted aboard the Space Station MIR. Eric has performed hardware, software, and firmware design for several engineering companies across Canada, gaining skills and insights into the industry that will be directly utilized in Design Outlaws.

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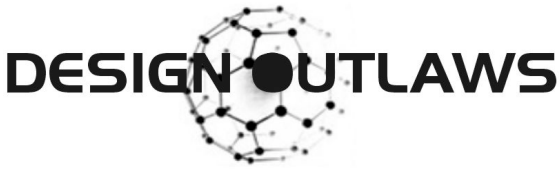

Eric Keung – Head of R&D

Eric Keung is a fifth year student enrolled in the Electronics Engineering program. His area of interest is in analog and digital hardware design. Furthermore, he has gained experience and skills while working on various co-op job placements. Eric has also been active in the community as a past Vice President of Events for the Engineering student society. This role allowed him to organize large-scale events such as the Applied Science Volleyball tournament, First Week events and the Polar Plunge.

Sam Hu – Lead Software Engineer

As someone who deeply enjoys outdoor activities, the environment that we live in is of utmost importance to Sam. Therefore, he intend to use the skills that he has developed during his 5 years of studies at Simon Fraser University as well as his experience in the engineering industry to assist Design Outlaws in developing the *Ranger*. Software skills he possesses includes programming in C/C++/Visual C++, PERL, and Assembly for Motorola and PIC micro-controllers.

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DESIGN OUTLAWS

Conclusion

This document should make our vision clear to colleagues, advisors, sponsors, and other interested parties. With proper support and assistance, we will succeed in providing a groundbreaking technology to the field of electric vehicle design. It is important for engineers today not just to re-invent the wheel, but to “think outside the wheel”. Design Outlaws has pinpointed a need – a need for public acceptance and adoption of alternative transportation – and is poised to implement a solution. The solution, the *Ranger* human-electric-hybrid bicycle, provides the safe, healthy, and enjoyable journey everyone desires. Thank you in advance for supporting our venture.

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