Undent Solutions
Simon Fraser University . Burnaby, BC . V5A 1S6

Jan. 18, 2010

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

RE: ENSC 440 Project Proposal for a Vehicle Lock-Out Prevention System

Dear Dr. Rawicz

Attached is our project proposal for ENSC 440. It explains our idea for a design that prevents users from getting locked out of their car.

The proposal outlines our design ideas, budget and funding plan, and project scheduling. We also discuss current solutions that are already on the market and compare them to our solution.

Undent Solutions is composed of Marissa Hun, Daphne Mui, Dona Patikiriarachchi, and Elisa (Xuan) Lu. We are a hardworking and focused team. If you have any questions or comments regarding our proposal, you can contact us through email at mmh2@sfu.ca.

Sincerely,

Daphne Mui

Daphne Mui
CEO
Undent Solutions

Enclosure: Proposal for a Vehicle Lock-Out Prevention System

Vehicle Lock-out Prevention System

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Submitted to:
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Steve Whitmore (ENSC 305)
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EXECUTIVE SUMMARY

Have you or has someone you know gotten locked out of your/their vehicle at any point in time? Imagine the frustration, the waste of time, the expensive call to the metal smith and the inevitable damage caused by break-opening the door. Would not it be nice to prevent this unfortunate scenario? The people at Undent Solutions think so.

According to the American Automobile Association (AAA) statistics, the auto club continues to receive a large volume of calls for help with "locked car-keys inside" [1]. This appears to be a common problem that many drivers encounter due to today's fast-paced, busy lifestyles. The goal of this project is to create a system that takes care of car lockouts, so that our customers have one less precaution to keep in mind.

As elaborated in this document, the Vehicle Lockout Prevention System designed by Undent Solutions proposes a unique and simple way to prevent car lockout with the help of the increasingly popular Radio Frequency Identification (RFID) technology. An RFID reader placed in the car will detect a unique RFID tag attached to the car keys when the keys are inside and if the car is locked it will alarm the user and will automatically unlock the doors so that the user can easily retrieve the keys. In the case when someone is in the car and they purposely want to lock the doors while having the keys inside, all the user has to do is push a button which will override the system.

Currently, there are many proposed ways to retrieve the keys from a locked car. Apart from forcing open the door with tools, there is a system that lets the user open the door with a sequence of taps [1]. When the pre-programmed personal code is entered as a sequence of taps on the windshield, the sensor placed in the car compares this sequence to the code stored. If the two codes match, the door will be unlocked. This imposes a security concern as anyone who memorizes the car owner's tap sequence can easily unlock the doors. Our solution is unique as it prevents lockouts and more effective as it is reliable and saves money and time.

Undent Solutions consists of four fifth-year engineering science students with extensive experience in analog/digital circuit design, mechanics and software and hardware programming. These four talented individuals have worked in ample projects ranging from microcontroller programming to robotics that has sharpened their skills in both hardware and software engineering.

We propose an engineering timeline consisting of research, design and construction. The timeline will span a 13-week period with a scheduled completion date of April 16, 2010. The entire project is tentatively budgeted at $545, which we expect to obtain from a variety of funding sources.

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1. INTRODUCTION

Today, we live in a fast-paced social environment. Time is limited and our minds are always thinking ahead to the challenges we face in day to day life. The last thing we need to worry about is locking our keys inside our car. Not only is it a frustrating experience, it wastes valuable time and money. Time is spent waiting for the AAA to assist in regaining access to your vehicle. Money is spent on repairing the car window you break after growing impatient while waiting for the AAA representative. If there is a pet trapped inside your vehicle or if the engine is still running while you are locked out, the problem introduces a safety issue and the situation becomes much more urgent. Locking your keys inside your car should not be a concern for drivers, but it is. The figures speak for themselves; according to the AAA, 546 drivers lock themselves out of their car each hour [1]. Even before considering drivers who don't bother calling the AAA, we clearly have a big problem.

For our ENSC 440 project, we are aiming to prevent this situation where the user gets locked out of their vehicle. Our solution is to create a system that checks if the car key is still inside the vehicle and takes the necessary action to respond. First, the system senses if the key is inside the vehicle. If it is not, then no further action is required. However, if the key is still inside, the system checks if all the car doors are locked. If both these conditions are met, the system alerts the user through a warning sound and unlocks a door so that the user can retrieve their key. A manual override switch can be used to shut down the system in situations where the user wishes to wait idle in their vehicle with the key and their doors locked.

Our project is meant to be used as an aftermarket addition to a standard key locking small car. There are many possible extensions that could be added, including integrating our system with a user interface LCD display, power locks or expanding our system for use with larger vehicles.

Our proposal will explain our system design in more detail, as well as compare it to other existing solutions. We also discuss sources of information, budgeting, funding, and our project schedule.

2. SYSTEM OVERVIEW

To explain the procedure of what our system goes through, the basic functionality of our design follows the flow chart methodology shown in figure 1.

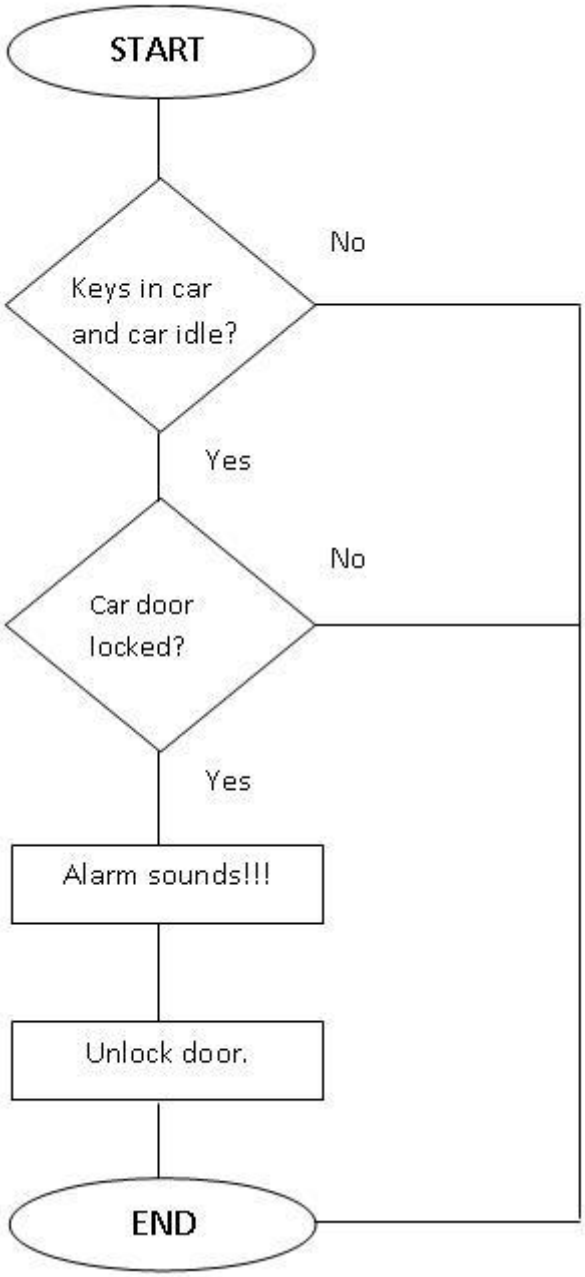


Figure 1: Algorithm flow-chart

The main system transceiver checks to see if the door is locked and the vehicle is stationary. With the RFID tag attached to the key, the transceiver continuously receives information from the tag checking to see if the key is still within the vehicle. If the tag is detected in the vehicle, the main transceiver will emit a warning sound notifying the driver. The door will then unlock allowing the driver to retrieve the key. If the keys are not in the car then the system will remain in an idle state. There is also a manual override button for situations where the user may want to wait inside the car with the doors locked.

3. EXISTING DESIGN SOLUTIONS

Many people have suggested numerous workarounds to retrieve keys from a locked vehicle. Trying to get into the car through the back window, using a long rod slid through a small gap between the car door, using a locksmith's tools to force-open door, using cell phone signals and tap opening the doors are some of them. All of these solutions have a common theme: trying to fix the problem of being locked out rather than preventing it. A more detailed description of the existing solutions and their drawbacks are given below:

3.1 Entering the car through an open back window

This method works well with older vehicles and Jeeps. One of our team members has first-hand experience with crawling through the back window of a Jeep and unlocking the doors. If no windows are open, this method becomes futile.

3.2 Sliding a long rod through the door gap

This method uses an air wedge to create a gap between the car door. The long rod is carefully slid through the gap to reach the lock and unlock the doors. It is a difficult task to locate the lock with the rod and manipulate it. Also, if the rod slides against the glass it creates a harmonic in the glass which causes shattering of the window [3].

3.3 Calling a locksmith

An experienced locksmith has all the right tools to carefully unlock car doors. However, with some of the newer car models, it has become an increasingly difficult task. The locksmith has to make sure that his/her tools do not interfere with the electronics in the car door and also prevent triggering of the airbags. Also, this is the most expensive method.

3.4 Using cell phone signals

A person with a spare key calls the person who got locked out on a cell phone and hits the unlock button while keeping the phone near the key. The person near the car has to hold the cell phone about one foot away from the car door and it should open the door. This method is a misunderstood chain letter adopted from General Motors' OnStar service. Many new cars are equipped with a keyless entry system (a transmitter tag) which allows its users to unlock doors from up to 300 feet away [4]. If the car is also equipped with the OnStar service, then an OnStar operator can unlock the vehicle via a signal sent through a cellular network. This requires a subscription to the OnStar service and if the cell phone is also locked in the car, it is ineffective.

3.5 TAPLOCK Finger Tap Keyless Entry System

This product uses a combination of taps to the windshield to unlock the car or trunk door. It comprises of an electronic device that is wired to the unlocking mechanism of the car door assuming electric locks and senses the sequence of taps on the windshield [1]. If the sequence of taps matches the stored code in the device then the car or trunk door unlocks. One of the problems with this design is that the door needs to have electric locks. Also, living in such a fast technology driven world with plenty of PINs to memorize and passwords, it is just one more thing the motorist needs to memorize. There is also the possibility that the microphone on the device is easily susceptible to outside noise thus, reading in the wrong code.

4. PROPOSED DESIGN SOLUTION

There are numerous methods of retrieving your keys from your locked vehicle some of which include: locating a spare key, calling a tow company, or breaking into your own vehicle. According to AAA, millions of motorists are affected by this problem every year [2]. From past experiences, the above solutions are not always available and they can become very costly and inconvenient. Our proposed design solution is to develop a system that detects whether the keys are locked in the vehicle and unlocks the door if the keys are locked in.

The system uses RFID transceiver sensors placed strategically at the center of the car which confines the range of the sensors to be just within the car frame minus the engine. The tag, targeted by the sensors, is attached to the car keys. When the sensor unit detects that the engine is turned off and the car doors are locked, it begins to check where the tag is located. If one of the sensors detects the tag, then a warning sound will be emitted alerting the motorist of the locked in key and consequently unlocking the vehicle door to retrieve the key.

This problem has already been approached by designing a remote keyless-entry system that is placed in newer vehicle models today. However, there are still many older vehicle models on the road that do not have this technology in place and still use a key entry system. We plan to target this medium because our system is designed as an add on to existing car models with minimal cost and long term benefits. Furthermore, our design solution is different from existing methods and products out on the market because our design approach is prevention first.

With the proposed time and planning schedule we understand that our designed system functionality may be limited in order to meet the deadline. Some of the design specifications we opted to remove from our design solution proposal was to not feature a user interface LCD screen for feedback. We chose to remove this because of the tight scheduling and deadline and our limited sources of funding.

5. SOURCES OF INFORMATION

In order to analyze and improve our product, we need to obtain quite a lot of information from various sources such as: professors, teaching assistants, electronics reference books, the internet, component manufacturers (data sheet, phone contact) and engineering journals.

There is no doubt that the internet is our most valuable and informative source for us to look for our funding, manufacturer contacts, and similar existing products. We located most of the parts we need from Digikey.com. The RFID reader, which is the most expensive and necessary component for our project is found from alibaba.com (china website) to reduce costs in our budget. By contacting customer service and the technical support department of manufacturing, we obtained the price range of the RFID reader needed. In addition, we needed to locate information on similar products out on the market from Ebay.

Moreover, Dr. Andrew Rawicz will be our best supervisor to ask the questions about hardware and mechanical design. He is professional and knowledgeable in mechanical design solutions which could give us a lot of suggestions on the unlocking mechanism we need to build. Also, his rich experience in working with previous capstone project groups can guide our team to picking the right RFID reader and microcontroller for our project. Also, John D.Smith, who is the co-op supervisor of one of the group members, is able to provide us with professional industry advice. He has almost thirty years experience working with electronics and related aspects. His help is definitely an asset to our project. Furthermore, other students who worked on RFID systems for their ENSC 440 project, such as Surbhi Seru and Rachel Cheng, could be another useful resource.

6. BUDGET AND FUNDING

6.1 Budget

Table 1 below shows the cost breakdown for the demo model of our vehicle lock-out prevention system. Since the demo model is still currently in the design stages, the budget amount may vary as the development progresses. Therefore, an estimation of 15% contingency fund has been considered for unexpected expenses.

Table 1: Tentative Budget

Equipment List (model no.)	Estimated Unit Cost
RFID Reader (AOSID 0702) x2	$517.50
RFID tag x2	$5.75
Microcontroller (Semtech)	$12.32
Piezo Ceramic buzzer (AVX Corporation)	$0.92
DC motor	$5.75
Switch	$3.45
Total Cost	**$545.69**

6.2 Funding

We are currently applying for Engineering Science Student Endowment Fund (ESSEF). Although we didn't get the final result from ESSS staff yet, each member is confirmed to obtain 50 dollars from engineering science faculty. We are also trying to look for funding from the Woman in Engineering Group (WEG) at the same time since each member of our group has participated in WEG events before. In addition, we may ask for grant funds from ICBC. The rest of the uncovered costs would be split equally among the team in the future.

7. SCHEDULE

Figure 2 and Figure 3 display the Gantt chart and Milestone chart respectively. The Gantt chart briefly sketches our project development timeline and working schedule we need to achieve. While the milestone chart lists the various documentation and relating demo and presentation due dates. Also, the timeline below is an approximate schedule due to the not yet determined presentation/demo, professional journal and post-mortem deadline.

Figure 2: Gantt Chart

ID	Task Name	Start	Finish	Duration
1	Research	04/01/2010	20/03/2010	75
2	ESSS Funding	06/01/2010	13/01/2010	7
3	Proposal	11/01/2010	18/01/2010	7
4	Function Specification	11/01/2010	08/02/2010	28
5	Oral Progress Reports	01/02/2010	12/02/2010	11
6	Design Speccification	25/02/2010	08/03/2010	11
7	Written Process Report	08/03/2010	22/03/2010	14
8	Unlocking Mechnism Built	18/01/2010	31/01/2010	13
9	Components Ordering	18/01/2010	07/02/2010	20
10	RFID and micocontroller testing	01/02/2010	14/03/2010	41
11	Integration/Prototype testing	15/03/2010	28/03/2010	13
12	Debugging/Prototype Modification	29/03/2010	13/04/2010	15
13	Documentation/website	04/01/2010	13/04/2010	99
14	Process Report	05/04/2010	19/04/2010	14

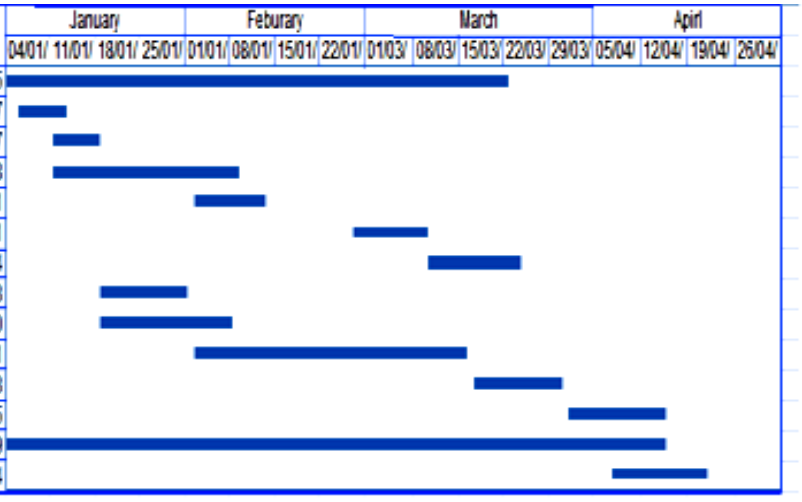
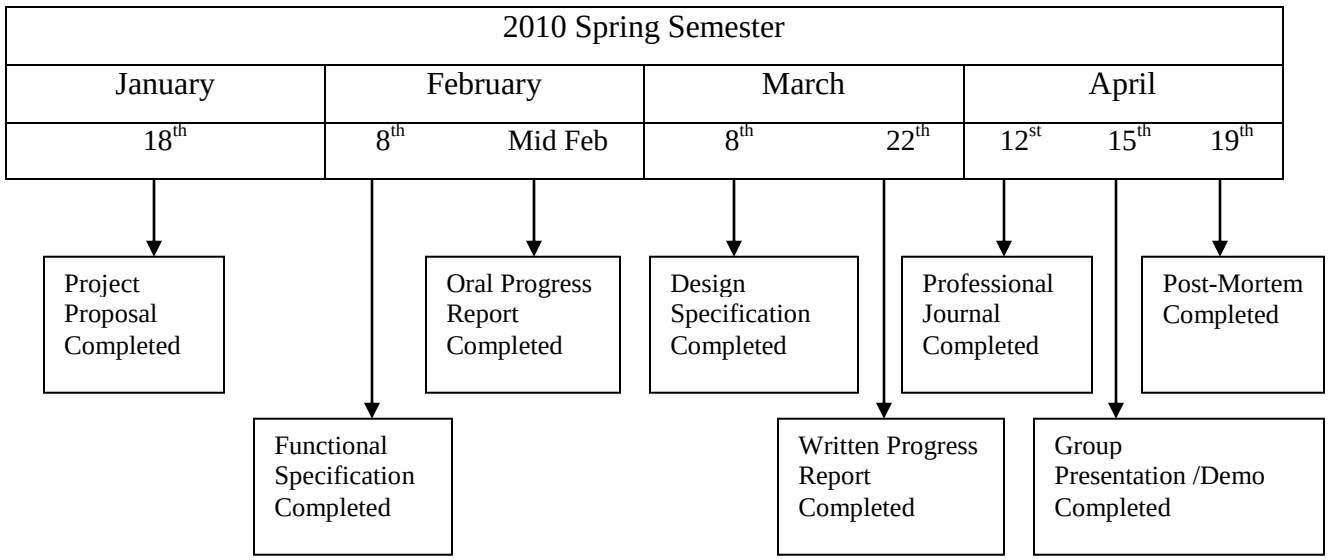


Figure 3: Milestone Chart



8. TEAM ORGANIZATION

Undent Solutions is a joint effort of four diligent and creative engineering science students at Simon Fraser University: Marissa Hun, Elisa (Xuan) Lu, Daphne Mui and Dona Patikiriarachchi. All members are fifth year undergraduate students. Marissa, Elisa and Dona are specializing in electronics and Daphne is specializing in systems engineering. These four enthusiasts with diverse interests joined Undent Solutions with a common goal in mind: to build a working model of device that will benefit the society as well as to further their education. The next section, Company Profile, highlights each individual's specific skills.

Aiming for the successful completion of the project, the staff at Undent Solutions is given a specific role and related responsibilities. Daphne Mui, Chief Executive Officer (CEO), is in charge of setting strategy and leading the company. She will manage the overall progress of the project and resolve conflicts of interest within its members. Marissa Hun, Chief Financial Officer (CFO) is responsible for managing financial risks as well as financial planning such as funding. Dona Patikiriarachchi, Vice President of Operations, is in charge of managing technical operations. She will apply her critical thinking and suggest unique ways to solve any technical issues of the project. Elisa (Xuan) Lu, Vice President of Marketing, is responsible for, but not limited to, managing vendor relationships, copywriting, web design and capital growth through product marketing and sales.

To ensure professionalism and to reduce communication issues, the team has designated a meeting time and place every week. During meetings, each person will give a brief update on what they have been working on, status/accomplishments of the week, issues and plans for next week. All members are in favor of meeting in-person rather than online networking such as chatting due to unexpected network failures. All team members have each other's schedules so everyone is aware of where the others are, what they are doing and when not to contact them. Furthermore, the tasks will be split among pairs so that two people can work together. In order to maximize project time while allocating enough time for other courses, rest and extra-curricular activities, one pair will work from early morning to late afternoon while the other pair will work from late afternoon to late night. The shifts will be interchanged according to needs.

We at Undent Solutions understand the importance of working as a team. The many project/lab courses we have taken throughout the past four years as well as our co-op experiences have considerably improved our teamwork ethics. Therefore, we are certain that we will be able to successfully complete our project while still being good friends as we respect each other's opinions and value their advice.

9. COMPANY PROFILE

Daphne Mui – Chief Executive Officer (CEO)

I am a fifth year systems engineering student at Simon Fraser University. My strengths lie in having a very diverse background and being highly adaptable. My work experience includes writing automated test scripts for the Subscriber Services Controller team at Alcatel-Lucent using Perl and TCL/Expect. Through various courses, I have become familiar with software programs such as Solidworks, Visual Studio, and MATLAB. I am also familiar with using electronic lab equipment. I have had a lot of experience leading teams in the past. Each team is unique, and it is important to use the strengths of each member to reach our goals.

Marissa Hun – Chief Financial Officer (CFO)

I am a fifth year electronics engineering student at Simon Fraser University. My previous co-op experiences include working at Icron Technologies Corp. where I worked in QA and contributed in debugging USB devices and researching new technologies. I have experience in programming with MATLAB and C++ and working with electronic lab equipment such as oscilloscopes, DMMs and function generators. I also have experience and work well in a team environment and I have good organizational and multi-tasking skills.

Dona Patikiriarachchi – Vice President of Operations (VP Operations)

I am a fifth year electronics engineering student at Simon Fraser University. I bring to Undent Solutions a wealth of experience ranging from microcontroller programming to analog/digital circuit design. My past co-op experience include Dolby Canada Corporation where I was responsible for the automation of optical instruments using MATLAB and C++ programming languages. I have a high-level understanding of microelectronic fabrication, circuit theory, Computer Aided Design/Manufacturing (CAD/CAM) as well as feedback control and systems. I have good communication skills and am an excellent team player.

Elisa (Xuan) Lu – Vice President of Marketing (VP Marketing)

I am a fifth year electronics engineering student at Simon Fraser University. I have past working experience in Analytics System for both mechanical and electronics technician. My roles include product prototyping, debugging analog circuits, inventory control and documentation control. I believe my MATLAB and C++ programming skills and my interest in microcontrollers will definitely benefit our group. In addition, I am recently involved in assisting a marketing promotion for a fashion shop. The experiences strengthened my skills in communication, organization and marketing analysis.

10. CONCLUSION

With today's fast-paced lifestyle, there is obviously a need for systems that allow users to take their mind off mundane things. We believe that our vehicle lock-out prevention system will be beneficial to many vehicle owners. It will allow people to shift their focus to more important things in their everyday lives.

We have presented our project ideas and compared them to existing solutions. Our research is conducted through many different sources of information. The resulting design is based on the simple, but effective concept of searching for the key and alerting the user. We have also considered our budget and funding, as well as our project timeline. The different experiences from each individual on the team were highlighted to show our best abilities.

In conclusion, with the combined efforts of everyone in our team, we are certain that we have the expertise and motivation to successfully complete this project.

11. SOURCES AND REFERENCES

[1] Wolfcom Innovations, “TAPLOCK Finger Tap Keyless Entry System”, Aug. 14, 2009. [Online]. Available: http://www.taplock.com/ [Accessed: Jan. 15, 2010].

[2] Ron Cogan, ”How to Avoid Getting Locked Out of Your Car”, [Online]. Availiable: http://www.ehow.com/how_2158390_avoid-getting-locked-out-car.html [Accessed: Jan. 15, 2010].

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