April 18th, 2010

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

Re: ENSC 440 Post-Mortem for a Blind Spot Safety System

Dear Dr. Rawicz,

The attached document contains the design specification of our project iChecked blind spot detection system for ENSC 440. The aim of our project is to implement a blind spot safety system for automobile drivers.

The purpose of the document is to describe the current status of our demonstrational system, deviations from the original design plans, and modifications for the future development. The actual time and budget will be discussed, and the individual member's experience will be presented for what we have gained after completing the project.

Ensuring the success of our project is a team of three enthusiastic and talented individuals from the School of Engineering Science: Barry Li, Victor Chen, Aron McKinnon and Elyas Sepasi. We believe this team is capable of accomplishing the proposed task in a timely fashion.

If you have any questions or concerns, please do not hesitate to contact us via email at blindspot-440@sfu.ca.

Sincerely,

Barry Li
Chief Executive Officer
iChecked Inc.

Enclosure: Post-Mortem for iChecked Inc. Blind Spot Safety System

Post-Mortem for

Blind Spot Safety System

iChecked Inc.

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Submitted to: Dr. Andrew Rawicz – ENSC 440
Mr. Steve Whitmore – ENSC 305
School of Engineering Science
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Issued Date: April 18th, 2010

Executive Summary

This document details the current state of our project, the problems encountered, the proposed and actual timeline and budget, our group dynamics, what was learned, and suggestions for future work in this project.

With respect to the current state of our project, all the functional specifications have been met and exceeded. The noteworthy problems that we encountered were few, and the only problem which remains on the reduction of vibration and noise coming from the actual testing vehicle. The actual timeline deviated for the proposed in terms of time allotments for individual tasks, although in the end the deadline for this project was met; most notably, things were accomplished in parallel as opposed to being linear in fashion.

The actual budget is less than both the proposed budget and our funding. Numerous lessons were learned as a group and as a whole, and cannot be done justice here; we refer the reader to section 6 which concerns the individual reflections. Several suggestions for the future direction of this project are mentioned briefly for the potential of its applications.

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1. Introduction

According to a report by Automotive News, more than 410,000 vehicles in North America are involved in lane-change blind-spot accidents annually [3]. A method to deal with this issue is very necessary, and should be made available to the general users.

iChecked Blind spot safety system is a driver assistant product that informs drivers of upcoming vehicles in the blind spots. It provides automated warnings before you even make a move on the road. By making the drivers more aware of potential hazards on the adjacent lane, we promote the driver to conduct more thorough shoulder checks and share the road. Although shoulder check is mandatory in North America, some still ignore or forget to do so. Certain vehicles have interior designs which limit vision and even with a shoulder check changing lanes can still be dangerous for the driver. The product cannot eliminate all the bad drivers, but will improve the safety records of anyone who is willing to do better. We feel that such system will significantly reduce the lane-changing related accidents.

The Blind Spot Detection system would consist of a sensing stage, a signal processing stage, and an output warning stage. The sensor of the blind spot of the system detects cars on the side-blind-spots of the vehicle. The signal is passed to a processor circuit which will process the data and determine if a vehicle is in the blind spot area. If so, warning signals consist of audio and visual components will alert the driver of neighboring traffic.

2. Current State of the Device

2.1 Overall System

The block diagram in Figure 2-1 shows the basic functions of iChecked BSDS. Once our blind spot safety system is powered, it will actively check the blind spots in surrounding area of the car to see if another vehicle is present. Our system is sensitive only to the blind spots in the lanes neighboring our vehicle. When the safety system is triggered, the driver will be notified via a discreet and non-distracting warning indicator.

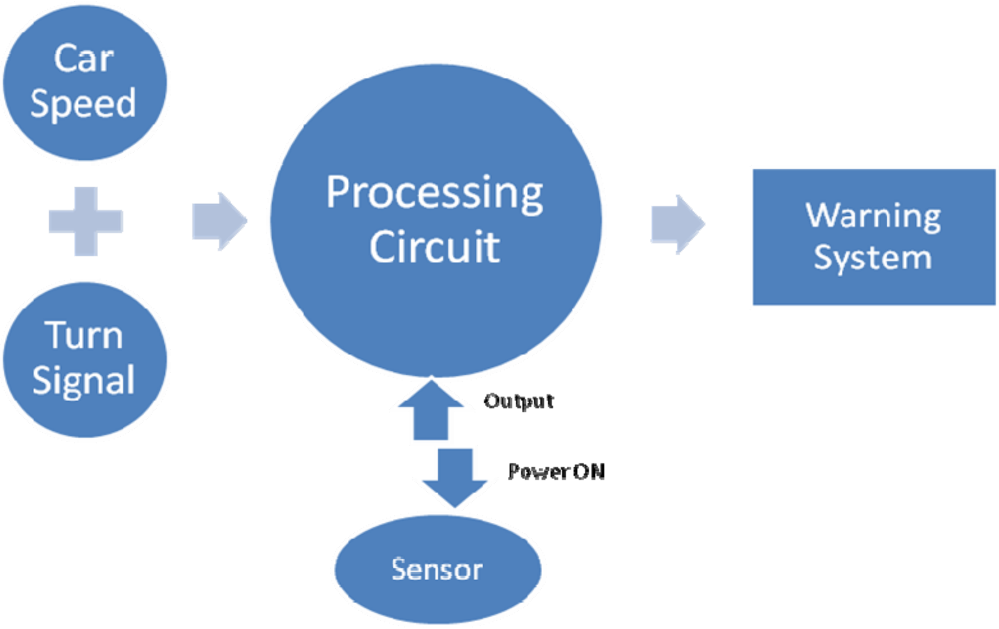

Figure 2-1: Overall Block Diagram

Figure 2-2 shows what we have envisioned the installation of our system on an actual vehicle. This design is a reflection of nearly 4 months of contemplation and constructive debate, and it best represents our design.

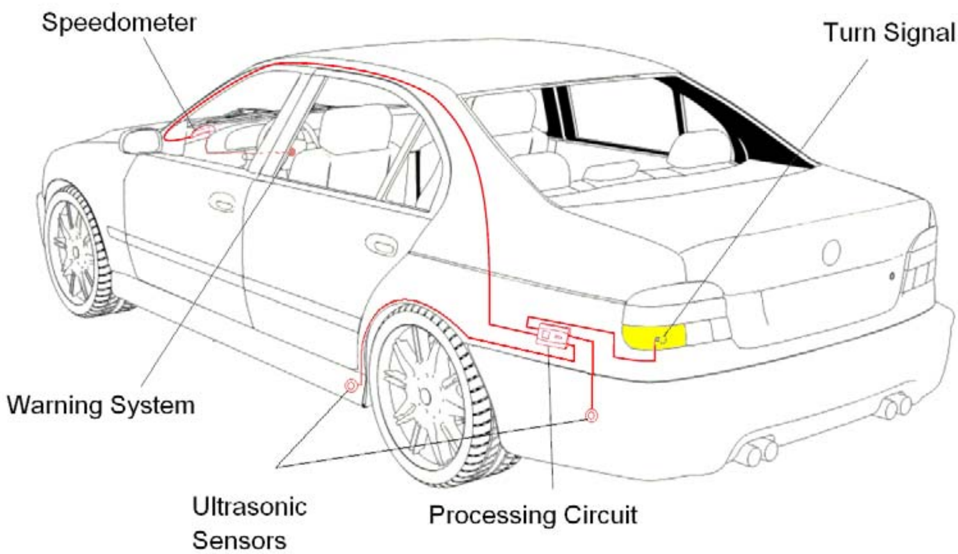

Figure 2-2: Left Side See-Through Sample of our product

2.2 Input Sensor Stage

At the beginning of the research and planning we agree on laser range finder as our input sensors, due to its precision in detection and minimum requirement for ambient condition. However we use low-cost ultra-sound range sensor as the final design after we research the listing price of all the possible sensors. We were looking for a sensor that can only cover 5 meters in length, but currently there are no exact range sensors satisfy our requirement. There are many sensors cover up to 10 meters and it has only digital output but since microcontroller is not used in the processing stage, we will have a hard time to extract the exact reading from digital to analog. Also there are high-precision sensors covers only up to 1.5 meters or less for industry use, which is still acceptable for our project. High-precision does come with a high price, so we found one in China that cover 3 meters is over 2000 Canadian dollar. Due to the limited choice of the input sensor, we think the rear parking sensor is cheap and relatively reliable for this project.

After we received the rear parking system package, we realized the sensor does not cover 3 meters as the package stated. As the time flied and the communication problem within the team we decided to live with the existing system and bought another one for backup. In the end we used up all two system separately for each side of the vehicle. In the lab we tear it apart and analyzed the component of system and able to pull out one usefully output for this stage. The sensors is powered by 12 V and the output is in the range of 0.4 V-0.7 V DC, when the sensor is ideal then is 0.4 V and when it senses an object within range then is 0.7 V.

Six sensors are positioned at the back side of the vehicle and it is responsive to cover blind spot object. At the prototype stage we just use foam and tape to secure the sensors for demonstration purposes, further improvement will be discussed in the later section.

The average cost of this ultra-sound sensor is 40 Canadian dollars, and therefore ultra-sound sensors are a huge advantage over other sensor type. However the responsive time of this system is under the requirement of our functional specification, a short responsive time is critical to the safety of our system can provide.

2.3 Processing Stage

This stage is completely built on two bread board for each side, and it is a duplicate of each other. At the design and planning stages we thought logical gate would be a good idea, but in the final version we used two BJT to function as two AND gates and simplified the circuit. The output signal from the input sensor will trigger the BJT to release power from the source, and the source is coming from the speed signal that is over 30 km/h. For the complexity of the speed signal, now nearly every vehicle use digital odometer, we are not able to use the speed signal as one of the logic condition. As an alternative and just for proof of concept we assume the speed condition is always on by using a 12 V DC power source. Therefore the condition to turn the system on will be only the turn signal.

The turn signal is pulled from the back of the vehicle since the processing circuit is located in the back. However the downside is the brake is also controlling the turn signal at the back, problem arises when we brake and there is an object in the blind spot the system will make a false alert. If time allows we could have use the turn signal from the front of the vehicle.

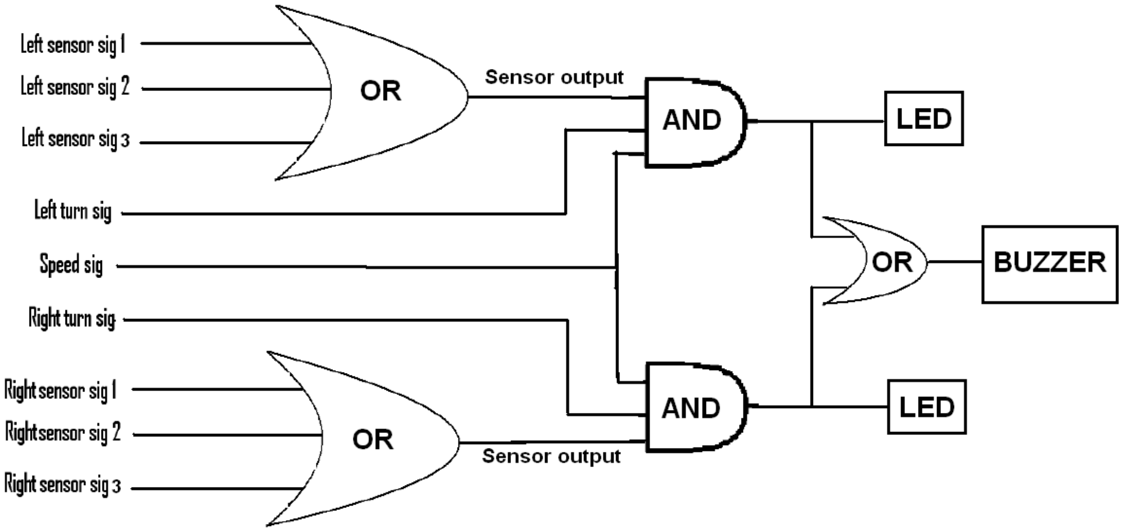

Figure 2-3: Processing stage design

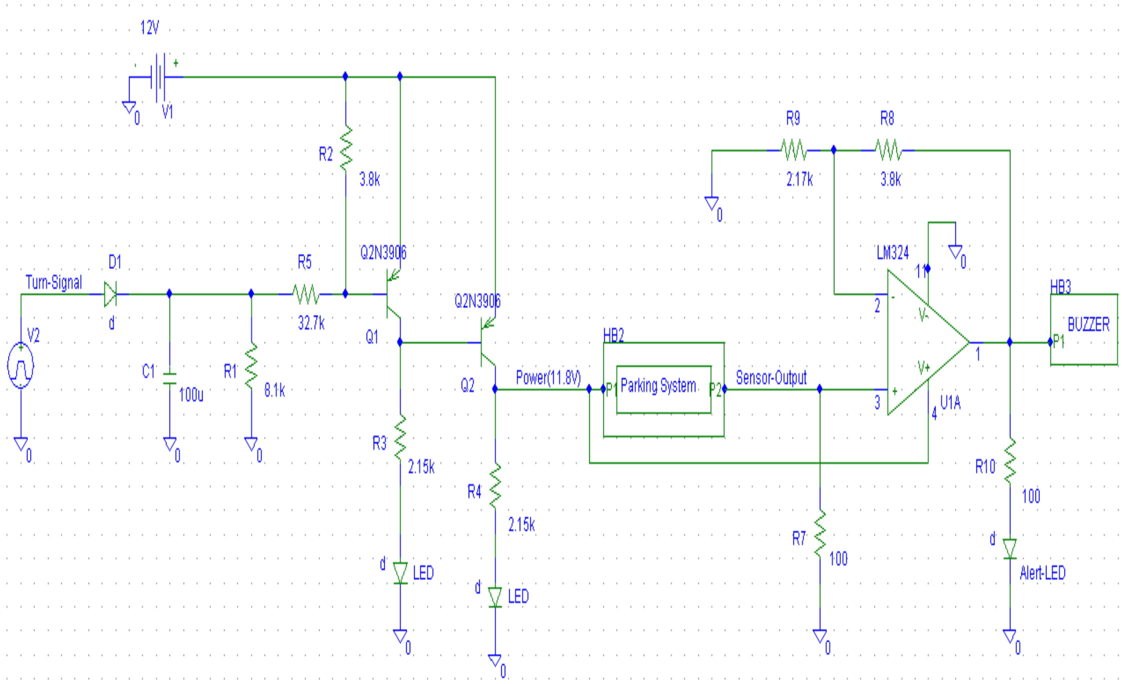

Figure 2-4: Processing stage circuitry

2.4 Driver Warning Stage

The purpose of the blind spot detector that we are designing is to increase the safety of the driving. For the safety of drivers, our system includes audio and visual parts, in order to use both sight and hearing senses. Having visual and audio decreases the chance that the driver misses the warning alerts. For instance, when, due to the combination of lights outside and inside the car, the driver misses the light indicator, there is a sound alarm as a back up to warn the driver. On the other hand, if the environment is too noisy (loud music or noise of traffic) and the driver cannot hear the alarm sound, there is a visual alarm to

inform the driver. Since iChecked is targeting after market, the design of blind spot detector shall be user friendly. As a result we make a small package for warning system which includes LED and buzzer. This kit is installed inside the car behind the wheel or on dashboard (preferred behind the wheel). The reasons we chose inside of the car to install the warning system are explained below.

First we do not change the exterior appearance of the car as well as the interior, which otherwise the costumers would not be happy with this feature. Second, , the design of the steering wheel for almost all the vehicles is same therefore, independent form the kind and model of the car, owners have this opportunity to buy the iChecked and have it installed on their cars. And at last, installation of such kit is straight forward enough to capable most of the costumer to install the kit by their own.

As it is mentioned before in our final design the warning system includes two subsections: auditory and visual in order to use both sight and hearing senses. For the visual part of the warning system we are using some LEDs. The LEDs that we are using have the fairly bright color. Hence, their effect is obvious even in day time. Because the light is bright and relatively strong, LEDs are implemented in such a way that they do not shine directly to the drivers' eyes for safety purposes. The LEDs are behind the steering wheel pointing toward the dashboard. Therefore, they light up the dashboard and attract drivers' attention. In addition, we designed the LEDs somehow that depend on how far the object is from the car have different speed of blinking. As the object gets closer to the car, LEDs blink faster. The auditory part of the warning system is responsible to make alert sound in order to warn drivers. A buzzer is installed on the board of the warning system, which is placed behind the steering wheel. The proposed location of the installation makes the buzzer really close to drivers. Therefore, the chance that the drivers hear the alarm is high. Also same as LEDs, buzzer has different rate to make sounds. As the object gets closer to the car, buzzer beeps faster. The different rate of blinking and beeping helps driver to have an idea about how far the object is from the car.

To explain briefly how the warning system works we can mention that:
Warning system received the signals from CPU passing those through an amplifier in order to have the desire current for LEDs and the buzzer. The signal sent form CPU has 5 V voltages which is enough for both LEDs and the buzzer on the warning system.

3. Future Improvements

Though our target goal is to have a working prototype by the second week of April 2010, we are not limited to think ahead on our actually production goal.

3.1 Overall System

In our future work we plan to add an accelerometer to our blind spot detector. Accelerometer will make sure that the vehicle is moving forward or it is better to say that make sure that sensors are off while vehicle moves backward. This trigger also is connect with an 'AND' gate to turning signals and speedometer.

The other feature that we will add to our design is the speedometer. Speedometer is another trigger works similar to turning signals. In this design speedometer and turning signals are connected through an 'AND' gate. Therefore, sensors are on if turning signals are on and vehicle is moving faster that specific speed.

3.2 Input Sensor Stage

Another change that we are willing to do is increasing the range and accuracy of sensors. To improve these aspects we have two options: we can choose different type of sensors which increase the cost of production, the other option is to modify the circuit that we have.

3.3 Driver Warning Stage

For auditory part in order to be more effective we will work with the speakers in a car as well as radio. Instead of turning the buzzer on, we play sound form speakers. In addition to this alarm, in case if the radio inside the car is on our warning system turns off the radio and play the sound from speakers. Therefore, we make sure that drives are hearing the alarm.

4. Budget

By the time we start working on our project we thought we might be faced by some financial issues for obtaining the required parts of the project. We also added 10% of each cost to our estimations and then calculated our estimate prices. Not only we over estimated our project at the beginning, but also, during actually working on the project we did our best to cut the costs as much as possible. For instance for some parts instead of buying new equipments, we modified some of old components that we already had. In addition, we designed some of our circuits in order to reduce the costs.

Table 4-2: Budget of iChecked Inc.

Components	Estimated Spending	Actual Spending
Sensors and receivers	$260.00 (for 2)	$110.00 (for 8)
Microcontroller board	$100.00	$30.00
Accessories	$200.00	$50.00
Total	**$560.00**	**$190.00**

As it is shown in table.1 our estimation is lower than actual cost of our project. As we mentioned before this difference is due to providing the equipments form different sourced to decrease our cost. For instance, we used electronic components form ENSC resource office, which worth $40, for free. The accessories we talked about is all small cost to modify the car such as fuse replacement, wire splitting, connectors, the 12V DC power supply (we used from an air pump). For this project the only funding that we were eligible to receive was from ESSSF and the total was $500 which covered all our costs.

5. Time

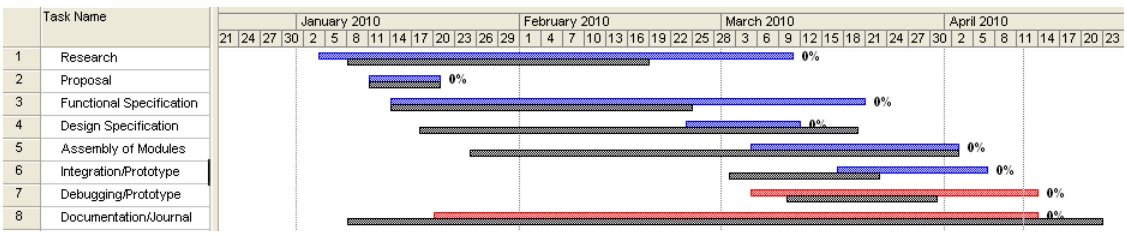

Figure 5-1: iChecked Inc. Time table*

* Blue/red color is our proposed time, and black is our actual time.

As it is shown in the time table above, all the deadlines in the course were met during the semester and the timeline was more or less followed with slight deviations. Even though design specification took so much time from us and we were behind our own schedule, we met the deadline for the course. In addition, because of the problem that we had with one of our member, which it is described in team dynamic section, our documentations could not meet our deadline. However, by the help of all other members this unfortunate event did not impact the result and the product was presented and documents were hand in at the course set date.

6. Personal and Technical Experience

6.1 Barry Li

As leader of the team, I have gained a strong leadership skill as well as technical skills, which have led me and my members to the accomplishment of a long time span project. We have managed time very well, and by distributing our responsibilities efficiently, accomplished our goals and integrated successfully at the end.

During the very early stage of this semester, our team took the time to think through about our proposed project. We went to former and current ENSC 440 TAs and professors and car specialists to asked quality questions. I appreciate very much of their honesty and patience. I feel by taking this step properly at the beginning we were able to achieve our goals.

Throughout this project, I came to fully realize the importance of self-initiative on behalf of all group members. It was immensely helpful when someone was able to say “I think we need to get task ‘X’ done, and I am going to tackle it,” rather than saying “What needs doing next?” I was very impressed with the amount of self-initiative, attention to detail, coordination, and troubleshooting that it took for the system to function. All in all, I gained valuable technical knowledge and important group work experience. I am proud of what I learned as an individual, and proud of what we were able to accomplish as a team. I can put some of my ideas into products now that I have some experience with one.

If I am asked to undertake similar project in the future, I would handle the following two things better. First of all, I will form a team based on reliability. Secondly, I will set up better communication structure. This is especially vital at the beginning. Although our team was very forthcoming and open to communicate amongst ourselves, we sometimes forgot to inform the whole team after a small discussion with another member. Therefore, a forum of some sort would improve this aspect greatly.

6.2 Elyas Sepasi

When I registered for ENSC-440, I was looking forward to the opportunity to do some hands on engineering experiments. I had heard from my colleagues that this course could be an opportunity to do what I desired. Now, when I look back to the whole process from defining this project all the way to actually building it and installing it, I can easily say that was a remarkable experience. During this course, I have learned three main aspects of a project; team work, documentation and hands on experiment.

First and foremost, it was very delightful and informative working along with my three colleagues. Finishing a project in a limited time requires a lot of effort and support. Despite of some problems, our team could manage it and meet the timeline in each step. During this project, I have learned the importance of the team dynamic and how this matter affects the final results.

The steps involved in writing and documenting, such as proposals, functional specifications, design specifications, etc, have thought me a lot about the documentations and how important these are.

During this project I have learned the differences between theories that I have read in text books and learned in lectures, and actual circuit implementations. Since I was responsible for developing the warning system, I have learned a lot about the interactions between the components. In addition, finding the right component was another challenge. It was hard to find the components which had all the specifications that we were looking for. Most of the companies that I talked to recommended me to ask for customized parts and consequentially the prices were much higher than regular ones. To overcome these challenges which are inherent in all engineering designs, I use the available components and modified them in order to get the best out of them.

6.3 Victor Chen

The most usefully experience I gained from this course would be the interpersonal skill, a skill to present myself and to solve the conflicts arise in the team. During this course we are required to give numbers of presentation and therefore provide a great chance to practice my presentation skill. I have learned not only the presentation skill and also the skill to win attention and satisfaction without product demonstration.

Furthermore I have to strongly recommend future students that ENSC 440 and ENSC 305 is an entity. Do not overlook ENSC 305 while one spends hundreds of hours on the technical and forget to keep a record of the progress on a lab journal. The lab journal is the chance to practice your professionalism will be used in ones career. Remember to keep the balance in between ENSC 440 and ENSC 305.

6.4 Aron McKinnon

Enigineering 440 has been a serious challenge in the area of time management for myself. Having retaken this course and still having difficulties with managing my time and coordinating with my group, I have realized that I am not suited to work on long projects and am more suited for a career dealing with small constantly changing tasks in a structured enviroment.

I feel that I was very active and excited during our group brainstorming process, and was actively involved in the research and planning of the project. However when the time came to assemble and debug our product, a lack of personal motivation and group coordination led to my lack of envolvment. Which in turn led to guilt which led to further lack of envolvment.

440 has taught me both limitations and intrests in various areas of project development, which will help guide my future career path.

7. Conclusion

Now that the development of our proof-of-concept device implementing the design discussed is complete, we can begin further planning and marketing in hopes of continuing on to complete a full prototype of the iChecked Blind Spot Detection System.

8. References

[1] iChecked Inc, "Functional Specifications for iChecked Blind Spot Detections System" February 08, 2010.

[2] iChecked Inc, "Design Specifications for iChecked Blind Spot Detections System" March 08, 2010.

[3] Center for the Study of Responsive Law. "Innovation and Stagnation: Innovation in automobile industry report Washington DC," 2006. Available: http://www.csrl.org/reports/Innovation.pdf [accessed: Jan 16, 2010]