April 20th, 2011

Dr. Andrew Rawicz
School of Engineering Science
Simon Fraser University
8888 University Drive
Burnaby, BC
V5A 1S6

Re: ENSC 440 Post Mortem for ShutSmart

Dear Dr. Rawicz,

Attached is a postmortem of the process of designing and implementation for our product ShutSmart. Our aim at **Universal Safety Solutions Inc.** was to develop a safety add-on for electric stoves throughout North America. It works as an emergency response to unattended stoves that are a major cause of fires in households. ShutSmart will be stove independent, in the sense that it can be installed by the user for any electric stove without making any changes in the stove design.

The post-mortem presents details about the current state of the device, deviations from the originally proposed design, and the further development of the product in future iterations. Moreover, it will also contain information about the problems we encountered while developing the product as well as the budgetary and time constraints. The document also talks about team dynamics and the technical experience gained from working on the project.

Universal Safety Solutions Inc. is a team of three hard-working and committed engineering students – Abhishek Dubey, Sibghat Ullah and Vikas Yadav – who bring to the table a wide spectrum of knowledge from various fields of engineering. If you have any questions or concerns regarding our project proposal, please feel free to contact me by email at vya3@sfu.ca.

Sincerely,

Vikas Yadav
Project Manager
Universal Safety Solutions Inc.

Enclosure: Post Mortem for ShutSmart

POST MORTEM for

ShutSmart – The Safety Add-on for Stoves

Project Team:

Vikas Yadav

Sibghat Ullah

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Submitted to :

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ENSC 440

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Issued Date:

Apr 20, 2011

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1. INTRODUCTION

Over the past 13 weeks, our team at Universal Safety Solutions Inc. has been working hard to build a working prototype of a stove safety add-on, ShutSmart. The product is focused on the numerous stove related fires that breakout in North America due to user negligence and inattentiveness. This system will detect the stove top conditions, and give the user visual and audio feedback for the appropriate action to be taken. The hard work and sweat has paid off, and USS is ready with a fully functional proof-of-concept design for the product which has undergone intense testing. There have been a few deviations from the originally planned design, details of which will be included in this document. The team has gelled quite comfortably and it has been an incredibly satisfying experience overall.

2. CURRENT STATE OF THE DEVICE

At present, Universal Safety Solutions has successfully produced and demonstrated a working prototype of ShutSmart, our safety add-on for electric stoves. The system consists of two basic components:

- Main Unit
- Wireless Control Unit

2.1. MAIN UNIT

This is the biggest component of our product. It is basically a sturdy and durable box that encapsulates a microcontroller chip along with a buzzer, LEDs, buttons and a relay mechanism. The box also contains the receiver end of the transmitter-receiver system which will be used as the means of communication between the main unit and the wireless control unit. The box is supplied power from a 12 volt ADC adapter, which is connected to the electric socket in the wall. The 4-pin plug of the stove is connected into the socket attached to the box and that is in-turn connected to the relay circuit inside. The main unit can be seen in Figure 1.

The main purpose of the main unit is to receive a signal from the wireless control unit, indicating the stove top conditions. After assessing the conditions, the main unit gives appropriate feedback in the form of alerts and alarms. These feedbacks will be discussed in details in section 2.3.

2.2. WIRELESS CONTROL UNIT

The wireless control unit is the other main component of our product which is placed beneath the stove plates. Its external casing is made up of a heat resistant material, so as to withstand high heat when the stove is switched on. There are two metal hooks attached to the top of the box, and function with a spring. Therefore, if the user places something on the stove, the hooks go down disconnecting the circuit within the wireless control unit. If there is nothing placed on the stove,

and the stove is on – the metal hooks remain in place and the wireless control unit is activated owing to the heat being emitted from the stove grill. The thermistor in the wireless control unit picks up heat, when the stove is on and sends a signal from the transmitter to the receiver end located in the main unit, where the main unit takes appropriate action. The external structure of the wireless control unit can be seen in Figure 2, while the inner circuitry is shown in Figure 3.

2.3. SEQUENCE OF ACTION

In this section we will give a detailed timeline of when the buzzer and the relays kick in. This will help in attaining a high level understanding of our product ShutSmart.

a. If the stove is switched off - no heat is being picked up by the thermistor. Therefore no signal is being sent from the wireless control unit (WCU) to the main unit (MU).
b. If the stove is switched on, and something is placed on the stove - the hooks will be pressed down and the circuit in the WCU will be broken. Therefore, no signal will be sent to the MU.
c. If the stove is switched on, and there is nothing placed on the stove – the thermistor will pick up heat and the WCU will send a signal to MU. If there is no interrupt for 10 minutes (the user has left the stove unattended for 10 minutes), the buzzer will sound. From this point onwards there are two steps of action that can take place:

    - If the user gets alerted from the buzzer, he/she can turn the stove off and press the buzzer reset button on the MU. This will reset the whole system to step a.
    - If the user is not around, the buzzer will continue to sound and upon 5 minutes of inaction, the relay mechanism will kick in shutting off the stove system. The user can later on reset the whole system by pressing the relay-reset button. This will reset the whole system to step a.

Figure 1: The main unit for ShutSmart

Figure 2: The external structure of Wireless Control Unit

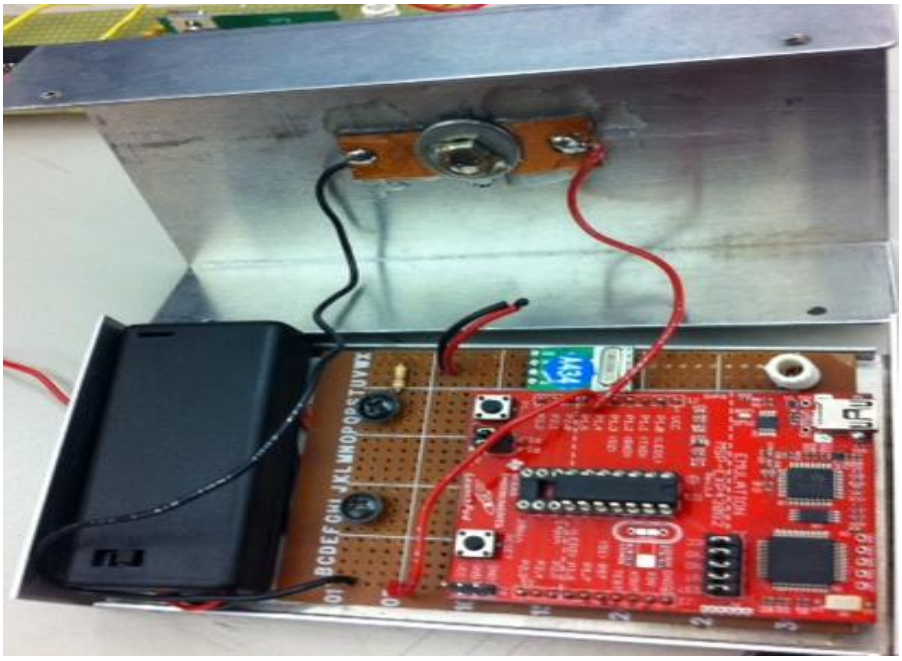

Figure 3: Inner circuitry of Wireless Control Unit

3. DEVIATION FROM THE ORIGINAL DESIGN

Midway through the project, we suffered a loss of personnel due to extenuating circumstances which resulted in making some changes to our original product proposal.

Besides the main unit and the wireless control unit, we had proposed to develop a third component for ShutSmart – the sensor unit. The sensor unit was supposed to have a motion sensor and a smoke detector system located on top of the stove, to form a more compact and complete product.

Some other changes we made to the product design are as follows:

1. The dimensions of the box were changed as per need. We were able to acquire a readymade chassis for the main unit, and its dimensions were different from the initially proposed box of 10in x 20in x 10in.

2. There was a slight deviation in the DC supply for the microcontroller, which was changed from the proposed 15V to 12V, and was provided with an external AC to DC adapter.

4. FUTURE PLANS

The first version of our product has a lot of room for improvement in the future, and here are a few ideas which can be incorporated with further development of the product.

Motion sensor – a motion sensor located on above the stove (near the exhaust) would detect the presence of the user near the stove. This will be a handy addition in cases where the user purposely wants to leave the stove on and unattended for a long time. This can happen in case of dishes that need to be taken off the stove for some time to stew, or if the user plans to heat his room by putting the stove on at low heat. If the user presence is detected near the stove, a signal would be sent to the main unit and no alarms would need to be triggered.

Smoke detector – this would be another useful addition, and would be located above the stove (near the exhaust). Even though almost all houses in North America have smoke alarms, this system would act as a localized smoke detector and alarms system. In many cases, where the household smoke alarms take a while to go off, our smoke detector system would immediately detect the presence of smoke and alert the user. The users can then take appropriate action and prevent any untoward incidents from occurring.

SMS Alerts – this would be a bit more complex addition to your product and would require establishing a communication channel between the stove system and the user's cellphone or other mobile device. Once the communication channel is in place, the user could be update and alerted about the stove top conditions. If the user is in the vicinity of the stove, he/she could take appropriate action to prevent any accidents.

5. BUDGET

In this section, we will be discussing the budgeting of the project. Table 1 gives detailed information about the funding and the expenditure involved in the development of ShutSmart. The CAD 800 for our project was provided by ESSEF, and the total expenditure came out to be around CAD 925. This was primarily because, at the time proposing our product, we were unaware of a lot of miscellaneous costs that would be involved in product development and testing. For instance, we had to acquire a working second hand stove to perform rigorous testing of our product in real world conditions. The ordeal of acquiring a second hand stove, as well as arranging for its transport cost us around CAD 235. This was one of the main reasons due to which we overshot the proposed budget. We are hoping to recover the remaining credit amount by applying for Wighton Fund.

Table 1: Details of Budgeting for ShutSmart

	Debit (CAD)	Credit (CAD)
ESSEF		800
Stove for testing + Transportation	236.58	
NerdKits MCU	106.77	
Circuit Components (RP electronics)	103.81	
Circuit Components (RP electronics)	34.27	
Circuit Components (Canadian Tire)	52.57	
DigiKey MCU	30.37	
Circuit Components (DigiKey)	335	
Chassis for the Main Unit	25	
TOTAL	**924.37**	**800**

As we can see, a major chunk of the budget was spent on circuit components like relays, transmitter-receiver pair, etc. The next major cost was for acquiring the stove for testing and arranging its transport. These costs were followed by relatively low prices of microcontroller unit and the hardware for the main unit and the wireless unit (the chassis). Overall, We only overshot the available funds by an acceptable margin which was due to the lack of foresight regarding acquiring a stove for testing purposes.

6. SCHEDULING

We were able to achieve the successful implementation of our product within the expected time frame since we followed a strict schedule. The framework for the schedule was provided by Mr. Michael Sjoerdsma and we continued building on the same to stay organized. Table 2 gives an idea about the expected time of completion and the real time of completion.

Table 2: Scheduling of the project

	Expected Date of Completion	Date Completed on
Finalizing product idea	15th January, 2011	20th January, 2011
Project Proposal	26th January, 2011	26th January, 2011
Functional Specification	16th February, 2011	16th February, 2011
Design Specification	9th March, 2011	16th March, 2011
Written Progress Report	23rd March, 2011	23rd March, 2011
Group Presentation	April 2011 - second week	13th April, 2011
Demo	April 2011 - second week	13th April, 2011
Post-Mortem	April 2011 - third week	20th April, 2011
Project Wrap-up	April 2011 - third week	20th April, 2011

7 .TEAM DYNAMICS

Working as a team for Universal Safety Solutions Inc. was a wonderful and fulfilling experience. Each member of the team performed exceptionally well, and did not fail to put up their hands in the time of crisis. The biggest test for team USS was the loss of personnel midway through the product development. We started off as a five member group, but lost one member owing to certain academic and professional commitments that came up for him. This was in the second week of the project, and we were quickly able to regroup after some initial problems. The next big blow came, when the second member missed a lot of action due to medical reasons and later withdrew from the project due to unavailability. This was a much bigger issue since that particular team member had been assigned certain tasks – mainly involving the sensor unit and the smoke alarm system which had been proposed initially by USS. To deal with this crisis, the three of us met up once again and redrew the project outline. We took some tough decisions and decided to postpone the addition of the sensor unit and the smoke alarm system for future iterations of product development. We had our task cut out after that, and each member put in a lot of time and effort to achieve the successful finishing of the project within the expected time frame.

We are proud to state that we stood our ground in tough times, and were able to achieve a successful end for our project within the proposed time frame.

8. TECHNICAL EXPERIENCES

8.1. Abhishek Dubey – *Hardware Engineer*

Over the past 13 weeks, my team and I spent a huge chunk of time working on the product development of ShutSmart. We set up base in the engineering science lab, while the product testing was performed at my house. At the beginning of this project, my main aim was to gather a detailed and in-depth knowledge about the project. Our team was a group of high energy, and high performing individuals which helped us in understanding each other well. Every team member was given equal opportunity to express their views and it was quite amazing to see all three of us bringing some invaluable experience to the table.

The ShurtSmart development gave me ample opportunities to implement my knowledge about electrical and hardware engineering. It also helped in the expanding my horizons in these fields as I learnt a lot of new stuff, which could only be learnt by getting some hands-on experience in the laboratory. I also learnt a lot software coding skills from my team members, and I am sure this exposure to various aspects of engineering will hold me in good stead in the future. Time was a huge issue, as we had to get a lot of things done within just four months. Moreover, the provisioned budget for this project was limited. This really helped me in enhancing my time management as well as resource management skills. Also, the requirement of documents like the proposal, functional specification, etc. helped me enhance my documentation skills. I am sure that these additions will be of immense help to me when I start working in the professional world.

One of the greatest highlights of the project was working with my group on a professional level, since I already knew the members very well on a personal level. It was a great experience, and I came to realize that we had excellent understanding between each other which greatly helped as there was no major miscommunication between the team members. There were moments when we had some conflicts over certain aspects of the projects, but these were only minor blemishes in an otherwise smooth journey. The biggest reason for that was that each one of us respected each other, and in the the project actually turned out to be an exhausting yet fun experience. I would love to work with the same group of individuals again in the future.

8.2. Sibghat Ullah – *Integration Engineer*

Hardware Skills:
This capstone project has enhanced my hardware skills a lot as making everything from scratch required a lot of study and physical work. Due to my co-op work terms, I had a good idea of how new products are developed and what standards are considered when they are in the phase of planning and design. In ENSC-440, though we didn't have enough resources to build the product at the same level as a proper company would do, I had to think of various alternative methods of product development so as to come up with a stable and efficient design model that can deliver the most promising results. I researched more on how to achieve our hardware objectives in an affordable and effective manner. My circuit analysis skills were also improved as dealing with circuit failures required me to go over my design again and again and I learned new ways of improving circuit architecture.

Software Skills:
ENSC-305/440 has allowed me to learn embedded programming in more detail. I programmed the wireless control unit microcontroller and learnt new ways of how controller design could be made more robust and stable by means of software programming. I programmed the micro-controller in C and I got the assembly programming code generated automatically. This made me understand assembly instructions of my program in detail and hence improved my assembly language skills beside C.

Hardware-Software Integration Skills:
Playing the role of an Integration Engineer, I gained knowledge on how software and hardware systems can be integrated together and the whole system works according to instructions programmed in the microcontroller. I also debugged the system and solved both software and hardware related issues. I first had to distinguish whether the problem was caused due to a software program instruction or an acting hardware device and hence targeted that specific piece of code or component. This way I learnt much on how debugging issues can be addressed in a quick and effective manner.

Mechanical Skills:
Before doing capstone project, I had very little mechanical engineering skills. In this project, I bored holes in the chassis, cut exact lengths of PCB's, carved circular holes of exact diameters in the front and back panel of the product and these all improved my mechanical skills to much extent. I also discovered new ways of how cutting and bending metals can be made easy by applying certain geometric techniques. I also learned how to weld metals properly and make our device heat and water resistant.

8.3. Vikas Yadav – *Software Engineer and Project Manager*

"A man may die, nations may rise and fall, but an idea lives on."
— John F. Kennedy

Capstone project has been a great learning experience for me. It exposed me to a scenario which could very well have been a real world scenario. There are always ideas and thoughts running in one's mind that can potentially change the course of life. This course taught me how to convert an idea into reality to improve the quality of everyday life. Few critical things that I learnt throughout the course are building your own company, leading a project team, and coding an IC.

I always used to think that building a company must be easy once you have an idea that's worthwhile. However, during the course of this project, I realized how hard it is to just build one product. There are various factors involved such as budget, funding (hard to get), timeline, standards, public safety, your own safety etc. There are a number of roadblocks such as availability of parts, technical difficulties, things are different in practicality at times compared to what they are in theory etc. I can imagine how hard it would be to setup a company and keep it running by launching different products every now and then in order to survive in a rapid growing economy.

Being a project manager, I learnt how to be patient and listen to everybody's ideas in the team. There were a few conflicts towards the beginning of the project as to which idea to go with. I learnt how to resolve such issues by setting up a meeting and talking it out as a group. I learnt that a project manager has to keep track of the overall progress, push the group when it's necessary mostly when deadlines approach. I got into a habit of keeping meeting minutes whenever we met and emailing it out to everybody at the end. All these little things that were learnt would help if I were to lead a project team in future.

So far I have only been coding at the software level dealing with text inputs and providing text outputs in programming languages like C, C++, and Java. This course gave me an opportunity to integrate software and hardware sides into one such that my software code would cause changes on the hardware end. This was mainly accomplished when a code written in C causes a buzzer to go off or causes a relay to activate. Therefore, this was a great addition to my programming skillset.

Finally, I would like to take a moment to thank all my group members, TAs, Mike, and Andrew for their continual support throughout the semester. Without you guys, it wouldn't have been possible.