eart Guard Technologies

December 4, 2007

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

RE: ENSC 440 Post Mortem Report For Portable Heart Rate Monitor

Dear Dr. Rawicz,

The attached document outlines insight to the post mortem report of our project. The goal of our product is to assist lifeguards in rescue situations by monitoring a victim's pulse rate.

This document was created in order to provide an overview of the current state and the future plans of the system functionalities of our heart rate monitor device.

Our team, Heart Guard Technologies consists of four talented, enthusiastic and hard-working engineering students from Simon Fraser University. These individuals include: Bryan Schurko, CEO; Stephen Czerniej, CFO; John Azer, VP Operations; and Vahid Shababi, VP Marketing. Please feel free to contact us at bns3@sfu.ca, if you have any questions or concerns regarding out product.

Sincerely,

Bryan Schurko
CEO
Heart Guard Technologies

Enclosed: Post Mortem Report for Heart Guard portable heart rate monitor

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Executive Summary

Finding a pulse in a rescued victim is a highly challenging task, and often weak pulses cannot be detected by the usual methods of sensing the wrist, or the side of the neck. Almost all lifeguards claim that much time is wasted, after a rescue, in finding the pulse of a victim. A major problem that arises when using the off the shelf heart rate measuring products, is that the conditions they are to be used in are very limited. For example, in wet conditions, such as a swimming pool, an ordinary pulse monitor can be damaged if water leaks into the case. Moreover, if a drop of water comes in contact between the victim's ears and the sensor, inaccurate results will occur, if the product is not particularly designed to operate under such conditions.

Our group (Heart Guard Tech.) have realized the need for such a product to overcome these limitations and have decided to invent a full proof product, not only to operate under the sever conditions mentioned above, but also to significantly reduce the time invested in finding the victim's pulse. The water proof casing of our product differentiates our product from previously designed heart monitors in such a way that the victim's heart rate can be measured accurately, even if the product is immersed under water. Also, the ear clip sensor to be used in this product is highly tolerant to water.

This document lays out the post mortem of the product Heart Guard Tech will be designing and implementing. The post mortem report of the entire product is segmented into subsystems, and the current state and future plans of each subsystem are further explained in detail.

ABSTRACT

We at Heart Guard Technologies propose to design a portable heart rate monitor, which is capable of measuring the number of heart beats per minute and displaying the heart rate information in a clear and simple way to avoid any confusion in chaotic situations. This device is composed of a small ear clip, which is similar to those used in hospitals and exercise equipments. In order to increase noise immunity, infrared light is used to for pulse rate measurements. Furthermore, the completion cost of this project will be kept low, since the use of pulse sensing equipment used for exercise means is widespread.

Heart Guard Technologies consists of four engineering students from Simon Fraser University, who bring extensive experiences and ideas to the design of our project. Our products must be conventional to the highest quality and usability standards. Due to the marketing expertise of one of out group members, our company is capable of coming up with plans to reduce its costs for a higher profit. Moreover, due to the high financial costs, we will try to obtain more funding through SFU as much as possible. However, our group members believe that it may not be possible to generate enough capital in order to support the entire project through funding. If such situations arise, the company members are willing to share the outstanding financial costs equally.

We at Heart Guard Technologies plan to compete with other engineers all over Canada, by attending in Western Engineering Competition, WEC, and hopefully to CEC.

The integration and development of our project contains two different sections. The first phase of our project develops a portable heart rate monitor. In the second phase, Heart Guard Technologies members try to move the project even further ahead and making it actually practical for future swimmers.

1. Project Overview and Introduction

After four months of hard work and team determination, Heart Guard Technologies have completed a fully working prototype heart monitoring lifesaving device model. Many hours were spent in the lab debugging, soldering, testing, and designing the product to ensure it met all the criteria listed in the proposal. There were many challenges that vexed the group throughout the last four months, but we worked together and put the entire system together three weeks before it was due.

The group first started off with three members being John Azer, Stephen Czerniej and Bryan Schurko. The project idea was passed around for a bit until it was decided the lifesaving heart monitor was to be built. Vahid Shababi was then added to the group showing expertise in areas where the rest of the group lacked. The group was then settled with four members each working on different parts of the project.

The first few weeks were used to design the project and order the parts for each component in the system. Research and design skills were improved by each member in this process searching for the best products available for the project. After all the parts were ordered, the group waited patiently for their arrivals while writing the documentation proposing our ideas.

Proper documentation was a meticulous process with all the group members focusing on their portion of the project. This was a team building process as we would combine all of our strengths and work on our weaknesses writing the proposal and design documentation. These skills were developed and fine tuned throughout the last three months.

In the second month, a major problem occurred when we could not find a proper or workable sensor signal. This large scare almost put the group off the project idea until we ordered the Cateye sensor and found a proper usable signal from the sensor. From that point on, the main concern was filtering and attaining a perfect digital signal from the circuit we created on a PCB to pass to the PIC Controller. After a month of work, a perfect signal was attained from the PCB circuit.

The next month consisted of programming the PIC Controller to display an accurate heart rate on the seven segment display. During this process, the enclosure was adapted to fit the switch and audio cable. The PCB was then solidly soldered into place and attached to the display PCB board.

Within the last week of November, the entire device was put together by the team as soon as the PIC Controller was programmed. It was tested numerous times throughout the week fairing the device ready for demonstration. The final system consists of the Cateye sensor, switch, audio cables, PCB sensor circuit, battery, PIC Controller, two LEDs, and three seven segment displays that is stationed inside the waterproofed enclosure.

The team gained much knowledge from the whole Ensc 440 experience and is very happy with the result. The final system boasts an accurate heart rate reading in a wet environment that is small and very easy to use. All of the proposed ideas were fulfilled by and the system works perfectly. Now Heart Guard Technologies is doing a patent search to copyright their knowledge and ideas processed through this course.

2. SENSOR

2.1 CURRENT STATE

The heart guard device captures the signal via an infrared sensor which clips to the victim's finger. The infrared sensor is composed of an LED infrared transmitter on one side, and a receiver on the other side, which detects the changes in absorbance of light through the finger. When powered appropriately, the infrared LED transmitter emits infrared light upon the victim's finger. As blood travels to the finger with each heart beat, the transmitted LED light emitted from the transmitter is absorbed by the hemoglobin in the blood, which causes less light to reach the receiver end of the sensor. This is further illustrated in the following figure.

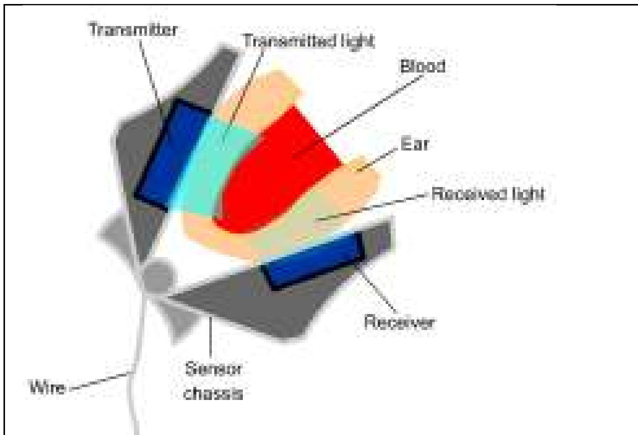

Figure 1: No light at receiver (no blood in finger)

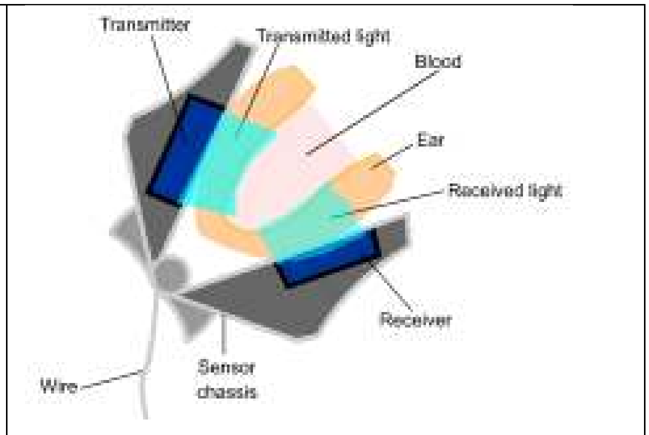

Figure 2: More light at receiver (less blood in finger)

This change in absorbance detected by the receiver is driven to a filter circuit, then into the main sensor circuit, and then through a one shot circuit, which contains the famous 555 timer integrated circuit. The overview of this signal path can be depicted by the following figure.

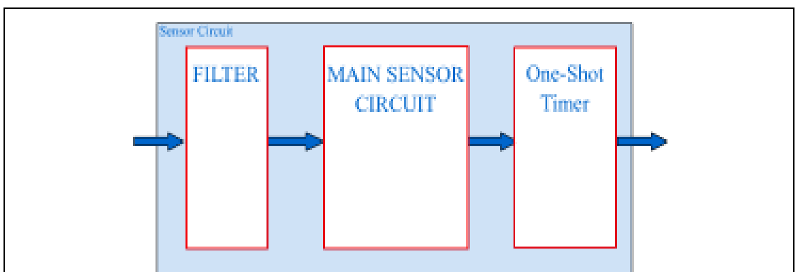

Figure 3: Three components of the signal capturing process

The signal coming straight from the infrared sensor into the filter circuit is shown below.

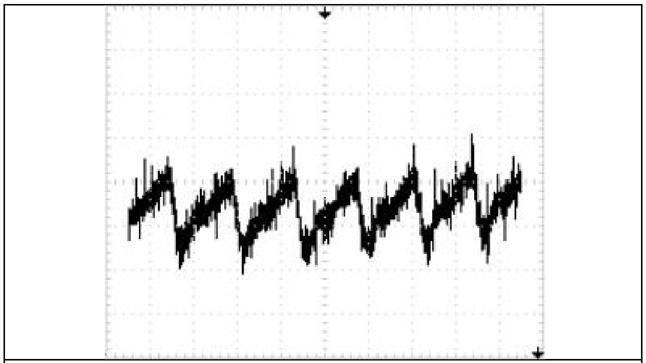

Figure 4: Before Filtering

Upon close analysis of the signal, it was observed that 60Hz was a main source of noise distortion in the signal; hence the filter circuit was designed to remove this extra frequency component from the signal. This was accomplished by connecting the appropriate values of resistors and capacitors to create the appropriate frequency cutoff. The signal after the filtering stage looks as follows.

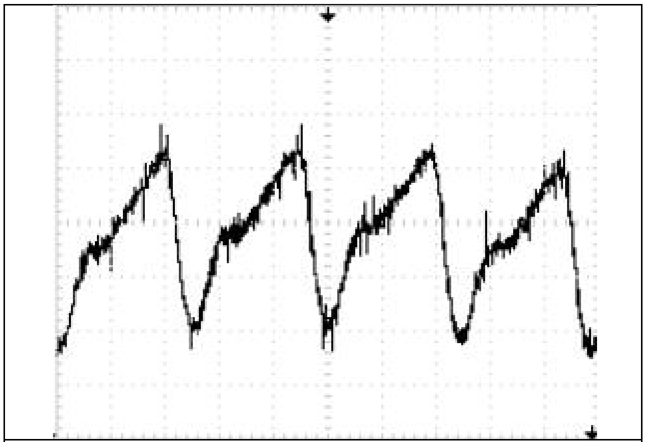

Figure 5: After Filtering

After the filtering stage, the signal is applied to the main sensor circuit, which is essentially what detects every heart pulse created by the human heart. The main component of the sensor circuit is the LM6848 OPAMP. This OPAMP is what is known to be a CMOS rail to rail OPAMP. The major advantage of this amplifier is that it is capable of converting the analog signal, initially received from the infrared sensor and cleaned by the filter, into a digital rectangular waveform. In other words, the OPAMP translates pulses in terms of zeros and ones, as shown below.

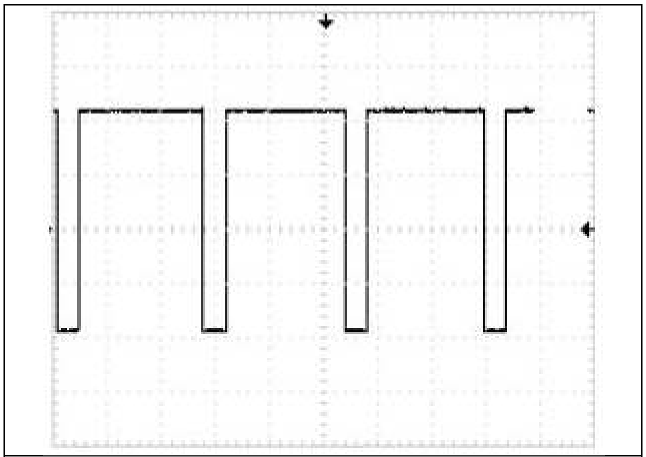

Figure 6: Rectangular output

However, even though the signal coming from the infrared sensor is being filtered, there is still random noise that is added to the signal, depending on the environment, in which the sensor circuit is being used in. Hence, due to this random external noise, the infrared sensor circuit might generate more than one rectangular pulse per heart beat. The job of the one shot timer circuit is to simply remove those extra pulses, and provide a more accurate representation of the heart beats.

2.1.1 Design challenges

With extensive knowledge in circuit design, creating the sensor circuit on a breadboard was not of major concern. However, the breadboard is a larger device, which will consume a great area. The solution taken to avoid this problem was to replace the breadboard by a much smaller copper circuit board, onto which the circuit components get soldered to. The circuit was fairly complex to fit onto a 3cm by 5cm copper circuit board. The major problem that arose in the design process was effect of short circuiting, due to the compact placement of the components. This took much time to debug and fix.

The shape of infrared sensor was also difficult to deal with, in terms of figuring out the most ideal place on the finger, onto which the sensor can be clipped on, disallowing as much of the external room light as possible. It was seen that this was not an accurate procedure, given that people have different finger shapes. So new circuitry had to be devised and implemented to deal with external noise sources, interfering with the infrared sensor. However, this noise varies from one place to the other. For example, in a dark room, there is less light interference with the infrared sensor, meaning that a more accurate result is received by the infrared receiver. However, in a room with bright lighting, interference is much higher, and the signal received by the infrared sensor is not an accurate representation of the heart beat, due to the additive noise. Coming up with a circuit to deal with all of these issues was a complicated and challenging process, in this segment of the project.

2.2 Future plans

Currently, the project is in a fully functioning state; however, there is always room for improvement. In the beginning of the design phase of this project, certain factors, such as the shape of the infrared sensor, were not taken into account. In a future design, a sensor that matches the shape of the human finger should be used. Moreover, it should be shielded with special material that blocks external light that interferes with the infrared signal. This would significantly reduce the amount of circuitry used to remove the additive, unwanted external noise.

In terms of the design of the actual sensor circuit, a more careful approach should be invoked in a future design. For example, to avoid the short circuits explained above, the circuit should be designed in more than one layer. For example, the filter, the main sensor circuit and the one shot timer circuits should all go on separate layers. This enables the designer to have more room to solder components on a specific layer, significantly reducing the probability of having a short circuit.

The entire project, including the sensor circuit, is powered by a DC voltage of 5V. This voltage is derived from a 9V alkaline battery. The 9V are reduced to 5V through the use of a linear regulator. This linear regulator draws approximately 90 mA. An alternative design methodology would be the use of what is known as a switching regulator. Such a regulator would significantly reduce the power consumption of the product, leaving the end user a longer battery life.

3. Software and Processing

3.1 Current State

In terms of software and signal processing, most planned algorithms were implemented. The algorithm to determine faulty pulses from the CMOS circuit were as follows:

- Frequency measurement discarding
- Pulse width measurement
- Pulse averaging
- Pre-pulse frequency comparison

The frequency measurement consists of monitoring the current beats per minute of each pulse that comes in. If the frequency rate exceeds a defined value, the pulse will automatically be thrown out as if no pulse occurred. The system will return the last known pulse. If the pulse drops below another defined value, the pulse will be thrown out a similar manner to high pulse frequency throw-out.

The pulse width measurement algorithm monitors the width of each low pulse width. An example of this can be seen below in figure 7. If the low pulse widths are lower than a specified value, the pulses are ignored and are assumed to be noise.

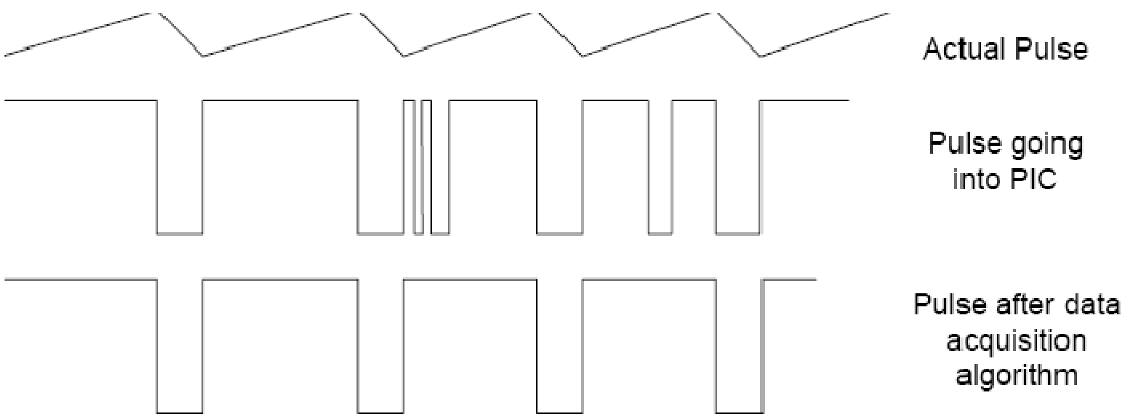

Figure 7: Example of digital noise being suppressed by the PIC

Pulse averaging was included due to the large sway of pulse frequencies because of unfiltered noise. Unfortunately not all noise could be filtered by analog or digital means, thus steps had to be taken to suppress it as much as possible. With this in mind, a previous number of pulses of size 10 or less were averaged before outputting the rate. Since when heart pulses are first detected, we must average our pulses based on how many proper pulses we have already received with a maximum of 10.

The last algorithm that was written was pre-pulse frequency comparison. In this algorithm, the current pulse frequency was compared to previous pulses to determine if the change was adequate or not. It was hoped that this would cut down on noise causing pulse rates to double or triple in single beats. Unfortunately this was not implemented. This is one of the slight differences between the final product and the design spec.

The display method used for the 7-segment displays was a simple look-up table. When a rate was determined in beats per minute, the unsigned char number was sent to a function which separated the digits and displayed them on the LED display. When outputting the signal for the display, two full ports were used to display the middle and last digit while only one pin was used to display the leftmost digit. The reason only one pin was used was because the most significant digit would only be '1' or cleared since we have a range of 1-199.

3.1.1 Design Challenges

Throughout the projects, design challenges arouse steadily as the complexity increased. There were two types of design challenges, unforeseen and foreseen ones. The unforeseen design challenges can be attributed to our inexperience in certain software and algorithm design. Most unforeseen challenges revolved around programming errors and the PIC's relatively heavy learning curve.

The main design challenge in terms of software was the pre-pulse frequency comparison algorithm. As mentioned in the current state section, the pre-pulse frequency comparison algorithm compares the current pulse frequency with its previous counterparts. The difficulty in this algorithm is determining if the previous pulses were even accurate pulses. If previous pulses turn out to be noise that was leaked in, the current pulse would never be allowed to store itself in the vector since it varied to heavily compared to the previous noise pulses. Although we were close to designing an adequate algorithm, the limit in terms of program memory of the PIC chip halted us from proceeding.

Because the 16F877A microcontroller was being programmed using PICC Lite which is a free C-Compiler, we had to adhere to Microchips limit of program memory which was 2kb. Since the chip was free, Microchip implements limits to encourage users to buy their full version of the software which costs money. This was one of the greatest setbacks in the project since we were not able to implement everything that was planned because of the limited memory. We ended up using approximately 1.9kb worth of program memory which was just hitting the limit. We kept the absolute necessary algorithms that were needed to allow the system to run properly.

3.2 Future Plans

After spending much time with the microcontroller and its software, obvious improvements were thought of for future plans on the project. The most important change in the system would be to use a full version C compiler as to avoid all problems with the memory limit of trial C compilers. This will allow us to proceed with more complex algorithms to catch and suppress noise that entries the system and makes its way passed the analog filter circuitry.

Because the limits of the 16F877A were reached quite quickly, not in terms of program memory but in functionality and executable commands, a later version of the PIC would be used. A 18F series PIC would fit our project better because of the larger variable memory and faster processing time. It is also advantageous to us because of the smaller learning curve since some ports have been predestinated in an easier manner. The documentation for the 18F series is also clearer.

It was originally thought that having a separate red LED that would light up when either no pulse is being acknowledged or the current pulses are full of errors would be a good idea. Unfortunately in use, the idea does not seem as practical because the LED is small and difficult to see in bright areas. A possible change would be to have the 7 segment display three dashed lines such as "---" when no pulse or an error is found. Currently we have the PIC holding the last pulse and displaying on the 7-segment while running the red LED to show that no pulse is present. We originally thought that keeping the last pulse detected would be good for the lifeguards when determining what the frequency of the heart rate was before they went into cardiac arrest. This change would be quite simple as it would only involve us adding in another point in the lookup table and adding an extra wire to the most significant 7-segment display digit. This, of course, would also save us an output port that was originally running the red LED.

Although not directly attached to the PIC, a separate 7-segment display chip would be better to use rather than directly attaching the PIC to the 7-segment display. Since our PIC drives the LED's on the display, a lot of current is running through the PIC because our 7-segment display is command cathode. A possible alternative would be to use a bcd to 7-seg decoder that will work for 3 separate 7-segment displays. This would allow us to only use six ports for the last two displays and one for the left most display. This would cut down on output pin usage from 15 to 7. In addition to the lowered number of ports used would be the fact that far less current would be drawn out of the PIC but rather the regulator.

Since we are deciding to go to use a decoder to power the 7-segment displays, we do not need a total of 40 pins for the PIC. It would be more advantageous to go to a smaller PIC of 28 pins. This would decrease the complexity of the PIC as well as greatly decrease its physical size in the overall system. Since compactness is extremely important in this project, this would be a vital change that would greatly help the aesthetics of the system.

4. Hardware

4.1 Current State

Enclosure: The current state of the enclosure is the waterproof enclosure bought from RP Electronics with two drilled holes in the side for the switch and the audio cable extremities. Due to the fact that the components for the system are a bit too large to properly fit inside the enclosure space, the lid over the top did not completely close as it should. Silicon was used to encase the entire system so that it was waterproof to protect all the internal components.

Switch: Currently, the switch used to turn the system "ON" and "OFF" is located sealed on the opposite side of the Audio Cable on the outside of the enclosure. The waterproof boot is over the entire switch component and is silicon sealed to the case to prevent water entering the system. The flip switch itself pokes outside from the inside of the enclosure while the end that connects to the battery and the rest of the system is located inside of the enclosure.

Audio Cable: Similar to the switch, the audio cable is placed through the enclosure. It has been also sealed with silicon to ensure the entire system is waterproof. It is located on the left side of the enclosure opposite from the switch so ensure better system usability. The end of the cable was stripped from its normal wire enclosure so that it could connect to the PCB board to retrieve a proper signal from the sensor. After properly connecting the wiring to the PCB, electrical tape was used to protect the soldered wires from interfering with the rest of the system.

Seven Segment Display: The three seven segment displays currently show the pulse rate of the user located inside the enclosure. The displays are mounted on a separate PCB board on top of the sensor circuit. The display can display a possible heart rate of 999, but, the highest heart rate displayed would be around 250.

4.1.1 Design Challenges

Enclosure: There were many design challenges that came with designing and finding the enclosure. There were a few enclosures bought that could have been possibly used for the device, but they were either too large or incapable to adaptation. There was a need to find an enclosure that could be adapted to support two outlet holes for the switch and the audio cable. The enclosure also needed to be waterproof and susceptible to opening and closing. There was a definite need to have the enclosure small enough to fit inside of a fanny pack so that a lifeguard could take a the heart monitor with them at all times. At the final decision, the enclosure supported all of these features plus it had a transparent top to view the heart rate.

Another great challenge involving the enclosure was waterproofing. All the components inside of the system were a bit too large to fit properly inside of the device. This in turn, stopped the top portion from properly closing to the waterproof level. To compensate for this issue, silicon sealing was used to fill in the gaps from the lid to the base of the enclosure. After the two outlets were created for the switch and audio cable, the silicon came into play again to seal the entire enclosure and waterproof it. Once again, this was very important to protect the inner circuitry from all possible leaks from the new outlets made. After testing, this method deemed worthy to be used in the demonstration of the product.

Switch: There were not too many design challenges for the switch in this product. From the start of the project, there was a need for a small, easy to use, and waterproof switch. In the end, the switch used was a one throw toggle ON-OFF switch with a waterproof boot or lid. The only design challenge was to decide which type of switch would be best for client usability and best for waterproofing.

Audio Cable: There was no design challenges found when choosing the audio cable. After receiving the sensor itself, the system could only connect to an audio cable to give transfer the signal to the circuit. The audio cable was then purchased and stripped to access the inner wires to connect to the sensor circuit.

Seven Segment Display: The seven segment displays needed to be small enough while visible to a user looking for a heart rate at least 10 feet away. The only design challenge was to purchase seven segment displays that would fit three in a row side by side inside of the enclosure that could be used by a PIC controller. This was easy enough to research and purchase at the local component store.

4.2 FUTURE PLANS

Enclosure: When the next prototype of the system is built, the enclosure needs to be changed for one major reason. The major reason is size of available space inside the waterproof enclosure. The prototype that was demonstrated needed to be silicon sealed to ensure the case was fully closed because the system components were pushing up the lid from the base. With more space, the inside components can easily be implemented and partitioned so the circuitry will not be pushed together tightly and the battery will be easy to replace. The future enclosure will still be transparent but will have the Heart Guard Technologies logo on the front.

Switch: The switch used in the future device will be more robust and less easy to be mistakenly activated. In terms of the model switch used, the one throw toggle switch will still be used.

Display: In the future the display showing the heart rate will be changed. A color LCD screen will show the heart rate and electro cardio display to the user in a professional manner. It will be larger and brighter than the current three seven segment red display. The display will be surrounded by a bright container not showing inner circuitry. This will instill a professional look to the system.

5. MARKETING AND SALES:

In addition to all the descriptions of the product mentioned throughout the document, our company is looking forward to add a couple of important features to the portable heart rate monitor in the future towards improving this device. One of the innovations to be added is the ability of the device to output the electrical activity of the heart over time, which leads to having several advantages. For example, it will help to detect electrolyte disturbances. Also, conduction abnormalities of any kind can be easily detected. In General, having such monitor around swimmers can provide a rough indication of increased or decreased contractility. In order to best use such added feature to the heart rate monitor, our company is looking forward for more creativity. Having wireless technology around, it is possible to provide connection between each portable heart rate monitor in the swimming pool and a screen in the first aid room, which outputs the results of each device. As a result, heart beats of all the swimmers in the pool can be under control and any abnormalities can be easily detected in order to maximize the safety of the swimmers in public places.

As discussed previously in the sales and marketing section of the report, consumers of this product should pay a final price between 25 to 30 Canadian dollars. On the other hand, total cost of each unit is between $19-23 Canadian. Basically, due to the fact that this innovation is new and not introduced to the public before, the company chooses to start with a low margin in order to make a good reputation. The company’s first market and customers are swimming pools and public places. Due to the fact that a lot of elders attend swimming pools every day, it would be a good idea to have ability for controlling their heart activities in order to prevent any damages. Furthermore, the company’s second market includes life guards and any patients who need to be under heart care on a regular basis. Life guards have the responsibility to prevent drowning in seas and summing pools. However, due to the fact that life guards continuously swim for rescue, their heart activity must be constantly under control.

6. Ecological Footprint

This project was developed and created to work in the most environmentally friendly matter. In terms of the components used for this project, there is only waste and one battery that could harm the environment. The device was built so that recycling and reusing of the components are a way to dispose of the product. Most of the hardware is plastic and malleable metals that can be reused and recycled. The product displays low complexity and low entropy proving that the product can be reused and recycled.

The design goal of this project was target durability and not product immortality. Once the product has seen its last use, there will be no need to repair the system, so the reusability of the components in the project once again is important to keep it environmentally friendly. Similar materials are used throughout the product to ensure material unification.

The available energy flow only comes from the one battery in the system. The integration and interconnectivity of the circuitry allows this available energy flow needing less battery components to charge the system.

In all, the project has considered the ecological footprint of the system and strived for sustainability, environmental, and social criterion.

7. TEAM REFLECTIONS

7.1 BRYAN SCHURKO:

The ENSC 440/305 project has given me valuable experience in many aspects of engineering. Throughout this project, I have been able to advance my skills that were first learnt in courses previous. Skills that I have acquired or improved were software programming, hardware debugging, team dynamics, presenting, and project management. I am thankful for this experience for it has improved me not only as an engineer but as an overall person who will be dealing with people.

As the CEO of Heart Guard Technologies, it was my duty to oversee the entire project from start to finish. I had to make serious decisions regarding the technical aspect but most importantly decisions regarding work delegation. It was my goal to keep everyone busy with work that they enjoy and are good at. Separating tasks helped members focus on their own respective areas rather than spreading their resources too thin on multiple tasks.

In terms of technical engineering, I was solely responsible for the programming, digital signal acquisition, and visual display of the project. Because of my previous project work at BCIT, I had experience in programming PIC microcontrollers, specifically the 16F877A (which is what we used). I was also highly involved in the original overall design and helped in other aspects of the project such as the analog circuit which processed the heart pulse signal.

Although I have experience in this type of engineering, I learnt a lot in terms of technical aspects. I was able to refine my knowledge of microcontroller programming. I discovered new uses, and better ways to use the PIC. I found myself constantly referring back to the data sheet to determine which was the most effective way to implement each algorithm or code snippet. In addition to software programming, I also improved my circuit troubleshooting. Because the project is very hardware based, all the components had to talk to the microcontroller with 100% accuracy. As one may know, communication between devices can be extremely difficult and tedious if you are using a new component.

I found that the most difficult portion of the project were the late nights programming the microcontroller. Since very few people are highly experienced with the PIC microcontroller, I had only myself and the data sheet to refer to. Although frustrations ran high, the experienced gained in trouble shooting the problems is highly valuable. Another difficult aspect of the project was the physical assembling of all the parts. Our box had to be small enough to fit in a lifeguards hand and fanny pack. Because of this, all our components (circuit, battery, switch, microcontroller, LED's etc.) had to be tailored to fit in this small box. This caused a lot of problems with soldering the components to the PCB. Although the soldering is not technically challenging, it is very tedious and time consuming.

If I were to do the project again, I would do a couple of things differently. The first would be to start the project sooner. This would allow for more time and every aspect of the system. Second, I would design and manufacture proper PCB's that were tailored to our circuit. This would allow us to fit more "stuff" inside a smaller area. Third, I would delegate tasks more effectively so the workload was not distributed unevenly to the team.

Overall I am very satisfied with how the project turned out. Not only am I happy with the project, but I am very happy with the experienced that was gained. I believe the skills learnt in this project will be skills that I carry with me throughout my career.

7.2 Stephen Czerniej:

This project course offered more than just refining skills but also learning new skills.

I feel I have learned more from this project than from what I have learned in all of the courses that I have taken so far. Integration and planning for the future was a huge part of this project and I was glad I took part in it.

In terms of my role in Heart Guard Technologies, I was in charge of hardware components and design of the overall idea of the project. Since I am a lifeguard, I found a need to create a device that could find and assess pulses from victims in an aquatic setting. We collectively as a group went over the fine details of how the project was going to be implemented and constructed. I helped with sensor circuitry during its debugging sequence and acquired the components left needed for the device. Near the middle of the semester, I adapted the enclosure to support the switch and audio cable while maintaining a water tight enclosure. I was mainly in charge of making the system work in an aquatic environment by creating and sealing a waterproof system with all aspects still working. A part from that, I would help in the sensor circuitry and LED testing and design. After the circuit and PIC were finished, the entire group integrated all parts of the project and connected the entire system and tested it to make sure it worked and was watertight. The group integrated and made the prototype work almost the first time it was put together.

Other then engineering skills acquired from this project, soft skills such as constructive meetings, pre-planning progress, and combining group strengths were an asset to me as a growing engineer. These skills are definitely needed in the workplace where you have to put together a project with different people's abilities and strengths. Good communication and constructive meetings set the tone for the overall project to be finished early and working properly. We as a team used each of our abilities and knowledge to fine tune our project and deliver it early.

Ensc 440/305 is perhaps the most rewarding course I have taken at Simon Fraser University and I was very happy with my group member's work. I was very happy with the direction and flow from Dr. Andrew Rawicz and from all of the Teaching Assistances. I hope that every student will have the same great experience with the course in the future as I have had.

7.3 John Azer:

In design of the sensor circuit, I faced many challenges. However, this was a leading factor in enhancing my knowledge in circuit design knowledge. The circuit which measures the heart beat, itself was not difficult to construct, however, understanding what each component does, and how to debug the circuit was a challenging task, but at the same time rewarding, in the sense that valuable knowledge was extracted from each trial and error, approached in fixing the circuit.

As the VP of operations, I was responsible for the technical aspects of this project, and how they function and integrate together. I had to make decisions regarding technical designs such as how to construct a circuit that would clean up the noise added to the real signal and other technically inclined solutions.

Overall, this project was quite enjoyable, given the freedom of design approach, as opposed to other hands on laboratory work in other engineering courses, where each step is predefined, eliminating creativity in the design. Surprisingly, this project has cleared up my confusions, which arose during previous engineering classes, of related circuit material.

Most importantly, Heartguard's team communication skills and other team dynamics where top quality. I have enjoyed every day spent working on this project with fabulous team members who are patient with each other, and took the time to help one another with more difficult tasks, such as debugging the sensor and thinking with one another in implementing more circuitry to enhance the quality of the heart beat signal.

Overall I am very pleased with the entire project deliverable. Not only am I happy with the project, but very content with the experienced that was gained from all the time that was spent in the lab. I definitely believe that the good work ethics of the group was leading factor in the success of this product design.

7.4 Vahid Shababi:

The ENSC 440/305 has been a very good experience for me. As the director of marketing for Heart Guard Technologies, I mostly responsible for the business end of the project. Although I already have much experience in business and marketing, I still learnt much throughout this project. In addition to the business end, I also helped with the technical aspect of the project such as the CMOS circuit which transformed analog pulses to digital pulses.

In terms of marketing, I headed up the final presentation which was executed very successfully. For our presentation, I was the main speaker who first addressed the audience. Because of my background I was able to use what I already knew to impress the audience and get them interested in the project. Although I am highly experienced in this aspect, I still learnt new things in presenting. I learnt that it is important to monitor the other speakers and make sure they don't say anything they are not supposed to say. I also learnt that it is very important to make sure all other speakers use their allotted time and do not exceed their time and/or presentation slide limit.

As mentioned before, I also helped with the analog circuitry. As an engineer in his last semester, I was able to use some of my previous courses and apply what I learnt in them to this circuit. I learnt a great deal trouble shooting the circuit with John Azer. Because the circuit was comprised of many components, I was able to improve my knowledge of CMOS devices and how they work. Not only did we just decide and use a component, we also had to study it and understand all the parameters involved so the circuit would work correctly.

Not only was the knowledge gained from this project important, I also believe that working with such talent individuals especially Bryan Schurko helped improved me as an engineer. I believe Bryan did a good job handling the project and administering tasks to the appropriate people. The other members were an enjoyment to work with as well.

Overall, I am quite happy with the project and how it turned out. If I were the redo the project, I would try to keep the project simple at the start. As someone with experience in engineering projects, engineers tend to overcomplicate systems before they even start them. The problem is that the technical complexities are never seen fully on the drawing table.