

January 21st, 2013
Dr. Andrew Rawicz
School of Engineering Science
Burnaby, British Columbia
V5A 1S6

Re: ENSC 440 Project Proposal for Personal Electronic Stethoscope

Dear Dr. Rawicz,

Attached to this letter is our team's proposal for a Personal Electronic Stethoscope (PES), as per our class: Engineering Science 440. This device is designed for users to monitor the condition of their heart by connecting to a smart phone via Bluetooth. Upon detection of any abnormal behaviour, an automatic instantaneous message will be sent to the individual's pediatrician.

The purpose of the proposal is to present an outline of our project's design, source of information, possible design solutions, proposed funding, and team overview. A schedule will also be attached in this document to ensure my team will not run out of time for this project. This proposal will also discuss future developments of this device and how it can help prevent hidden heart diseases.

Better Life Technology is consisted of five-member team, all of whom are confident, skilled, and motivated. Real Yuen, Guntae Park, Jungioo Lee, Seven Yao, and Jesse Yang are all fourth-year engineering students majoring in electronics or systems engineering. Should you have any concerns or questions about our proposal, please feel free to contact me by phone (604) 773-3766 or by email at yky1@sfu.ca.

Sincerely,



Real Yuen
President and CEO
Better Life Technology

Enclosure: *Proposal for Personal Electronic Stethoscope*



Proposal for PES

• Personal Electronic Stethoscope

Project Team: Real Yuen
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Submitted to: Dr. Andrew Rawicz - ENSC 440
Steve Whitmore – ENSC 305
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Executive Summary

“There is nothing that destroys your happiness more than trying to live with an illness. Trying to live with some contact sickness when suddenly the lights go on and people will discover that they are the ones that absolutely could be in control of preventing a disease.”- *Caldwell Esselstyn Jr. M.D.*

People can live without the appendix, spleen, gallbladder, one of your kidneys, or even one of your lungs. However, when it comes to your heart, people cannot live without it for even one second. The heart is the first organ which becomes functional when a human is inside their mother’s womb. It starts functioning until the day people die.

Arthur’s father, who was physically fit, was on his way home for Arthur’s two years old birthday. Suddenly, chest pains appeared, and he started to have difficulties breathing. Slowly, he lost his sensation and fell down on the street. He was immediately sent to the hospital where unfortunately, it was too late. His death was due to a hidden heart defect. Two months before this incident occurred, Arthur’s father started to feel heartburn, indigestion, and sudden dizziness. Nevertheless, he ignored the symptoms and continued living his daily life. At the end he paid the ultimate price for the oversight.

Heart disease is preventable. If Arthur’s father did not ignore the symptoms and went for a body check, things might have changed. Research from Dr. Andrew Krahn of the University of British Columbia presented a study at the 2012 Canadian Cardiovascular Congress saying that in 126 cases, about 78 percent between the ages of 18 and 40 have hidden heart disease. [1] Based on the research, it is not hard to see why heart disease is the number one killer in the world.

Nowadays, people are busy with their work, relationships, and other activities. People rarely realize or pay attention to physical warnings. According to these reasons, Better Life Technology is going to create a device for people that can monitor their heart conditions by themselves. Once there are any abnormal activities happening on the user’s heart, a message will be sent to the user’s phone and provide advices. We aim to create an inexpensive device that is affordable for everyone. Our device will work continuously for a range up to 168 hours. When compared to the traditional electrocardiogram (ECG), our device provides the result and usage not only for doctors, but for patients as well. We believe this device can reduce numerous cases of deaths caused by hidden heart disease.

Better Life Technology is a group of five fourth-year engineering students with strong background in electronics circuits, signal processing and programming. For the coming twelve weeks, we hope to design and implement a device that can show the conditions of the user’s heart and prevent any tragedy caused by hidden heart disease. Currently the project is budgeted at \$455 and we have already applied the funding from ESSEF.



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Glossary

ESSEF	Acronym; Engineering Student Society Endowment Fund
PES	Acronyms; Personal Electronic Stethoscope
iOS	Acronyms; Apple's mobile Operating System
BLT	Acronyms; Better Life Technology
RF	Acronyms; Radio Frequency
MRI	Acronyms; Magnetic Resonance Imaging
ADC	Acronyms; Analog to Digital Convertor



1. Introduction

A lot of people have heart diseases and heart attacks. Around 600,000 people die every year because of heart diseases in the United States. There are also hidden heart diseases patients do not notice themselves. [1] About 935,000 Americans have heart attacks every year. [1] “With sudden cardiac deaths, people who seem to be perfectly healthy can die suddenly. A significant proportion of such cases occur in otherwise healthy, young individuals.”. [4] People do not recognize that they may have a heart disease unless they experience a heart attack or experience any chest pains themselves. Coronary heart disease is the most popular type of heart disease, and it alone costs about \$108.9 billion in medical expenses each year in the United States. [1]

If people diagnose it by themselves, they can prevent heart diseases and decrease the possibility of heart diseases or heart attacks by checking their heart condition periodically. There are some electronic stethoscopes in the market now to diagnose heart beat condition, but these electronic stethoscopes are for hospital purposes and only comprehensible by doctors. If there is a personal heart diagnosis device, more heart defects can be detected by the general public. The heart beat has a distinct range deduced by medical research over many years. A device with data in the form of graphs and numbers will be used to determine the status of heart beat, and the data can be displayed on a personal screen such as smart phones; especially iPhone. With this device, patients or healthy people who want to check their heart beat condition are able to see heart condition on their iPhone. If they notice that the heart condition is not normal, then they can see a doctor right away.

Better Life Technology (BLT) is proposing a product that will meet specifications for self-diagnoses of heart beat rate. Personal Electronic Stethoscope (PES) is the product that would be utilized to detect and diagnose heart beat rate, and if abnormal heart beat or arrhythmic heart beat is detected, then the abnormal condition message or warning will be shown. This function will help people to preserve themselves, and there will be economic positive effects in medical industries and government.

This proposal will discuss Better Life Technology’s design consideration for a personal heart beat detection device with iPhone app. This proposal provides an overview of our design, concepts of possible design and suggestion, our project sources, budget analysis, team information, and time schedule.

1. System Overview

The project design consists of three different systems: the electronic part of electronic stethoscope that includes a sound amplifier; a data transfer device through wireless signal dependent on bandwidth limit; and a mobile user interface. The purposing device will provide amplified sound signal detected from stethoscope. This sound signal will be converted to a digital signal to be provided in data form for the iPhone application. At this point, the data will be transferred from the wireless device to the iPhone application. Figure 1 shows basic block diagram of functions of the product we are aiming for.

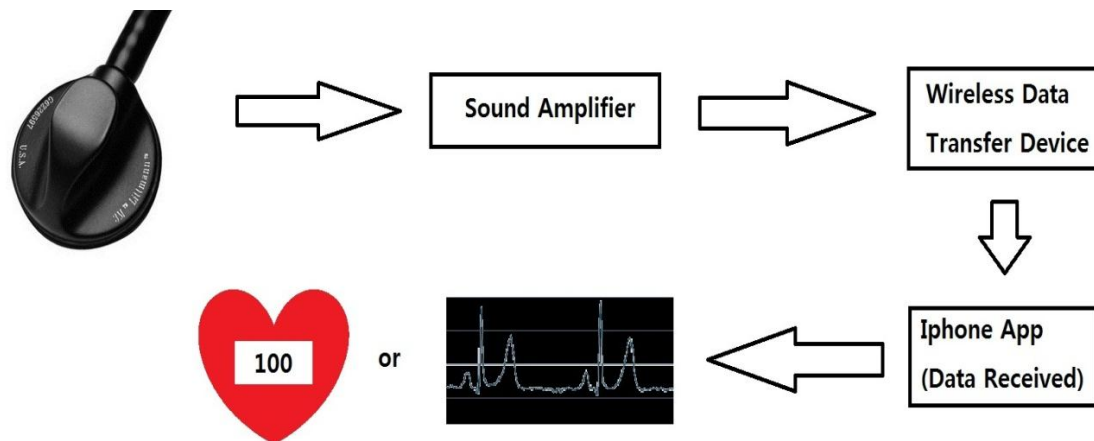


Figure 1: Block diagram of functions for PES

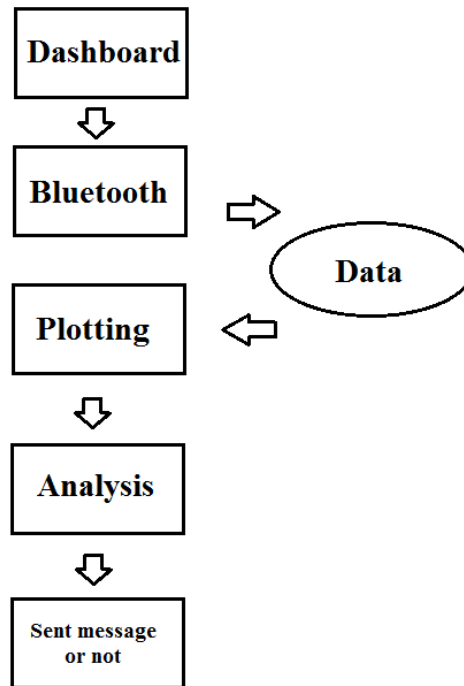


Figure 2: Simplified Diagram of how it works

Figure 2 shows the simplified diagram of how the product works in details. The explanation of each term is as follows:

Dashboard: Design the dashboard for our App.

Bluetooth: Write the code which can convert and receive data from our hardware.

Plotting: Plot the sound data by coding.

Analysis: Design our way to analyze the heart beat results.

Send Message: Future plan base on the analysis part, like warning notification.

2. Existing Solutions

There are a couple of ways to detect the heart diseases. Two common methods are by looking at the coronary angiography or the ECG. Coronary angiography is the best way to detect heart diseases. [3] During this process, a long thin tube is inserted into a blood vessel in the arm, groin or neck. Then a special X-ray is taken to measure blood flow and pressure in the heart and to see if the arteries are blocked.

For the ECG, electrical heart activity is based on depolarization and re-polarization of myocardial cells. [5] For every heart beat, a signal will be generated in six different steps. First, the atrium begins to depolarize, then it depolarizes, follow by that the ventricles begin to depolarize at apex and atrium repolarizes, next, the ventricles depolarize and then it begin to repolarize at apex and finally ventricles repolarize.

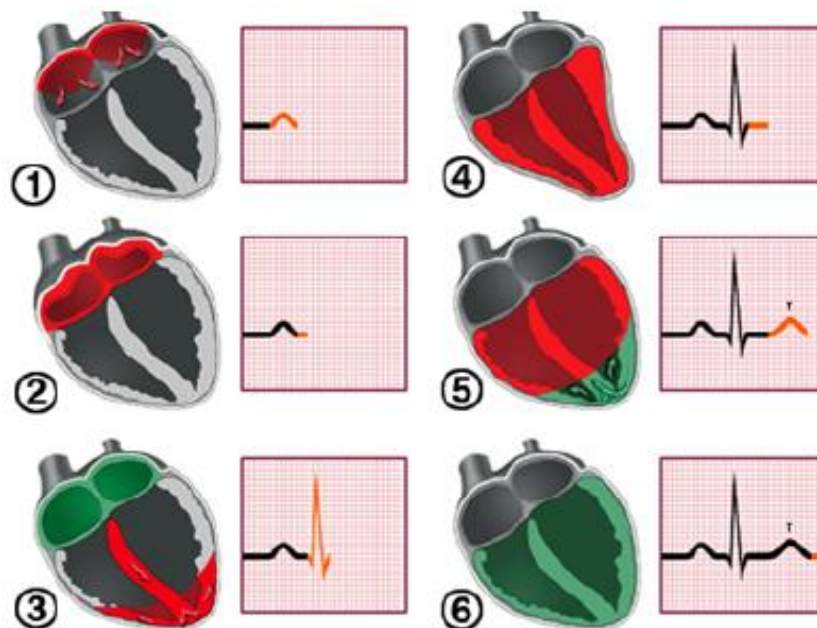


Figure 3: Myocardium electrical activity

By observing the ECG, doctors or any specialists are able to tell if the patient has heart disease. Recently, a cardiac MRI is getting comments to observe heart diseases. Doctors are able to see the chambers and valves inside the heart. However, people will need to book an appointment for the test and that costs time. Hence, not everyone will do a detail body check every year. When they eventually notice the alarm that came from their body, it is too late.



3. Proposed Solutions

From all the existing solutions, they all require doctors or specialists for the result. Nobody cares about your own body more than yourself. With this belief, our team at Better Life Technology came out with an idea to create a PES that the users can use to monitor their own heart condition.

The project criterion requires the final product solution to satisfy three core areas: affordable, portable and intuitive for users.

Nothing is more important than life. Base on this concept, we tried to reduce the price for PES so more people can afford it. If time is adequate, we will decide our own circuits and that can reduce a significant amount of cost from the device

The portability of the product is equally an essential aspect of the solution. The user is able to monitor his/her heart condition anytime and anywhere. At the beginning, the size of PES will be around 8cm x 5cm x 3cm of a rectangular box. Our final target is to implement this technology that attach to our daily clothing and users will not even be aware of it.

We are going to develop a software that is user friendly. Users can simply follow the instructions and discover their heart condition.

4. Sources of Information

This project requires a certain level of knowledge in specialized fields of study. Through the process, our team at Better Life Technology collected information from various articles from the internet, course textbooks, professor with experience in specialized fields, and friends with experience in designing iPhone applications.

The primary foundation behind this project is the work on converting and transmitting signal. The articles by Thato Tsalaile and Saeid Sanei from Cardiff University[6] has provided us some background knowledge on how to separate the heart sound signal from lung signal by adaptive line enhancement.

One of the challenges that our team faced in this projects is to convert the signal we received from the stethoscope into digital form and send it to the receiver, then convert it back to an analog signal and plot that signal on the phone. Fortunately, all members of Better Life Technology have experience on signal processing and we believe that we can overcome the problems that we will have during the design process. Another interesting challenge is from the iOS software developer's kit. Nevertheless we believe our experience in programming with C or C++ at Simon Fraser University will help us reduce our learning period in regards to the design of an iPhone application.

We decided to approach our goal step by step. We will first need to purchase components like an amplifier, ADC, and a Bluetooth device, which already exists on the market. After ensuring all parts are functioning properly, we will then decide our own circuit and system in order to reduce the total cost.

5. Budget & Funding

Budget

To design PES with an iPhone application, basically several components, devices already existed in the market, and development fee are required. Table 1 shows how much money we will need to develop this product and where the money goes in dependent on parts.

Table 1: Estimated budget for PES

Equipment List	Estimated Unit cost(CAD)
Stethoscope	\$120
Sound amplifier	\$35
PCB layout cost	\$100
iOS App development fee	\$100
Network cost	\$50
Components	\$50
Total cost	\$455

Funding

The total cost we provided above is the estimated cost of actual product. After presenting a presentation to the Engineering Student Society Endowment Fund (ESSEF), we were granted to make a prototype, and we might need more money. However, we can get more funds from other sources such as the Wighton fund due to it being a biomedical project.

We may not get a full amount of money we expected, and the actual price of the product can be more expensive than we think. In this case, our members agreed that we will share the exceeded expenses.

6. Schedule

Table 2: Schedule of the project

	Spring 2013											
	January			February			March			April		
Research												
Proposal												
Functional Specification												
Design Specification												
Order Part												
Test Part												
Build Module												
Integration Testing												
Debugging												
Demo												
Final Report												

Attached above is the schedule for the construction of the PES. In order to achieve the timeline, the team at Better Life Technology has come out with our milestone chart to ensure everything will be on schedule and finally achieve the goal. The milestone chart is represented below, in figure 4.

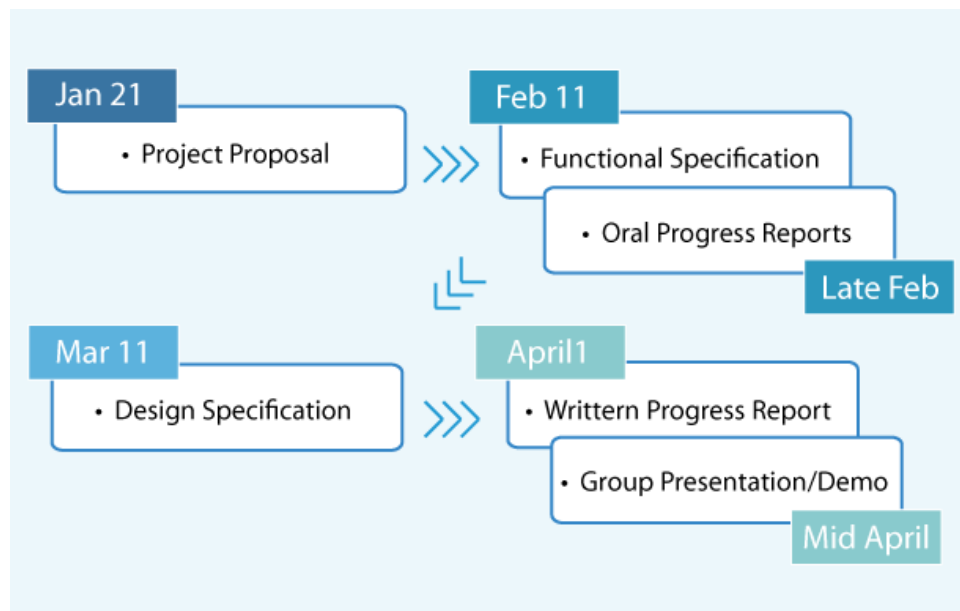


Figure 4: Milestone chart of the project



7. Team Organization

There are five talented engineers gathered in one group which is called Better Life Technology. It is consisting of Real Yuen, Guntae Park, Jungjoo Lee, Seven Yao, and Chao Yang to make better life in the world. All of the engineers are fourth year students at Simon Fraser University with two different engineering options. These talented students have different duties to finish our project successfully and from the projects we can learn the importance of team work from this course.

From our projects, we can divide our parts into two; hardware and software. For hardware, we are going to develop a present electronic stethoscope to connect with a device that can send and receive signals. The other parts are focused on the development of the iPhone application and display signals on the screen. The group members are designated in either one of the parts depending on their specialties.

Real Yuen has been nominated to be the CEO of the team because of his background of co-op and his talents of hardware skills. He is going to lead and manage our group with time planning. As well, he is going to use his documentation skills for our reports and assignments. Guntae Park is the CFO who is responsible on making the actual hardware device which can connect to an iPhone via any wireless device. Jungjoo Lee is the CMO, and he is going to be working on the hardware with Guntae Park. Seven Yao is the CTO, and he is working on the software in our group. He will be working on the data signal processing. Lastly, Chao Yang is our COO, who has great skills on software. He is going to be working on developing the applications for iPhone to connect our device.

With tons of working processes in the projects, we require to keep our promises to process our steps forward. For example, every week we are going to have at least two meetings to talk about our progress and goals. Based on our meeting, we will discuss about our problems if it occurs, and by solving matters to approach to our actual goal. Members of Better Life Technology know they have to work on their parts to finish up the project.



8. Company Profile

Real is currently a fourth year Electronics Engineering student at Simon Fraser University. He has worked at Verathon Medical Canada as a Junior Electrical Engineer and at Honeywell as a Security and Labor Technician. He is interested in hardware design. In his spare time, he enjoys playing soccer. He also loves aviation and decides to get a private pilot licence after his graduation.

Chao is currently a fourth year system options student at Simon Fraser University. He has worked at RIM as hybrid position designer. His skills lie on software design. Now he will work on our smartphone application design for our project. Singing and playing basketball are his hobbies.

Guntae is currently a fourth year Electronics Engineering student at Simon Fraser University. He has worked at Kensington Computer Product Group as a Hardware and QA Engineer and at Honeywell as a security technician for the Olympics. He is interested in hardware design. He likes to play golf and watch movies.

Seven is a fourth year Electronics Engineering student at Simon Fraser University. He is strong in hardware design and execution. He has very strong practice ability, and every mechanical construction or manually hand-on work excites him. Furthermore, Seven is also proficient in MS Excel and Photoshop.

Jungjoo is a fourth year Electronics Engineering student at Simon Fraser University. He is ready to get more experiences and he wants to develop his knowledge with this projects. He is going to work on hardware parts in this project, and he hopes to work in hardware position after graduation.



9. Conclusion

Better Life Technology is dedicated to create Personal Electronic Stethoscope (PES) for monitoring heart conditions. This product will be very useful and helpful to prevent the death caused by heart diseases and heart attacks. Our company goal is mainly providing a better life for people. The product is not only for patients who have heart diseases, but also the product can be used for healthy people or anyone who has hidden heart diseases that are not noticed yet.

We are making this product for normal people and patients, not for doctors or hospitals. Furthermore, the people can easily monitor their heart conditions using smart phones, and if there are any problems, they can contact a doctor or go to the hospital right away.

The time schedule is provided in the time table and the milestone diagram, and our budget and funding resources are also laid out in this proposal. In addition, this proposal describes what the difference between existing solution and proposed solution is, as well as the sources of information, and overall explanation of how our product is running.

11. Reference

[1] Centers for Disease Control and Prevention. (2012, October) Heart Disease Facts. [Online]
<http://www.cdc.gov/heartdisease/facts.htm>

[2] Hidden heart disease, not sports, behind sudden cardiac arrest. (2012, October) Percentage of people who have heart disease. [Online]
<http://www.thehindu.com/health/medicine-and-research/hidden-heart-disease-not-sports-behind-sudden-cardiac-arrest/article4043954.ece>

[3] Robert T. O'Sullivan, D.O. (2013) New Methods for Detecting Heart Disease. [Online]
<http://www.homehelpersphilly.com/resources/new-methods-for-detecting-heart-disease>

[4] The HINDU. (2012 October) Hidden Heart disease, not sports, behind sudden cardiac arrest. [Online]
<http://www.thehindu.com/health/medicine-and-research/hidden-heart-disease-not-sports-behind-sudden-cardiac-arrest/article4043954.ece>

[5] Carlos Casillas. (2010) Heart Rate Monitor and Electrocardiograph Fundamentals. [Online]
http://www.freescale.com/files/microcontrollers/doc/app_note/AN4059.pdf

[6] Thato Tsalaile and Saeid Sanei (2007) Separation of heart sound signal from lung sound signal by adaptive line enhancement. [Online]
<http://www.eurasip.org/Proceedings/Eusipco/Eusipco2007/Papers/c11-e01.pdf>