

# **Post Mortem**

*for CARE, A Carotid Artery Diagnosis Tool*

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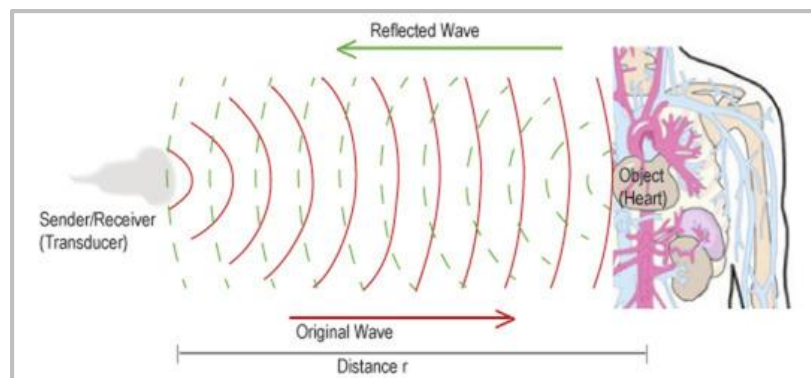
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# 1. Introduction

The purpose of the CARE product is to produce a portable, cost-effective, ultrasound system. Designed specifically for detecting carotid artery disease, the product aims to aid in the efforts of providing early diagnosis to patients. Due to the current market cost, not all medical professionals have the availability of an ultrasound machine for diagnosis purposes. CARE aims to be a practical solution for all medical professionals and patients, to be proactive about carotid artery disease.

## 1.1. Background

Ultrasound, or “medical ultrasonography”, is a non-invasive, low-risk method of detecting and visualizing biological structures within the body. As shown in **Figure 1**, a transducer does this by transmitting a high-frequency sound wave through the tissues and measuring the wave that is reflected back off of structural interfaces.

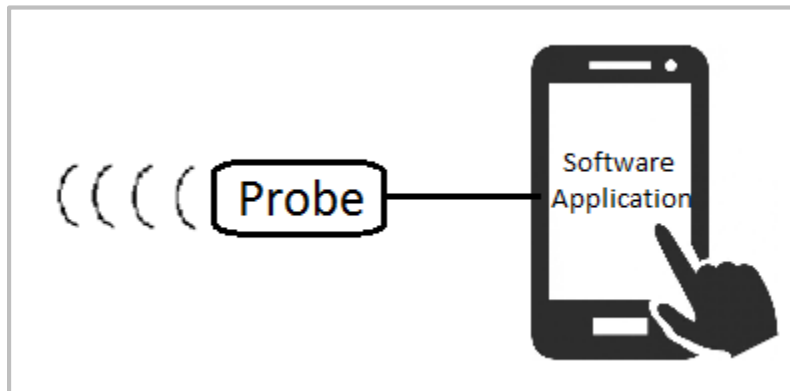


**Figure 1:** Principle of an Ultrasound [1].

There are three different modes of sonography: A-mode, B-mode, and M-mode. A-mode (Amplitude mode) imaging displays 1D data, which is at one location. B-mode (Brightness mode) imaging displays a 2D image of the internal structures of the body. This uses the entire transducer array and is also the most common type of ultrasound. M-Mode (Motion mode) imaging displays the A-mode scan over time. Using a single transducer, the M-Mode scan enables the user to measure the diameter of the artery, or thickness of plaque, at that location. During the scan time, the artery contracts and relaxes according to systolic and diastolic blood pressure, and is clearly visible in the M-Mode scan. Our product will utilize the M-Mode scan, to measure the diameter of the artery and to detect plaque.

## 2. System Overview

CARE consists of a probe and corresponding software. As shown in **Figure 2**, the probe uses ultrasound technology against the carotid artery while the software displays the information captured by the probe. The software can be installed on any portable device, such as a smartphone or tablet. Both components significantly reduce the cost of the product from current ultrasound systems due to its ease of use and portability. Featuring a handheld design and compatible software, CARE is an alternative to traditional ultrasound systems for providing early diagnosis of carotid artery disease.

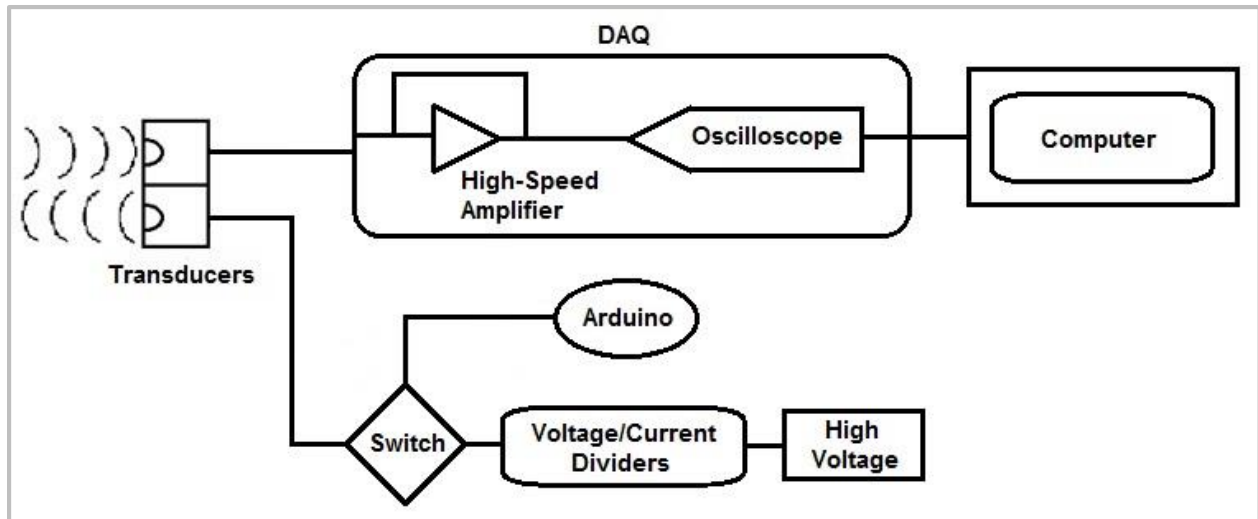


**Figure 2:** System Overview of CARE

Our design will consist of a pair of ultrasonic transducers: one will produce the emitting waves and will be driven by high voltage pulses, and the other will receive the reflected waves. These reflected waves will be modified through a few stages of circuitry. First, the reflected waves will be amplified, followed by filtering to reduce the overall noise, and finally be converted to a digital signal. Accompanying application software will process the digital signal. The prototype device will initially be powered and connected through USB, while the final production design will have Bluetooth compatibilities as well as an internal rechargeable battery integrated into the design.

### 2.1. Proof of Concept Stage

There are three modules for this project, encompassing the main functionalities: the transmitter, the receiver, and the GUI. **Figure 3** illustrates the setup to test our proof of concept. The two hardware modules transmit and receive the signals using the transducers, and the software module processes the data that is received. Our proof of concept is to confirm that our transducer can transmit and receive appropriate signals interacting with human tissue.

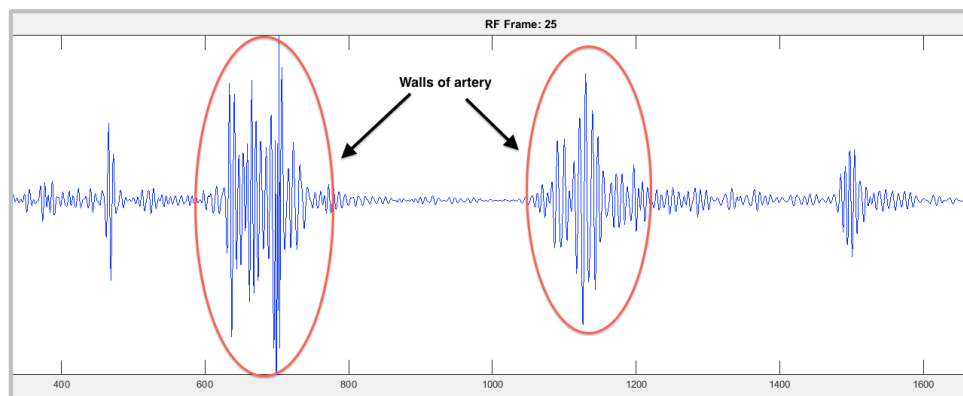


**Figure 3:** Block Diagram of Proof of Concept

## 2.2. Hardware

The transmitter consists of a microcontroller, a transistor switch, and a high voltage converter. The receiver consists of a two-stage amplifier and an oscilloscope. The microcontroller drives the transistor switch properly, so that the DC-DC converter excites the transducer with a short duration, high –voltage, pulse to emit an ultrasound wave at a frequency of 15MHz.

The reflected signal will be processed through a two-stage high-speed amplifier and then displayed onto an oscilloscope via a microdot to BNC cable connection. **Figure 4** displays a representation of the desired signal, an A-Mode scan, which shows the walls of the artery circled in red. In addition, the volunteer will also be tested with the Ultrasonix machine. If the signal on the oscilloscope is similar to what is viewed on the Ultrasonix machine our proof of concept will be completed.



**Figure 4:** Transducer Signal of Carotid Artery

## 2.3. Software

The third module of this project is the software module. A MATLAB GUI is used to acquire and display all the relevant information to the user. The program connects to the oscilloscope, and pulls data from it, using the microcontroller pulse as a trigger. When the trigger is high, the software will read the echo from the screen and plot it in the first window. Then the data is processed using the Hilbert transform for envelope detection, and is displayed in the second window. Then the data is shown as an M-Mode scan, which shows the received signals over time.

## 3. Finances

**Table 1** lists the projected revenue and costs while **Table 2** lists our final income statement for the project. The actual expenses are approximately \$600 over budget, mostly due to a domino effect of unnecessary purchases, which, at the time, we thought we needed. While 66.5% of the expense amount is from the transducers alone, the total expenses could have been lowered to about \$1650, \$400 less than current amount, if we knew what we know now. Various group members are covering this debt until reimbursements can be made. To handle the debt, we are applying for the Wighton Fund at the end of the semester and have already applied for the MDDC Awards for Excellence in Biomedical Engineering Student Design & Innovation. With the support of either of these awards, Cardiowave will be able to continue to thrive and produce a usable, efficient, ground-breaking product.

**Table 1:** Project Revenue and Costs

Cardiowave Projected Revenue and Costs					
Revenue		Expenses			
Item	Total	Item	Quantity	Amount	Total
ESSEF Funding	\$500.00	Transducer	2	\$400.00	\$800.00
Wighton Fund	\$500.00	Transceiver	2	\$60.00	\$120.00
Personal Funding	\$352.70	Digital to Analog Converter	3	\$10.00	\$30.00
		Ultrasound Gel	1	\$27.25	\$27.25
		Wires & Electronic Components	1	\$100.00	\$100.00
		Administrative Expenses			\$50.00
		Contingency (20%)			\$225.45
<b>Revenue Total:</b>	<b>\$1,352.70</b>	<b>Expenses Total:</b>			<b>\$1,352.70</b>



**Table 2: Current Income Statement**

<b>Cardiowave 2015 Income Statement</b>						
<b>Revenue</b>		<b>Expenses</b>				
Item	Total	Item	Quantity	Amount	Subtotal	Total
ESSEF Funding	\$700.00	Locker Lock	1	\$8.91	\$8.91	\$8.91
Nick Pizzacalla	\$200.00	Olympus Transducers	2	\$611.50	\$1,223.00	\$1,369.76
Bonnie Ha	\$200.00	BNC to Microdot Cable	2	\$49.72	\$99.44	\$111.37
Scott Beaupre	\$200.00	Ultrasound Gel	1	\$8.25	\$8.25	\$9.24
Alex Hauser	\$200.00	15MHz Signal Generator	10	\$6.73	\$67.30	\$67.34
		SSOP to Dip	2	\$12.06	\$24.12	\$24.12
		ADC & Breakout to BNC	2	\$30.35	\$60.70	\$60.74
		200 MHz Op-Amp	4	\$4.00	\$16.00	\$25.92
		20 MHz Op-Amp	4	\$4.00	\$16.00	\$17.92
		Printed Circuit Board	2	\$2.70	\$5.40	\$6.05
		Inductors	2	\$1.20	\$2.40	\$2.67
		Arduino	1	ESSEF Parts Library		
		DC-to-DC	2	\$81.00	\$162.00	\$312.02
		Transistor 2N5550G	2	\$1.00	\$2.00	\$2.24
		Transistor 2N2222	1	\$1.00	\$1.00	\$1.12
		IC MJE13003G	3	\$0.80	\$2.40	\$2.69
		Coaxial BNC-BNC	2	\$2.99	\$5.98	\$6.70
		BNC Connector to PCB Mount	4	\$1.95	\$7.80	\$8.74
		Diodes	3	\$1.60	\$4.80	\$5.38
		Radial 50V Capacitor	8	\$1.25	\$10.00	\$11.20
		Proto-board (103x53mm)	2	\$4.60	\$9.20	\$10.30
		Ceramic Capacitor 25V	1	\$2.83	\$2.83	\$3.17
		Battery Holder 9V	2	\$1.50	\$3.00	\$3.36
<b>Revenue Total: \$1,500.00</b>		<b>Expenses Total:</b>				<b>\$2,059.18</b>
<b>Current Standing:</b>		<b>\$(559.18)</b>				

## 4. Materials

As seen in **Table 3**, we purchased a long list of materials because some key data sheets were initially read wrong. The data sheets for the transducers were, in our opinion, poorly written. We followed these data sheets as we interpreted them, which turned out, was incorrect. Some initial purchases were deemed unnecessary for our final stage due to incorrect understanding of the datasheets. **Table 3** lists the items that were purchased, what they were purchased for, and if they were necessary for the final version of our demonstrated product.

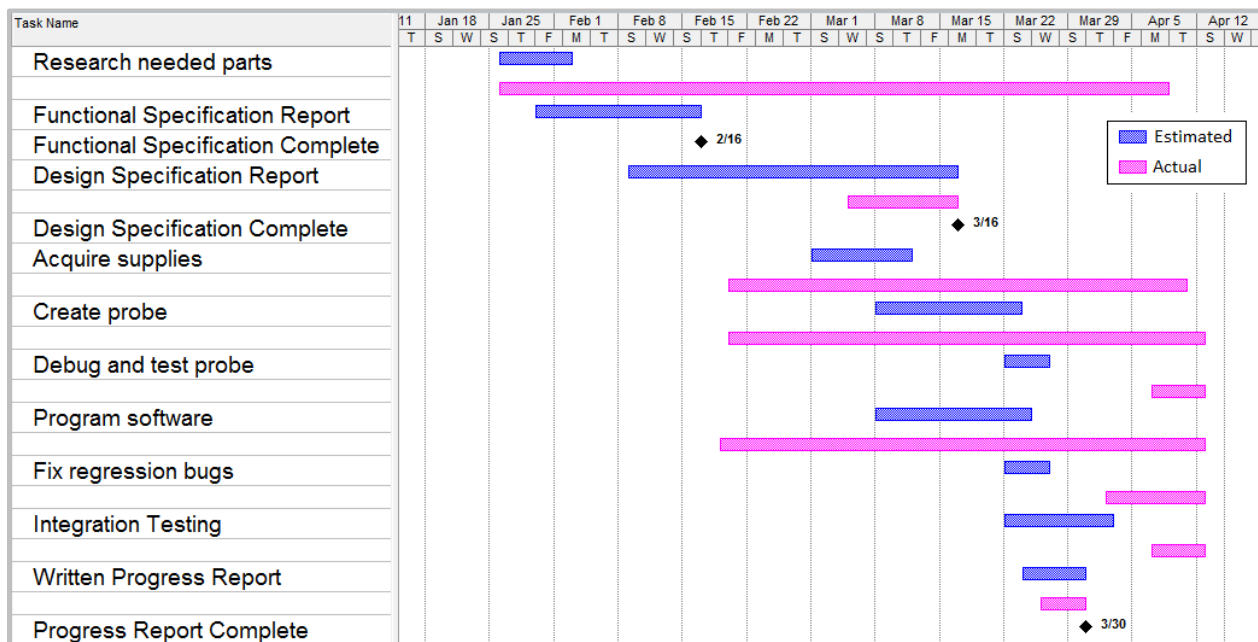
**Table 3:** Materials Purchased and its Use

Material	Purpose	Used in Final Design
Transducers	Transmit and Receive Ultrasound signal	Yes
BNC to Microdot	Connect transducers to Oscilloscope or BNC connections	Yes
Ultrasound Gel	To allow even signal flow through material	Yes
15MHz Crystal Oscillator	To transmit 15MHz signal to transducer	No
SSOP to Dip	To be able to mount ADC	No, did not ship.
ADC	To convert Analog received signal to digital for computer	No, due to connecting parts failing to ship
Breakout to BNC	Connect BNC side of transducer cable to circuit	Yes
200MHz Op-Amp	Receiving Circuit, to amplify signal to a measurable level	Yes
20 MHzOp-Amp	Receiving Circuit, to amplify signal to a measurable level	No
Proto-board	To solder various circuits on to	Some, not all
Inductors	Initially for a passive Bandpass circuit, however circuit was determined to be unnecessary	No
Arduino	Transmit square wave	Yes
BJT	Switch between 140V and 0V pulses	Yes
DC-to-DC Converter	Create high voltage, 140V	Yes
Transistor - 2N5550G	Switch to send 140V to transducer	Yes
Transistor - 2N2222	Switch to send 140V to transducer	No
IC MJE13003G	Switch	No
Coaxial BNC-BNC	Connect BNC Cables	Yes
BNC Connector to PCB Mount	Connect BNC to board for amplification of signal	Yes
Diodes	Create Voltage Booster	No, not needed
Radial 50V Capacitor	Create Voltage Booster	No, not needed

Proto-board (103x53mm)	Create Voltage Booster	No, not needed
Ceramic Capacitor 25V	Create Voltage Booster	No, not needed
Battery Holder 9V	Hold 9V batter	Yes

## 5. Schedule

Compared to our original schedule, we completed our project with an extension of two weeks. **Figure 5** showcases the estimated and actual schedule. Originally, we expected to complete our project by the end of March. One major difference is the research of needed parts and the acquirement of supplies occurred throughout the duration of the product development. The driving force for purchasing new parts was due to product design changes. Another difference is we started creating the probe and programming the software ahead of schedule as we expected some technical difficulties. However, we underestimated the time and effort needed to develop the probe and thus, we spent an extra two weeks due to the number of technical issues we encountered. Due to the delay of the probe, integration of the system was also delayed. Similarly, developing and testing the software took longer than expected due to a reliance on the probe for input signals. Nonetheless, although integration of the system was delayed by two weeks, our product was completed on April 12.



**Figure 5:** Estimated and Actual Project Timeline

## 6. Challenges

We had discussed a lot of potential starts with professionals in the field and were generously given a high speed ADC development board from Pavel Haintz. However, we decided against using it as we wanted to build the circuitry ourselves and avoid using something that was already made. This increased the overall complexity and ambition of the project, but we never would have learned from the many mistakes we made along the way. Due to this time increase, however, we didn't have enough time to get a PCB made based on our ground-up circuits.

One of the initial problems we encountered was trying to understand how the transducers operated. Not only did they not come with any documentation explaining how they needed to be driven, the company website (Olympus) barely had any further documentation as well. It wasn't until two weeks before the demonstration that we received an answer on just how much voltage was required, approximately 150V, and along with the knowledge received from the Underwater Research Lab, how to apply the mentioned voltage. We initially thought we had to drive the piezoelectric film with an oscillator. However, it needed to be driven with very short, high-voltage pulses.

With respect to the "transmitting" circuit and the "receiving" circuit, we ran into many walls. In the sending circuit, an oscillator circuit was designed to send a 15MHz signal to the transducer. Since this was the incorrect way to drive the transducer, we removed it from the design. Instead, we employed an Arduino to create the voltage pulses which were amplified and sent to the "transmitting" transducer. A "voltage booster" was implemented as the amplifier after the Arduino, but was then altered to a transistor switch and a high voltage supply. The Arduino controlled the switch which let high voltage pulses through to the transducer.

In terms of the receiving circuit, the initial amplifier design was built on a breadboard which resulted in a smooth and accurate amplification. However, when we increased the frequency, the amplification was reduced to almost nothing and was mostly noise. We found that the cause was due to the breadboard and operational amplifier (OpAmp) in the design. Breadboards introduce unwanted capacitance to the overall circuit which at high frequencies is detrimental. The OpAmps we had used were only rated for up to 1 MHz whereas we needed around 15 MHz. To resolve these issues, we moved our circuit to a prototype board, which reduced the capacitance, and purchased OpAmps that were rated for high frequencies. After the amplification, the analog signal was to be converted to a digital signal via an analog-to-digital converter (ADC). We purchased an ADC that appeared to fit our criteria; however, there was an unsolved issue in the shipping process. We were not notified that the part had arrived in Vancouver within a week of purchase and then three days later, the part was "returned to sender". Due to this unexplainable error, we decided to direct the output of the amplifier circuit to an oscilloscope and send that signal to a computer where we could analyze it. In other words, we used the oscilloscope as the ADC.

On the software side of the project, our initial aim was to create an application for smartphones and tablets. Since this goal was not attainable in the timeframe we were given, a MATLAB GUI was developed instead to take the signal from an oscilloscope and provide an M-Mode scan. Using the computers available in the lab, there was a 7-8 second delay in the signal transfer from the oscilloscope. This was due to the processing power of the lab's computers and could not be corrected.

The final issue that occurred was the worst thing that could have happened: one of the transducers stopped working. This issue completely prevented us from proving our concept. With only one transducer working and the lack of a T/R switch, we could only transmit signals OR receive signals, but not both.

As a team, we have all made many mistakes and misunderstandings by overlooking small details, but by doing so, we have come out of this project with a plethora of knowledge that will stay with us for many years to come!

## 7. Group Dynamics

Cardiowave consists of 4 members. Nick was the Chief Executive Officer, Bonnie was the Chief of Operations Officer, Alex was the Chief Technology Officer, and Scott Beaupré was the Chief Science Officer.

Initially, the team was divided into pairs. Scott and Nick were responsible for the hardware component, which included exciting the transducer and the receiving circuit. On the other hand, Bonnie and Alex were responsible for the software component, which included processing the reflected signal and displaying it in an A-mode and M-mode scan. However, the hardware team had a much more demanding task. Thus, Bonnie offered to help Scott. In the end, Nick implemented the sending circuit, Bonnie and Scott implemented the receiving circuit, and Alex implemented the software display.

For all required documentation, each team member was delegated a number of sections. Each member was responsible for composing their own section, but gathered ideas from the rest of team. Once the sections were composed, Bonnie was designated to compile the sections and format and style the document. Afterwards, all team members would revise the document for complete content and correct grammar. Once all members deemed the document accurate and problem-free, Bonnie would submit the document.

The major problem that arose was trying to arrange a common meeting time. We encountered this problem due to vastly different schedules. However, prior to the start of the semester, we agreed to work on the project on Thursdays, a common meeting time amongst our team. This allowed us to work individually until each meeting. To make up for a lack of meeting times, we

maintained good communication by updating each other through a group messaging application called Whatsapp.

## 8. Work Breakdown

**Table 4** outlines the major tasks and member's contributions where XX represents primary responsibility and X represents some responsibility.

**Table 4:** Work Breakdown

High Level Tasks	Scott Beaupre	Bonnie Ha	Alexandra Hauser	Nick Pizzacalla
Research Parts	X	X	XX	X
Purchase Parts	X	X		X
Contact Industry Professionals	X		XX	
Ultrasound Machine Operation	X	X	X	X
Company Logo Design	XX	X	X	X
Exciting Transducer Design				XX
Exciting Transducer Implementation	X		X	XX
Voltage Booster Design				XX
Voltage Booster Implementation				XX
Receiving Transducer Testing	XX			
Amplifier Design	XX	X		
Amplifier Simulations	X	XX		
Amplifier Implementation	XX	X	X	
Matlab Simulations		X	X	
Matlab GUI Programming		X	XX	
Documentation	X	XX	X	X
Meeting Agendas & Minutes		XX		
Administrative Tasks			X	XX

## 9. Individual Learning

The following sections are the reflections of what each member learned from the project, both technically and interpersonally.

## 9.1. Nick Pizzacalla, Chief Executive Officer

Capstone. The final, be-all, end-all, project of ones engineering degree. While not all students wait until the end to take ENSC 440, I felt it was the most appropriate thing to do. This allowed me to bring as much class knowledge and real-world co-op experience as possible to the table. However nothing in my five years at SFU could have prepared me for the whirlwind that is capstone. I've heard rumours of sleepless nights on end, but I shrugged them off. Oh how naïve I was.

I have worked with every one of my group members previous to ENSC 440, be it in other engineering classes or in my extracurricular activities at SFU. This allowed me to be sure that I had a strong team that I knew would communicate well. We were able to efficiently have some ideas rolling of what we wanted to do before the semester even started, but didn't finalize our project completely until mid-late January. We wanted to be sure our idea was usable, novel, would help people, and, debatably most importantly (well to me at least) marketable. We all agreed upon a project after personal research online and discussion with industry and research professionals.

Being the only team member in the Electronics discipline, and with no previous biomedical related experience or classes; our project on ultrasound carotid artery detection was something completely new to me. I had to put a lot of time in at the start of the semester to understand not only ultrasound itself but also the potential uses and effects on the body. This initial research actually lead to some assumptions and eventual complications/hindrances with the transducers circuit, which was discussed above in a previous section. I was on the Hardware Team with Scott, so I spent most of my time with him completing required tasks. I learned what transducers are, what they do, and how to get them to do what I want. I focused on making sure the transducers was sending a signal, while Scott focused on the receiving circuit. Through initial, incorrect, assumptions and misreading of data sheets, the sending of a signal to the transducers was incorrectly setup by yours truly. This caused not only a waste of funding due to purchased parts no longer being necessary but also slowing down the testing phase on whether a signal was being produced or not.

Through this I learned the very important rule of research before doing. I am on the impulsive side of the 'engineer' spectrum, but have learned that special instruments, such as \$600 transducers, require special knowledge. While I did not break or damage them in anyway, I very well could have. I also went through designing high frequency filters, transformers, worked with a microcontroller to send pulses and created a crystal oscillator circuit. This brought so many classes together into one exciting adventure. It was a nice refresher on many things I have learned.

Interpersonally, I learned to be able to call people out. To hold people accountable for what they are assigned to do. As CEO, not only did I have my own tasks, but I had to make sure everyone completed theirs. Thankfully we had very little arguments or disagreements in the group. We had our moments of annoyance, but they always quickly faded away, and all was well again.

## 9.2. Bonnie Ha, Chief Operations Officer

Steve Whitmore was surely correct when he said this experience would be more like a part-time job. One of my main responsibilities was documentation. On a weekly basis, I prepared meeting agendas and recorded meeting minutes. As the COO, my goal for meetings was to ensure team members were updated on each other's progress and to stay ahead of schedule by having early discussions of upcoming deadlines. With regards to ENSC 305W/440W reports, after delegating report sections, I was responsible for compiling everyone's, including my own, write-up. In addition, I was responsible for formatting and styling the entire document.

For the product implementation, I worked on both the software and hardware components. Initially, Alex and I partnered for the software component. We performed image processing techniques, similar to those used by ultrasound machines, and simulated a real-time M-mode scan. Next, I began working on the amplifier circuit of the receiving circuit with Scott. Together, we went through several iterations of designing, implementing, and testing the circuit. I simulated circuit schematics using TINA Spice while Scott physically built the circuit. In addition, I assisted with assembling the components of our product together. Throughout the product development stage, I visited Lee's Electronics and RP Electronics on several occasions to purchase parts.

Technically, I realize how much I don't know. Sure, I have taken all the pre-requisite courses during the completion of my degree, but applying my knowledge to this project tested my intuitively understanding. It has been a few years since I've taken electronic courses and it was evident with the numerous times I was reviewing my previous notes and textbooks. Although this experience has made me question every bit of my technical understanding, I learned a great deal in regards to ultrasound technology, image processing, and building high-frequency amplifiers.

Interpersonally, I learned that I am constantly planning ahead and moving very quickly. Throughout the past four months, I have been planning in advance to manage my time amongst my other courses. During this experience, I initiated setting internal deadlines within our team, which allowed our documentation to be completed effectively and efficiently. Furthermore, I noticed that in regards to my work habits, I want to complete tasks as quickly as possible. This has its advantage of meeting project deadlines. However, despite being beneficial in fast-paced environments, one major drawback is overseeing details. This drawback was significant in the development of the amplifier, which resulted in several iterations of redesign and



implementation without fully understanding the main underlying problems. From this experience, I learned the importance of analysis problems with forethought and practicality before making snap decisions. With these two lessons of planning ahead and working quickly, I am more certain of the type of potential careers paths that would better suite me.

If I were to undertake a similar project, I would definitely put more effort into developing a detailed low-level design specification. A lot of the problems that our team had encountered during the implementation phase of the project were due to overlooking the technical data sheets, or interpreting the data sheets incorrectly. As a result, our overall schedule was delayed and our expenses were increased. As well, I would seek advice from specialized professionals while composing this document to ensure we have not overlooked major technical considerations. If I had known this advice now, I would aim to produce a design specification with circuit schematics, part names, and simulation results.

### 9.3. Alexandra Hauser, Chief Technology Officer

Before this semester I had taken a number of courses relating to biomedical imaging, which initially aided the team in understanding the project, and in the development of the software component. I had a high level understanding of how ultrasound works, and was very excited at the prospect of building one. I had some idea of the complicated nature of the project, but didn't fully grasp it until we spoke to people in the industry and began our design. This didn't deter our group, and we learned a great deal over the course of the semester.

I realized how much I don't know, and how planning in advance can help in the design process. We selected a very challenging project, which was not within the comfort zone for anyone in our group. I am glad we did this, since we were able to learn a lot, even though we were not entirely successful. I think the soon to be adopted 8-month capstone schedule would have made this project more feasible for completion, as 3.5 months was not a lot of time. Picking a project that could not be easily done on an Arduino, or similar microcontroller, enhanced our knowledge of hardware design and implementation processes first hand.

I'm very grateful for my team, since we worked harmoniously, and everyone was reliable and dedicated. We all made time for the project, but the team was understanding if someone was sick, or had a family emergency. We were able to redistribute the work, or move internal deadlines around to accommodate each other.

Our weekly meetings were productive. We delegated tasks and made sure everyone was on the same page every step of the way. We spent a lot of time together collaborating on the project and coming up with ideas. These meetings enabled me to improve my communication and listening skills, and expressing my ideas with confidence. I learned how to divide work evenly, and to trust that the team will complete their tasks. Meeting deadlines, while also taking other courses was difficult, especially with the course timeline.

I think we could have put more effort into planning our budget originally, since we had no idea what we really needed. I found that doing this project helped me get to know my team better than I had before, and we were able to have professional discussions about design issues even if we had differing opinions. I realize now that we had not planned our schedule accordingly, and we should have started building sooner, and spent more time debugging. We ran into so many problems in the last few weeks of the project, but we kept working at it and learned a lot from our mistakes everyday. I contacted many experts in the field to receive recommendations for components, and technical advice for troubleshooting.

High frequency electronic components are tricky to work with since we couldn't use the traditional methods for circuit building and testing as we had used previously in our education. Reading the data sheet for parts is critical. Since I focused on the software component of the project, I became more versatile in switching between hardware and software jobs, and understanding how each component worked. Our hardware was falling behind schedule, so I had to switch in between my software and the two hardware teams. I am not the strongest at circuit design, so trying to debug was a challenge for me. After we realized issues with our project, I researched many op-amps to find one suitable for the project.

This project helped me with a personal goal of applying my MATLAB skills to a project. I adapted open-source software to build a GUI that would connect to an oscilloscope. We originally had planned that we would build an app and connect our probe via USB, but the hardware issues took the focus away from the software. The GUI was implemented quickly, and has some bugs, but it does the trick to process the data as desired.

#### 9.4. Scott Beaupré, Chief Science Officer

I don't think I have ever learned as much relevant knowledge from one course in my life. This course had everything: Individual aspects, group aspects, applying previous knowledge, learning new skills, teaching others, and getting out in the real world and seeing how it actually works. You can't ask for a more dynamic course.

From the beginning we had discussed a few potential topics, or at least a direction we wanted to go. The group went back and forth for some time before the ultrasound project was chosen (thank you Dr. Andrew Rawicz) and we all dove head first into researching right away. I spent the first three years of my engineering degree in Biomedical Engineering and had some relevant knowledge of how ultrasound machines worked, while Alex had done some work with ultrasound imaging. Thus, I was part of the hardware side (with Nick) and Alex went to software (with Bonnie).

After a few meetings and talking with a few industry experts, we got started on our respective project sections. My first task was to build an amplifier circuit. Seemed simple enough. Turns out that was the wrong assumption to make. I designed the circuit to have a gain of about 100

and built it on a breadboard. I connected a function generator to the input, applied a sine wave and connected the output to an oscilloscope. This was the first personal experience I had with the difficulties of high frequency circuitry and I had no idea that I would be taking the rest of the group with me to find the answers. This ultimately led to us looking through many datasheets and redesigning the circuit many times. Due to this almost constant redesigning, we purchased various parts that ended up not being used. Lesson learned.

In terms of the team dynamic, I have known Nick since first year and just met Alex and Bonnie. This turned out to not be any kind of problem since we all got along really well and got to know each other very quickly and comfortably. The hardest part was trying to balance everyone's schedules. They all had full course loads and also put a day or two of work in, while I was/am doing my own full-time research elsewhere which left minimal time to all be working on the project. Weekends came in very handy for this. Other than that, everyone was very reasonable and helpful, and even sometimes got sick but we worked around that very smoothly and realistically.

Overall this project was a great experience in both learning and dealing with groups and industries. It also became clear that we chose a very ambitious goal which we had to keep lowering our own scope to meet the deadlines for. We were warned that something like this might take industry professionals a couple years to accomplish, but we were all determined to show we had enough drive to prove the concept (at the very least). Once the timeframe of this course is changed, we should all expect to see many more amazing ideas come to life.

Beware the blasted STOBORS!

*"I wish that I knew what I know now, when I was younger." - Rod Stewart*

## 10. Conclusion

The overall outcome of our project did not meet the goals that we had set out to accomplish. We scheduled to have better integration, more testing done, and live demonstrations comparing plaque in carotid artery and a plaque-free carotid artery. That being said we are proud of the outcome, both in a sense of project completion and in what we have gained in soft skills from this project. The previous section described each of our experiences and they all point to a successful outcome. This project was the most hands-on and exciting class throughout all our engineering undergraduate careers. The freedom to learn, set our own schedules, and work so closely for so many hours made this project enjoyably frustrating.

The point of completion that we reached in this project is far enough to prove that the device will work. The concept was successfully proven. We know it will work; now, we have to make a prototype that is portable, still works, and can connect to a smartphone.

Cardiowave does plan on continuing this project, funding dependant. We plan on continuing this project to prove to ourselves, and hopefully the medical industry, that we can create a working, functional, and useful product. It will also act as a sort of hobby to take away from the daily tasks of working in an office. Three of the four members of Cardiowave are graduating and plan on continuing this to keep their minds running, learning, and expanding.

## 11. References

- [1] "What is Diagnostic Medical Ultrasound?," Ultrasound Imaging Solutions, [Online]. Available: <http://ultrasoundsolutions.net/>. [Accessed 22 January 2015].

## 12. Appendix

The following section lists our meeting agendas and minutes throughout the duration of this project.

## 12.1. 2015-01-15 Agenda

### AGENDA

Thursday, January 15, 2015 @ 11:00am – 12:00 pm in ASB9817

#### Discussion Items:

- Consolidate research notes
- Assign team roles
- Financial Matters
- Brainstorm Company Name & Logo
- Should we get professional pictures taken?
- ESSEF Funding Application Deadline
- Proposal: Deadline, Delegate Responsibilities

## 12.2. 2015-01-15 Minutes

### MINUTES

Thursday, January 15, 2015 @ 11:00am – 12:00 pm in ASB9817

#### 1. Call to Order

- Meeting was called to order at 11:17am

#### 2. Roll Call & Ratification of Regrets

Name	Present	Absent
Scott Beaupre		✓
Bonnie Ha	✓	
Alex Hauser	✓	
Nick Pizzacalla	✓	

##### **MOTION 2015-01-15.01**

Be it resolved to ratify regrets from Scott Beaupre

**Raised:** Nick

**Seconded:** Alex

**Discussion:** Scott will be free around 12pm

**MOTION PASSES UNANIMOUSLY**

#### 3. Adoption of Agenda

##### **MOTION 2015-01-15.02**

Be it resolved to adopt the agenda as presented

**Raised:** Nick

**Seconded:** Alex

**MOTION PASSES UNANIMOUSLY**

#### 4. New Business

##### **A. Consolidate Research Notes:**

- Nick researched about carotid artery disease and portable ultrasound machines. The cheapest option is \$8000. Nick also found that ultrasound technology, used at higher frequencies, can be used to clean up plaque. Nick suggests incorporating this into our project if time permitted.
- Nick believes our purpose is to decrease the cost of ultrasound tests for patients. On the other hand, Alex believes our purpose is to decrease the cost of the ultrasound system itself, considering the machines are so expensive and thus, each doctor's office can't afford to have one.
- Alex reviewed her Sensor and Actuator notes. She also researched the parts that make up a transducer. She showed a high-level block diagram of an ultrasound system, with parts such as transducer, amplifier, digital controller, etc.



- Bonnie researched how ultrasound waves are generated and how the acoustic impedance of body tissues affect the way the ultrasound waves travel through the body.

Action:

- We need to talk to Scott about defining the exact purpose of project because Scott has a better idea of the scope of the project.
  - As a result of *MOTION 2015-01-15.03*, Scott confirms our purpose is to decrease the cost of the machine itself. By making the machine cheaper, more doctor offices can be equip with ultrasound technology to detect blood flow through arteries and provide early diagnosis of carotid arteries.
- Our next step is to figure out how to build the ultrasound system.

**B. Assign Team Roles:**

- Nick is comfortable with being in charge of finances. His role will be Sexy Chief Executive Officer (SCEO).
- Bonnie is Chief Operating Officer (COO).
- Alex is Chief Technology Officer (CTO).
- Scott is Chief Science Officer (CSO).

Action:

- For the Proposal, each team member will write their biography for their position and submit it our shared Google Drive > Proposal folder.

**C. Financial Matters:**

- Nick has opened up a bank account at Scotiabank. As a result, he got a Visa Debit card, which allows us to make online purchases through the Chequing account. However, it doesn't matter who makes purchases as we will have to pass motions to reimburse from the Chequing account.
- For reimbursements, if there are no costs to ordering cheques, we will write cheques. Otherwise, we can withdraw money from the account.
- All money will be put into the Savings account, so we can't take money directly out of the Savings account. To take money out, we will have to transfer money from the Savings account to the Chequing account and then, withdraw the money.
- Chequing account will have Nick's own money for his convenience, but Nick will give everyone access to the bank account.
- Nick is proposing that we all deposit some of our own money into the account because doing so will give us some funds to begin with and encourage us to take this project seriously. Any leftover money will be divided evenly amongst ourselves. Nick is proposing \$100/person. Bonnie is proposing \$50/person.

Alex agrees with \$50/person. Nick's counter proposal is \$75/person. Bonnie is hesitant, but Alex suggests we can put in more money later.

Action:

- Each team member will pay Nick \$50, to be deposited into the bank account.

MOTION 2015-01-15.03	
Be it resolved to add Scott Beaupre as an attendee at 11:52pm	
<b>Raised:</b> Nick	<b>Seconded:</b> Alex
MOTION PASSES UNANIMOUSLY	

**D. Brainstorm Company Name & Logo:**

- For room bookings, Nick used *Team Ultra*.
- Scott came up with *Wavez (wuv-vez) Innovations* and showed a design. Everyone likes the wave design. Scott may alter the design more to his liking.

Action:

- Keep brainstorming and we'll decide next week.

**E. Should we get professional pictures taken?**

- Nick is in favour and thinks it will be funny.
- Pictures will be used in the Proposal for the biography section.

Action:

- We will take team photos next Thursday, after our meeting. Please be in formal wear.

**F. ESSEF Funding Application Deadline:**

- Application due Sunday, Jan 18.

Action:

- We will work on the application, especially the budget, after today's meeting.

**G. Proposal Deadline and Responsibility:**

- Proposal due on Jan 26.

Action:

- We will work on Proposal together after today's meeting and tomorrow.

MOTION 2015-01-15.04	
Whereas Alex bought a lock for ENSC lab locker, be it resolved to reimburse Alex \$8.91	
<b>Raised:</b> Nick	<b>Seconded:</b> Scott
<b>Discussion:</b> We need a lock to secure our locker	
MOTION PASSES UNANIMOUSLY	

## 5. Adjournment

The next meeting has been arranged for January 22, 2015 at 11am-12pm in ASB 9817

<b>MOTION 2015-01-15.05</b>	
Be it resolved to adjourn the meeting at 12:20pm	
<b>Raised:</b> Nick	<b>Seconded:</b> Scott
<b>MOTION PASSES UNANIMOUSLY</b>	

### 12.3. 2015-01-22 Agenda

#### AGENDA

Thursday, January 22, 2015 @ 11:00am – 12:00 pm in ASB9817

#### 1. Old Business

- A. **Submit Biography for Team Role**
- B. **Deposit \$50/member into Account**
- C. **Finalize Company Name & Logo**
- D. **Professional Photos**
- E. **ESSEF Funding Application**
- F. **Proposal Report: Delegations**

#### 2. New Business

- A. **Meeting with Ultrasonix**

## 12.4. 2015-01-22 Minutes

### MINUTES

Thursday, January 22, 2015 @ 11:00am – 12:00 pm in ASB9817

#### 1. Call to Order

- Meeting was called to order at 11:28am

#### 2. Roll Call & Ratification of Regrets

Name	Role	Present	Absent
Scott Beaupre	Chief Science Officer	✓	
Bonnie Ha	Chief Operating Officer	✓	
Alex Hauser	Chief Technology Officer	✓	
Nick Pizzacalla	Chief Executive Officer	✓	

#### 3. Adoption of Agenda

MOTION 2015-01-22.01	
Be it resolved to adopt the agenda as presented	
<b>Raised:</b> Nick	<b>Seconded:</b> Alex
MOTION PASSES UNANIMOUSLY	

#### 4. Approval of Previous Minutes

MOTION 2015-01-22.02	
Be it resolved to approve the previous meeting minutes as presented	
<b>Raised:</b> Nick	<b>Seconded:</b> Alex
MOTION PASSES UNANIMOUSLY	

#### 5. Old Business

##### A. **Submit Biography for Team Role**

- Completed by everyone

##### B. **Deposit \$50/member into Account**

- Completed by everyone

##### C. **Finalize Company Name & Logo**

- Alex came up with CardioWave and the product name CARE (Carotid Artery Real-time Echos)
- We have decided to go with CardioWave Innovations as the company name

##### Action:

- Scott will revise his Wuvez Innovations logo to CardioWave Innvoations.

**D. Professional Photos**

- Being taken today after meeting

**E. ESSEF Funding Application Report**

- Presentation went well. We are waiting to hear back about how much funding we will receive.

**F. Proposal Report: Delegations**

- Bonnie – Introduction & Background, Project Planning, Format, Organization
- Alex – Scope/Risks/Benefits, Letter of Transmittal
- Scott – Market Rational, Executive Summary, Correctness/Style
- Nick – Cost Considerations, Conclusion
- Everyone – Company Profile

Action:

- Everyone complete their sections by Saturday morning. On Saturday, Scott will work on correctness/style. On Sunday, Bonnie will work on formatting and organization.

**6. New Business**

**A. Meeting with Ultrasonix**

- Andrew Rawicz gave us a contact, Reza, for Ultrasonix.
- Scott called Reza, but he is in Boston for 2 weeks. Andrew is taking his ENSC 370 class on a visit to Ultrasonix, either next week or the week after. Thus, Scott suggests we go with the ENSC 370 class and speak with Reza then.

Action:

- We find out when ENSC 370 is visiting Ultrasonix

**7. Adjournment**

The next meeting has been arranged for January 29, 2015 at 11am-12pm in ASB 9817

**MOTION 2015-01-22.01**

Be it resolved to adjourn the meeting at 11:52am

**Raised:** Nick

**Seconded:** Scott

**MOTION PASSES UNANIMOUSLY**

## 12.5. 2015-01-29 Agenda

### AGENDA

Thursday, January 29, 2015 @ 11:00am – 12:00 pm in ASB9817

#### 1. Old Business

- A. Proposal Report
- B. Meeting with Ultrasonix

#### 2. New Business

- A. Functional Specification: Overview, Delegations

## 12.6. 2015-01-29 Minutes

### MINUTES

Thursday, January 29, 2015 @ 11:00am – 12:00 pm in ASB9817

#### 1. Call to Order

- Meeting was called to order at 11:06am

#### 2. Roll Call & Ratification of Regrets

Name	Role	Present	Absent
Scott Beaupre	Chief Science Officer	✓	
Bonnie Ha	Chief Operating Officer	✓	
Alex Hauser	Chief Technology Officer	✓	
Nick Pizzacalla	Chief Executive Officer	✓	

#### 3. Adoption of Agenda

<b>MOTION 2015-01-29.01</b>	
Be it resolved to adopt the agenda as presented	
<b>Raised:</b> Nick	<b>Seconded:</b> Bonnie
<b>MOTION PASSES UNANIMOUSLY</b>	

#### 4. Approval of Previous Minutes

<b>MOTION 2015-01-29.02</b>	
Be it resolved to approve the previous meeting minutes as presented	
<b>Raised:</b> Scott	<b>Seconded:</b> Nick
<b>MOTION PASSES UNANIMOUSLY</b>	

#### 5. Old Business

##### A. **Proposal Report**

- Completed and submitted on Jan 26

##### B. **Meeting with Ultrasonix**

- ENSC 370 class is going on Feb 20. Reza is away until a couple days before the visit. Reza recommended we talk to PR about speaking with someone

##### Action:

- Scott will contact PR of Ultrasonix to find another engineer, who we can visit for the day.

##### C. **Finalize Company Logo**

- For the Proposal, Bonnie picked one of Scott's logos. However, we can collectively decide on one.



- Majority vote on “Block-C” design with blue and teal wave
- However, keep black/white version as well

Action:

- Scott will upload coloured and black/white logo to Drive

## 6. New Business

### A. **Functional Specification: Overview, Delegations**

- Functionalities:
  - Detect plaque of carotid artery – production product, using an array of transducer
  - Detect blood velocity and flow using Doppler on ID image
  - Display images in real-time – prototype
  - Different scans:
    - A-scan
    - M-scan – prototype, first
      - How scans work – proof of concept
    - Doppler on ID image – prototype, second
- USB connectivity has been done already, so we shall research about wifi and Bluetooth options
- Will need to research about safety standards for medical devices
- Will need to consider sustainability of production product

Action:

- Bonnie and Nick will look into Bluetooth while Alex and Scott will look into Wifi
- Nick will define connectivity function
- Bonnie will define detect plaque of carotid artery
- Scott will define blood velocity function
- Alex will define display image function
- Each person will find engineering standards for their functionality
- Everyone will research about sustainable and safety standards for entire product and electronics.

### B. **Additional Resources**

- Scott found a similar market item on MobiSante.
- Andrew gave us one of John Bird’s contact ([pavel\\_haintz@shaw.ca](mailto:pavel_haintz@shaw.ca)) who has worked extensively with transducers

Action:

- Scott will email MobiSante to find out more about their product.
- Alex will contact Pavel to request for his assistance with our project.

## 7. Adjournment

The next meeting has been arranged for February 2, 2015 at 2:30-3:30pm in ASB 9817

<b>MOTION 2015-01-29.03</b>	
Be it resolved to adjourn the meeting at 12:04pm	
<b>Raised:</b> Scott	<b>Seconded:</b> Alex
<b>MOTION PASSES UNANIMOUSLY</b>	

## 12.7. 2015-02-02 Agenda

### AGENDA

Monday, February 2, 2015 @ 2:30pm – 3:20pm in ASB9817

#### 1. Old Business

- A. Ultrasonix Meeting
- B. Meetings with MobiSante and/or Pavel
- C. Functional Specification Discussion

#### 2. New Business

- A. Meetings During Reading Break

## 12.8. 2015-02-02 Minutes

### MINUTES

Monday, February 2, 2015 @ 2:30pm – 3:20pm in ASB9817

#### 1. Call to Order

- Meeting was called to order at 2:32pm

#### 2. Roll Call & Ratification of Regrets

Name	Role	Present	Absent
Scott Beaupre	Chief Science Officer	✓	
Bonnie Ha	Chief Operating Officer	✓	
Alex Hauser	Chief Technology Officer	✓	
Nick Pizzacalla	Chief Executive Officer	✓	

#### 3. Adoption of Agenda

<b>MOTION 2015-02-02.01</b>	
Be it resolved to adopt the agenda as presented	
<b>Raised:</b> Alex	<b>Seconded:</b> Nick
<b>MOTION PASSES UNANIMOUSLY</b>	

#### 4. Approval of Previous Minutes

<b>MOTION 2015-02-02.02</b>	
Be it resolved to approve the previous meeting minutes as presented	
<b>Raised:</b> Scott	<b>Seconded:</b> Nick
<b>MOTION PASSES UNANIMOUSLY</b>	

#### 5. Old Business

##### A. **Ultrasonix Meeting**

- Have no contact for PR; have to go in person

##### Action:

- Scott will go to Ultrasonix to setup a meeting

##### B. **Meetings with MobiSante and/or Pavel**

- Only contact for MobiSante is through Sales rep
- Alex contacted Pavel. He will be in underwater research lab tomorrow afternoon and available to help. He cautions integrating transducers and electronics can take a long time.

##### Action:

- Scott will contact Sales rep for MobiSante

- Alex, Scott, and Bonnie will go see Pavel tomorrow afternoon to discuss the use of transducers. We will bring a copy of our proposal. We would like to know which type of transducers and electronics (FPGA, MCU) to get.

#### C. Wifi vs Bluetooth

- Bluetooth – different frequency, 24mbps, version 4.0, short-range health sensor data, better for symmetrical (1:1) data connection, Bluetooth dongle, low power consumption, no middle man,
- Wifi – larger range, high security, depends on internet connection, higher consumption
- Scott found the chip in Google Comcast, but needs to be programmed and setting up wifi connectivity; possible, but out of scope for project
- There's a chip that has both wifi and Bluetooth capabilities
- We should consider packet loss and speeds.
- Majority feels Bluetooth would be better appropriate for our application.

#### D. Functional Specification Discussion

- Misunderstandings of responsibilities we delegated

##### Action:

- Everyone look at previous 440 projects related to Ultrasound, specifically what was included in Functional Specification document.

## 6. New Business

#### A. Meetings During Reading Break

- Fri, Feb 6 – Collaborate on Functional Specification
- Mon, Feb 9 – Skype meeting
- Wed, Feb 11 – FS follow up
- Thu, Feb 12 – FS follow up
- Fri, Feb 13 – BCIT visit

## 7. Adjournment

The next meeting has been arranged for February 11, 2015 at 11am-12pm in ASB 9817

<b>MOTION 2015-02-02.03</b>	
Be it resolved to adjourn the meeting at 3:08pm	
<b>Raised:</b> Nick	<b>Seconded:</b> Alex
<b>MOTION PASSES UNANIMOUSLY</b>	

## 12.9. 2015-02-11 Agenda

### AGENDA

Wednesday, February 11, 2015 @ 11:00am – 12:00 pm in ASB9817

#### 1. Old Business

- A. Meetings with Ultrasonix, MobiSante, and Pavel
- B. Functional Specification Update

#### 2. New Business

- A. Parts Procurement

## 12.10. 2015-02-11 Minutes

### MINUTES

Wednesday, February 11, 2015 @ 11:00am – 12:00 pm in ASB9817

#### 1. Call to Order

- Meeting was called to order at 11:02am

#### 2. Roll Call & Ratification of Regrets

Name	Role	Present	Absent
Scott Beaupre	Chief Science Officer	✓	
Bonnie Ha	Chief Operating Officer	✓	
Alex Hauser	Chief Technology Officer	✓	
Nick Pizzacalla	Chief Executive Officer	✓	

#### 3. Adoption of Agenda

<b>MOTION 2015-02-11.01</b>	
Be it resolved to adopt the agenda as presented	
<b>Raised:</b> Nick	<b>Seconded:</b> Scott
<b>MOTION PASSES UNANIMOUSLY</b>	

#### 4. Approval of Previous Minutes

<b>MOTION 2015-02-11.02</b>	
Be it resolved to approve the previous meeting minutes as presented	
<b>Raised:</b> Nick	<b>Seconded:</b> Alex
<b>MOTION PASSES UNANIMOUSLY</b>	

#### 5. Motion

<b>MOTION 2015-02-11.03</b>	
Whereas Scott purchased ultrasound transmission gel, be it resolved Scott be reimbursed \$9.24.	
<b>Raised:</b> Nick	<b>Seconded:</b> Alex
<b>MOTION PASSES UNANIMOUSLY</b>	

#### 6. Old Business

##### A. Meetings with Ultrasonix, MobiSante, and Pavel

- Ultrasonix meeting with ENSC 370 class
- MobiSante is not happening because its not relevant
- Spoke to Pavel and Andrew together; clarified that we are doing a 2-channel echo sounder

#### **B. Functional Specification Update**

- Scott will expand on his analysis
- Alex needs access to Standards documentation
- Alex came up with 30 requirements
- Nick researched Bluetooth details and will expand on
- Scott say we will need to buy an ~20MHz oscillator. He calculated 6MHz, but will need to recalculate.
- Bonnie will continue to look at cradle-to-cradle

#### Action:

- Drafts are due Saturday. Scott and Nick will complete executive summary and conclusion respectively.

### **7. New Business**

#### **A. Parts Procurement**

- Linear.com has free samples, based in California. Ash and other professors have an account so we can ask them to get them for us.
- Alex has contacted Andrew's grad student about dual-transducers. They are approximately ~\$600.

#### Action:

- We will continue to select parts.

#### **B. Reminders**

- Training session - tomorrow at 11am
- Functional Specification Report Discussion tomorrow after training session

#### Action:

- Read ultrasound manual for training session tomorrow at 11am

### **8. Adjournment**

The next meeting has been arranged for February 19, 2015 at 11am-12pm in ASB 9817

<b>MOTION 2015-02-11.04</b>	
Be it resolved to adjourn the meeting at 11:41am	
<b>Raised:</b> Nick	<b>Seconded:</b> Alex
<b>MOTION PASSES UNANIMOUSLY</b>	



## 12.11. 2015-02-19 Agenda

### AGENDA

Thursday, February 19, 2015 @ 11:00am – 12:00 pm in ASB9705

#### 1. Old Business

- A. **Functional Specifications Report**
- B. **Parts Procurement**

#### 2. New Business

- A. **Oral Progress Report**
- B. **Design Specifications Brainstorm**

## 12.12. 2015-02-19 Minutes

### MINUTES

Thursday, February 19, 2015 @ 11:00am – 12:00 pm in ASB9817

#### 1. Call to Order

- Meeting was called to order at 10:58am.

#### 2. Roll Call & Ratification of Regrets

Name	Role	Present	Absent
Scott Beaupre	Chief Science Officer	✓	
Bonnie Ha	Chief Operating Officer	✓	
Alex Hauser	Chief Technology Officer	✓	
Nick Pizzacalla	Chief Executive Officer	✓	

#### 3. Adoption of Agenda

MOTION 2015-02-19.01	
Be it resolved to adopt the agenda as presented	
<b>Raised:</b> Nick	<b>Seconded:</b> Alex
MOTION PASSES UNANIMOUSLY	

#### 4. Approval of Previous Minutes

MOTION 2015-02-19.02	
Be it resolved to approve the previous meeting minutes as presented	
<b>Raised:</b> Scott	<b>Seconded:</b> Nick
MOTION PASSES UNANIMOUSLY	

#### 5. Motion

MOTION 2015-02-19.03	
Whereas the parts need to be purchased, be it resolved Nick purchases the parts using the funds in the joint Scotiabank account and ESSEF source. Be it further resolved that each member deposits an additional \$150 to cover the cost until reimbursement can be made.	
<b>Raised:</b> Nick	<b>Seconded:</b> Scott
MOTION PASSES UNANIMOUSLY	

#### 6. Old Business

##### A. **Functional Specifications Report**

- Handed in, completed

##### B. **Parts Procurement**

- Yesterday, Alex, Scott, and Bonnie spoke to Pavel about the parts we were looking of getting. He advised that the parts seems appropriate for our

project. In addition, he gave us two Analog-to-digital/data acquisition development board, which we will need to hook up to an FPGA board to control. Pavel suggested to look at microchip.com for development board and he may be able to get us some free parts.

- Nick is ordering parts: transducer, transducer-to-BNC cables
- We can get the FPGA board from the ESSEF Parts library
- Connection between transducer to microcontroller will need to be IEEE 1451.2 compatibility

Action:

- Scott will look into development board and transmitters
- Scott will try to get some plaque so we can model the carotid artery.

**C. Ultrasonix Meeting**

- Feb 20 @ 9:25-10:25am at Ultrasonix's office in Richmond
- Alex will attend. Nick will try to attend.

## 7. New Business

**A. Oral Progress Report**

- Presentation is on Mar 6 @ 3:30pm
- Will aim to complete proof of concept done by presentation
- Discuss presentation details the week before the presentation

Action:

- Nick and Scott will work on acquiring electronic components
- Alex and Bonnie will get raw data from ultrasound machine and process the signal to produce an image

**B. Design Specifications Brainstorm**

- Deferred to next meeting

Action:

- We will look at the rubric in preparation for next meeting

## 8. Adjournment

The next meeting has been arranged for February 26, 2015 at 11am-12pm in ASB 9817

<b>MOTION 2015-02-19.04</b>	
Be it resolved to adjourn the meeting at 11:55am	
<b>Raised:</b> Alex	<b>Seconded:</b> Scott
<b>MOTION PASSES UNANIMOUSLY</b>	

## 12.13. 2015-03-05 Agenda

### AGENDA

Thursday, March 5, 2015 @ 11:00am – 12:00 pm in ASB9817

#### 1. Old Business

A. Oral Progress Report Update

#### 2. New Business

A. Design Specification: Brainstorm and Delegate Responsibilities

## 12.14. 2015-03-05 Minutes

### MINUTES

Thursday, March 5, 2015 @ 11:00am – 12:00 pm in ASB9817

#### 1. Call to Order

- Meeting was called to order at 10:53am

#### 2. Roll Call & Ratification of Regrets

Name	Role	Present	Absent
Scott Beaupre	Chief Science Officer	✓	
Bonnie Ha	Chief Operating Officer	✓	
Alex Hauser	Chief Technology Officer	✓	
Nick Pizzacalla	Chief Executive Officer	✓	

#### 3. Adoption of Agenda

<b>MOTION 2015-03-05.01</b>	
Be it resolved to adopt the agenda as presented	
<b>Raised:</b> Nick	<b>Seconded:</b> Alex
<b>MOTION PASSES UNANIMOUSLY</b>	

#### 4. Approval of Previous Minutes

<b>MOTION 2015-03-05.02</b>	
Be it resolved to approve the previous meeting minutes as presented	
<b>Raised:</b> Scott	<b>Seconded:</b> Nick
<b>MOTION PASSES UNANIMOUSLY</b>	

#### 5. Old Business

##### **A. Oral Progress Report Update**

- Alex will talk about background in brief. Remediation will be proof of concept if prototype idea fails. Matlab GUI for plan B
- Scott will talk about Progress. He will emphasize our meetings with Pavel and other industry professionals.
- Nick will talk about Finances: sources of funding, current expenses. Currently in the process to buy microdot-pin cable and a Raspberry pi.
- Bonnie will talk about being ahead of schedule and if things go wrong, we have 2 weeks between our expected end date and the demo. Currently, on schedule, over budget, etc.

##### Action:

- Nick and Alex will be buying Raspberry pi.
- Oral Progress Rehearsal meeting tomorrow at 2pm in L9014.

## 6. New Business

### A. **Design Specifications: Brainstorm and Delegate Responsibilities**

- Scott will take on Probe Specifications and Executive Summary
- Nick will take on Product Stages and Conclusion
- Alex will take on General Requirements and Letter of Transmittal
- Bonnie will take on Probe and Software Requirements
- For Test Plan, Scott and Nick will come up with one for hardware and Alex and Bonnie will come up with one for software
- We will aim to have the report completed by Mar 14; thus, drafts will have to be completed by Mar 12.

#### Action:

- We will have a Google Hangout meeting on Tuesday night to update each other on our assigned section.

## 7. Adjournment

The next meeting has been arranged for March 10, 2015 at 8pm over Google Hangout

<b>MOTION 2015-03-05.03</b>	
Be it resolved to adjourn the meeting at 11:30am	
<b>Raised:</b> Nick	<b>Seconded:</b> Scott
<b>MOTION PASSES UNANIMOUSLY</b>	

## 12.15. 2015-03-10 Agenda

### AGENDA

Thursday, March 10, 2015 @ 8:30 – 9:00 pm over Google Hangout

#### 1. Old Business

- A. **Design Specification Follow Up**
- B. **Raspberry Pi Acquisition Follow Up**

## 12.16. 2015-03-10 Minutes

### MINUTES

Thursday, March 10, 2015 @ 8:30 – 9:00 pm over Google Hangout

#### 1. Call to Order

- Meeting was called to order at 8:33pm.

#### 2. Roll Call & Ratification of Regrets

Name	Role	Present	Absent
Scott Beaupre	Chief Science Officer	✓	
Bonnie Ha	Chief Operating Officer	✓	
Alex Hauser	Chief Technology Officer	✓	
Nick Pizzacalla	Chief Executive Officer	✓	

#### 3. Adoption of Agenda

<b>MOTION 2015-03-10.01</b>	
Be it resolved to adopt the agenda as presented	
<b>Raised:</b> Nick	<b>Seconded:</b> Scott
<b>MOTION PASSES UNANIMOUSLY</b>	

#### 4. Approval of Previous Minutes

<b>MOTION 2015-03-10.02</b>	
Be it resolved to approve the previous meeting minutes as presented	
<b>Raised:</b> Scott	<b>Seconded:</b> Alex
<b>MOTION PASSES UNANIMOUSLY</b>	

#### 5. Old Business

##### A. Design Specification Follow Up

- Bonnie went through functional requirements and added implementation details for each.
- Scott added more details to how the probe works, especially the physics behind it.
- Nick took the product stages and added more implementation details where he could. However, he needs some more details about the software component.
- Alex will continue to go through the functional requirements to add implementation details.
- Nick pointed out that we have not used our free late yet. Since this would be the last chance to use the free late, we are all in agreement that we should use it.



Action:

- Bonnie will email Steve Whitmore regarding extension.
- Bonnie and Alex will submit details about the software process during the proof of concept stage.
- We still need to come up with a test plan for the Design Spec.

**B. Raspberry Pi Acquisition Follow Up**

- Nick decided not to get them because it is another learning curve.
- Instead, he found an oscillator that could do the work.

## 6. Adjournment

The next meeting has been arranged for March 12, 2015 at 11am-12pm in ASB 9817

<b>MOTION 2015-03-10.03</b>	
Be it resolved to adjourn the meeting at 8:46pm	
<b>Raised:</b> Scott	<b>Seconded:</b> Alex
<b>MOTION PASSES UNANIMOUSLY</b>	

## 12.17. 2015-03-12 Agenda

### AGENDA

Thursday, March 12, 2015 @ 11:00am – 12:00 pm in ASB9817

#### 1. Motions

<b>MOTION 2015-03-12.01</b>
Whereas Nick purchased 15MHz frequency generators, BIRT he be reimbursed the full amount of \$67.34.

#### 2. Old Business

- A. Design Specification Update

#### 3. New Business

- A. Project Progress Update
- B. Create Internal Deadlines

## 12.18. 2015-03-12 Minutes

### MINUTES

Thursday, March 12, 2015 @ 11:00am – 12:00 pm in ASB9817

#### 1. Call to Order

- Meeting was called to order at 11:06

#### 2. Roll Call & Ratification of Regrets

Name	Role	Present	Absent
Scott Beaupre	Chief Science Officer	✓	
Bonnie Ha	Chief Operating Officer	✓	
Alex Hauser	Chief Technology Officer	✓	
Nick Pizzacalla	Chief Executive Officer	✓	

#### 3. Adoption of Agenda

MOTION 2015-03-12.01	
Be it resolved to adopt the agenda as presented	
<b>Raised:</b> Nick	<b>Seconded:</b> Alex
MOTION PASSES UNANIMOUSLY	

#### 4. Approval of Previous Minutes

MOTION 2015-03-12.02	
Be it resolved to approve the previous meeting minutes as presented	
<b>Raised:</b> Nick	<b>Seconded:</b> Alex
MOTION PASSES UNANIMOUSLY	

#### 5. Motion

MOTION 2015-03-12.03	
Whereas Nick purchased 15MHz frequency generators, BIRT he be reimbursed the full amount of \$67.34.	
<b>Raised:</b> Bonnie	<b>Seconded:</b> Scott
<b>Discussion:</b> Nick will buy some off the group. One of them is programmable. \$50 USD total with \$25 USD shipping included. They will be coming tomorrow or Monday.	
MOTION PASSES UNANIMOUSLY	

#### 6. Old Business

##### A. Design Specification Update

- Scott is waiting for the oscillator circuit from Nick.

- Proof of Concept to show that transducer works and displays the artery walls on the artificial or animal arteries. Basically, oscilloscope should show the same as the raw data ultrasound.

Action:

- Drafts are due on Saturday night.
- Quick meeting on Monday @ 2:30pm to touch base of report.

## 7. New Business

### A. **Project Progress Update**

- Bonnie and Alex have already stimulated real-time M-mode display. Their next focus will be to show the artery walls and the duration of testing on the display. Afterwards, we'll focus on Android application.
- Scott is still looking for an opamp to amplify the signal.
- Nick is waiting for the function generators, so he can send a signal on the transducer.

### B. **Create Internal Deadlines**

- March 19 – Design Spec Due
- Mar 21 – Proof of Concept completed: function generator sending signal, receiving transducer displaying raw data on screen, raw data from artificial artery
- Mar 28 – Prototype version: add DAQ board and FPGA, software will stream data in
- Mar 30 – Post Mortem Due
- Apr 4-6 – Hashout Weekend; have prototype complete

Action:

- Scott will get synthetic artery for testing.

### C. **Finances Update**

- We are in the red. Nick's current expenses are on this credit card. If we buy anything else, we will need to add additional funding personally.

## 8. Adjournment

The next meeting has been arranged for March 19, 2015 at 11am-12pm in ASB 9817

<b>MOTION 2015-03-12.04</b>	
Be it resolved to adjourn the meeting at 11:45am	
<b>Raised:</b> Nick	<b>Seconded:</b> Bonnie
<b>MOTION PASSES UNANIMOUSLY</b>	

## 12.19. 2015-03-19 Agenda

### AGENDA

Thursday, March 19, 2015 @ 11:00am – 12:00 pm in ASB9817

#### 1. Old Business

A. Design Specification Update

#### 2. New Business

A. Proof of Concept Progress Update

## 12.20. 2015-03-19 Minutes

### MINUTES

Thursday, March 19, 2015 @ 11:00am – 12:00 pm in ASB9817

#### 1. Call to Order

- Meeting was called to order at 11:10am

#### 2. Roll Call & Ratification of Regrets

Name	Role	Present	Absent
Scott Beaupre	Chief Science Officer	✓	
Bonnie Ha	Chief Operating Officer	✓	
Alex Hauser	Chief Technology Officer	✓	
Nick Pizzacalla	Chief Executive Officer	✓	

#### 3. Adoption of Agenda

<b>MOTION 2015-03-19.01</b>	
Be it resolved to adopt the agenda as presented	
<b>Raised:</b> Nick	<b>Seconded:</b> Alex
<b>MOTION PASSES UNANIMOUSLY</b>	

#### 4. Approval of Previous Minutes

<b>MOTION 2015-03-19.02</b>	
Be it resolved to approve the previous meeting minutes as presented	
<b>Raised:</b> Alex	<b>Seconded:</b> Nick
<b>MOTION PASSES UNANIMOUSLY</b>	

#### 5. Motion

<b>MOTION 2015-03-19.03</b>	
Whereas Scott ordered 2 ADC and 2 Breakout BNC, be it resolved he be reimbursed \$60.70.	
<b>Raised:</b> Nick	<b>Seconded:</b> Alex
<b>MOTION PASSES UNANIMOUSLY</b>	

<b>MOTION 2015-03-19.04</b>	
Whereas Scott ordered 2 SSOP-to-DIP, be it resolved he be reimbursed \$24.12	
<b>Raised:</b> Bonnie	<b>Seconded:</b> Alex
<b>MOTION PASSES UNANIMOUSLY</b>	

#### 6. Old Business

##### A. Design Specification Update

- Bonnie is revising the document currently. She will upload the copy and notify everyone.

Action:

- Alex will have the final look over and submit it before midnight.

## 7. New Business

### A. **Proof of Concept Progress Update**

- Scott and Nick are having problem interacting with the transducers. Scott is ordering parts for receiving the signal. Nick did some testing on the transducers.
- Alex and Bonnie have not progressed on the software portion. Seeing as the hardware components are troublesome, Alex and Bonnie will focus their efforts in helping Scott and Nick.

Action:

- We will meet up tomorrow after 2pm to work on transducers

## 8. Adjournment

The next meeting has been arranged for March 26, 2015 at 11am-12pm in ASB 9817

<b>MOTION 2015-03-19.05</b>	
Be it resolved to adjourn the meeting at 11:34am	
<b>Raised:</b> Scott	<b>Seconded:</b> Nick
<b>MOTION PASSES UNANIMOUSLY</b>	

## 12.21. 2015-03-26 Agenda

### AGENDA

Thursday, March 26, 2015 @ 12:00pm – 1:00 pm in ASB9817

#### 1. Motions

<b>MOTION 2015-03-26.01</b>
Whereas inductors were purchased, be it resolved that Bonnie be reimbursed \$2.70.

#### 2. Old Business

##### A. Progress Update

#### 3. New Business

##### A. Written Progress Report



## 12.22. 2015-03-26 Minutes

### MINUTES

Thursday, March 26, 2015 @ 12:00pm – 1:00 pm in ASB9817

#### 1. Call to Order

- Meeting was called to order at 12:01pm.

#### 2. Roll Call & Ratification of Regrets

Name	Role	Present	Absent
Scott Beaupre	Chief Science Officer	✓	
Bonnie Ha	Chief Operating Officer	✓	
Alex Hauser	Chief Technology Officer	✓	
Nick Pizzacalla	Chief Executive Officer	✓	

#### 3. Adoption of Agenda

<b>MOTION 2015-03-26.01</b>	
Be it resolved to adopt the agenda as presented	
<b>Raised:</b> Nick	<b>Seconded:</b> Scott
<b>MOTION PASSES UNANIMOUSLY</b>	

#### 4. Approval of Previous Minutes

<b>MOTION 2015-03-26.02</b>	
Be it resolved to approve the previous meeting minutes as presented	
<b>Raised:</b> Scott	<b>Seconded:</b> Alex
<b>MOTION PASSES UNANIMOUSLY</b>	

#### 5. Motion

<b>MOTION 2015-03-26.03</b>	
Whereas inductors were purchased, be it resolved that Bonnie be reimbursed \$2.70.	
<b>Raised:</b> Alex	<b>Seconded:</b> Scott
<b>MOTION PASSES UNANIMOUSLY</b>	

#### 6. Old Business

##### A. Progress Update

- Scott's epiphany: use only one transducer. He's also playing with the amplifier.
- Nick's filter filters. It's more like a sieve though, so he is working to increase the order of the filter.
- Bonnie was looking at high frequency amplifiers. Want something that amplifies x2000.

- Alex is working on the Matlab to connect it to the oscilloscope. She found some GUIs.
- The parts that Scott ordered has not arrived yet.
- Sonopen doesn't have a datasheet, so we're confused if we need to drive the transducer.

Action:

- Need some clarifications of the Sonopen

## 7. New Business

### A. **Written Progress Report**

- 2 page report due on Monday
- Delegation:
  - Bonnie – Schedule
  - Nick – Finance
  - Alex – Progress and Remediation on Software
  - Scott – Progress and Remediation on Hardware

Action:

- Individual sections are due Saturday night

### B. **One or Two Transducers?**

- If we have 2 transducers, the reflected waves are distorted. Hence, using 1 transducer will gather the reflected waves at it's focal point.
- However, as advised by Arash, *"One point that I can make is this: When I was designing the T/R switch, I had to tweak it a lot and it is extremely sensitive to the values you select in your design. You can look up my thesis that is up in SFU library to get some feedback. But the most important part of your project is designing your T/R switch. If you don't do that well, there is no way you can obtain your signals. You need to excite your transducer with the right threshold value."*

Action:

- We will continue discussion after meeting

## 8. Adjournment

The next meeting has been arranged for April 2, 2015 at 11am-12pm in ASB 9817

<b>MOTION 2015-03-26.04</b>	
Be it resolved to adjourn the meeting at 12:35pm.	
<b>Raised:</b> Nick	<b>Seconded:</b> Scott
<b>MOTION PASSES UNANIMOUSLY</b>	

## 12.23. 2015-04-02 Agenda

### AGENDA

Thursday, April 2, 2015 @ 11:00am – 12:00 pm in ASB9817

#### 1. Motions

<b>MOTION 2015-04-02.01</b>
Whereas inductors, prototype boards, and 20MHz opamps were purchased, be it resolved that Bonnie be reimbursed \$26.66

<b>MOTION 2015-04-02.02</b>
Whereas 250MHz opamps were purchased, be it resolved that Scott be reimbursed \$25.92.

#### 2. Old Business

##### A. Progress Update

#### 3. New Business

##### A. System Test Plan Concerns

##### B. Remaining Timeline

##### C. Post Mortem: Delegate Responsibilities

##### D. Presentation: Discussion, Delegate Responsibilities

## 12.24. 2015-04-02 Minutes

### MINUTES

Thursday, April 2, 2015 @ 11:30am – 12:30pm in ASB9817

#### 1. Call to Order

- Meeting was called to order at 11:37am

#### 2. Roll Call & Ratification of Regrets

Name	Role	Present	Absent
Scott Beaupre	Chief Science Officer	✓	
Bonnie Ha	Chief Operating Officer	✓	
Alex Hauser	Chief Technology Officer	✓	
Nick Pizzacalla	Chief Executive Officer	✓	

#### 3. Adoption of Agenda

MOTION 2015-04-02.01	
Be it resolved to adopt the agenda as presented	
<b>Raised:</b> Alex	<b>Seconded:</b> Nick
MOTION PASSES UNANIMOUSLY	

#### 4. Approval of Previous Minutes

MOTION 2015-04-02.02	
Be it resolved to approve the previous meeting minutes as presented	
<b>Raised:</b> Alex	<b>Seconded:</b> Nic
MOTION PASSES UNANIMOUSLY	

#### 5. Motion

MOTION 2015-04-02.03	
Whereas inductors, prototype boards, and 20MHz opamps were purchased, be it resolved that Bonnie be reimbursed \$26.66	
<b>Raised:</b> Nick	<b>Seconded:</b> Alex
MOTION PASSES UNANIMOUSLY	

MOTION 2015-04-02.04	
Whereas 250MHz opamps were purchased, be it resolved that Scott be reimbursed \$25.92.	
<b>Raised:</b> Alex	<b>Seconded:</b> Nick
MOTION PASSES UNANIMOUSLY	

#### 6. Old Business

##### A. Progress Update

- Bonnie and Scott went to Lee's Electronics and purchased opamps and prototype boards. However, opamps did not work as expected so we purchased new one. They arrived Tuesday and we have them in prototype board. Going forward, we need to solder and test the amplifier.
- Alex got the Matlab to run and pull data from the oscilloscope. However, there is a delay that she's working on reducing and showing the signal as an image.
- Alex and Nick moved the Ultrasound machine this morning, so we have access to it this weekend. Nick is the doorman and has the key.
- Nick got the Aurdino to send pulses to active the transducer. He still needs to verify the voltage to send in. The datasheet from Olympus was not helpful and Arash is not responding. He will call the Olympus company to get some more info.

## 7. New Business

### A. **System Test Plan Concerns:**

- Test Plan outlines 2-4 pages, but Bonnie made a 1-page document similar to the examples provided.

#### Action:

- Bonnie will email Steve about length of document and able to revise it.

### B. **Remaining Timeline:**

- Apr 6 – Signal showing on the oscilloscope
- Apr 10 – Post Mortem, Presentation documentations complete
- April 14 & 15 – Practice Presentations
- Apr 16 – Demo

### C. **Post Mortem: Delegate Responsibilities**

- Nick – materials and costs, conclusion
- Bonnie – schedule, group dynamics, introduction
- Alex – main functions and project modules
- Scott – problems and challenges

#### Action:

- Complete your individual learning pages and sections by Apr 7 evening
- Workload distribution will be completed this weekend together

### D. **Presentation: Discussion, Delegate Responsibilities**

- Flyer should include M-mode scan
- Demo of the Ultrasound machine
- Video of our product working

- Nick – business case, introduction, and conclusion
- Alex – high-level description of main functions
- Bonnie – schedule, materials and cost
- Scott – details major scope and design
- Next meeting, we will revise the PowerPoint slides together.

Action:

- Complete PowerPoints slides by April 7 evening

## 8. Adjournment

The next meeting has been arranged for April 9, 2015 at 11am-12pm in ASB 9817

<b>MOTION 2015-04-02.05</b>	
Be it resolved to adjourn the meeting at 12:21pm	
<b>Raised:</b> Alex	<b>Seconded:</b> Scott
<b>MOTION PASSES UNANIMOUSLY</b>	

## 12.25. 2015-04-09 Agenda

### AGENDA

Thursday, April 9, 2015 @ 11:30am – 12:30 pm in ASB9817

#### 1. Motion

<b>MOTION 2015-04-09.01</b>
Whereas capacitors, diodes, and prototype boards were purchased, BIRT Bonnie be reimbursed \$33.41.

<b>MOTION 2015-04-09.02</b>
Whereas coaxial cables, BNC connectors, and transistors were purchased, BIRT Bonnie be reimbursed \$21.48

<b>MOTION 2015-04-09.03</b>
Whereas DC-to-DC converters were purchased, BIRT Nick be reimbursed \$242.35.

#### 2. Old Business

- A. Progress Update
- B. Revise Post Mortem
- C. Presentation Update

#### 3. New Business

- A. Schedule Presentation Practice Times

## 12.26. 2015-04-09 Minutes

### MINUTES

Thursday, April 9, 2015 @ 11:30am – 12:30 pm in ASB9817

#### 1. Call to Order

- Meeting was called to order at 11:37am

#### 2. Roll Call & Ratification of Regrets

Name	Role	Present	Absent
Scott Beaupre	Chief Science Officer	✓	
Bonnie Ha	Chief Operating Officer	✓	
Alex Hauser	Chief Technology Officer	✓	
Nick Pizzacalla	Chief Executive Officer	✓	

#### 3. Adoption of Agenda

MOTION 2015-04-09.01	
Be it resolved to adopt the agenda as presented	
<b>Raised:</b> Alex	<b>Seconded:</b> Nick
<b>MOTION PASSES UNANIMOUSLY</b>	

#### 4. Approval of Previous Minutes

MOTION 2015-04-09.02	
Be it resolved to approve the previous meeting minutes as presented	
<b>Raised:</b> Alex	<b>Seconded:</b> Bonnie
<b>MOTION PASSES UNANIMOUSLY</b>	

#### 5. Motion

MOTION 2015-04-09.03	
Whereas capacitors, diodes, and prototype boards were purchased, BIRT Bonnie be reimbursed \$33.41.	
<b>Raised:</b> Nick	<b>Seconded:</b> Alex
<b>MOTION PASSES UNANIMOUSLY</b>	

MOTION 2015-04-09.04	
Whereas coaxial cables, BNC connectors, and transistors were purchased, BIRT Bonnie be reimbursed \$21.48.	
<b>Raised:</b> Alex	<b>Seconded:</b> Scott
<b>Discussion:</b> Scott drove Bonnie to Lee's Electronics.	
<b>MOTION PASSES UNANIMOUSLY</b>	



<b>MOTION 2015-04-09.05</b>	
Whereas DC-to-DC converters were purchased, BIRT Nick be reimbursed \$242.35.	
<b>Raised:</b> Nick	<b>Seconded:</b> Scot
<b>Discussion:</b> Bought 2 as a safety net. Parts should arrive today	
<b>MOTION PASSES UNANIMOUSLY</b>	

## 6. Old Business

### A. Progress Update

- Over the weekend, Alex produced a M-mode scan on the Matlab code, but it's slow. Bonnie and Scott were getting inconsistent results from the amplifier. Nick built a voltage booster to power the amplifier of the excitation circuit.
- Alex and Nick spoke to Ash this past Tuesday. He advised the following: Use a transistor as a switch to the excitation circuit. PBC would be ideal for this project; however, our prototype board will do because it's neat. Watch out for too much solder because it can add capacitance. Ask Fred for frequency counters. Talk to Carlo Menon's group about DC-to-DC converter. Using the wall as a power supply would be a safety issue. Talk to Pavel from Underwater Research lab.
- Nick ordered a DC-to-DC converter. It outputs 0-200V and takes in 12V DC. He also spoke to a BJT consultant and got the proper BJT for the excitation circuit. The input will be a square wave from the Arduino. Also, Nick got an in-kind sponsorship from On Time Service, in the form of batteries. Head of HR will be coming our presentation.
- Also, on Tuesday, Bonnie spoke to Lucky regarding high frequency amplifiers. Lucky emphasized that verification of testing equipment is often times the problem. With Lucky's help, we verified that the amplifier circuit works with an input signal from the function generator. Lucky was very curious how we were going to excite the transducer, so he built a circuit with the function generator as the driver. At 10V, a reflected signal can be seen. At higher voltages, the reflected signal is more visible. Scott got electrocuted though. However, when the amplifier was attached, the produced signal was static and did not adjust to input from the transducer. This could be due to mismatching input impedance or grounded 2 power supplies.
- Bonnie and Scott will try to match the impedance since we have 50Ω transducer, 75Ω cable, and BNC connectors, as well as using just 1 power supply. After we have can see a reflected amplified signal, we will build our second stage.

### B. Revise Post Mortem

- Bonnie and Nick will finish their sections today.

Action:

- When compiled document is uploaded, please edit and revise!

**C. Presentation Update**

- Alex wants to use a lion photo "I never lose. Either I win or I learn." from Reddit
- Nick wants to make a video for our project. He will be the director
- Bonnie will compile PPT slides on Mon Apr 13 night

Action:

- Individual sections for PPT slides are due Mon Apr 13. See previous minutes for sections you are responsible for
- Be ready to shoot video on Tues Apr 14 after 3pm

**7. New Business**

**A. Schedule Presentation Practice Times**

- Tues Apr 14 after 3pm – general overview and run through
- Wed Apr 15 after 3pm – practice and perfect

**8. Adjournment**

This is the last meeting before presentation/demo on April 16

<b>MOTION 2015-04-09.06</b>	
Be it resolved to adjourn the meeting at 12:09pm	
<b>Raised:</b> Nick	<b>Seconded:</b> Scott
<b>MOTION PASSES UNANIMOUSLY</b>	