Progress Report

1. Introduction/Background

Introducing CARE: 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 and preventative measures of strokes to patients. CARE consists of a probe and compatible software. The probe sends and receives ultrasound waves to the carotid artery via a transducer. The software then displays the information captured by the probe in an A-mode and M-mode scan. A-mode scan displays the amplitude of the radio frequency signal of one location over the distance of penetration into the artery; M-mode scan displays the motion of the A-mode scan over a period of time. Due to its ease of use and portability, both components significantly reduce the cost of the product from current ultrasound systems. Featuring a portable design and compatible software, CARE is an alternative to traditional ultrasound systems for providing early diagnosis of carotid artery disease.

2. Schedule

In relation to our original schedule, we are two weeks behind schedule. Figure 1 showcases the original schedule, in which we expected to complete our project by the end of March. Due to several iterations of re-designing and testing, we are still developing the probe. As such, we are also still actively researching the needed parts and acquiring supplies. Regarding the software aspect, we cannot program any further because we have been unsuccessful in receiving a signal from the probe. We have yet to debug and test the probe, fix regression bugs in the software, nor integrate the components.

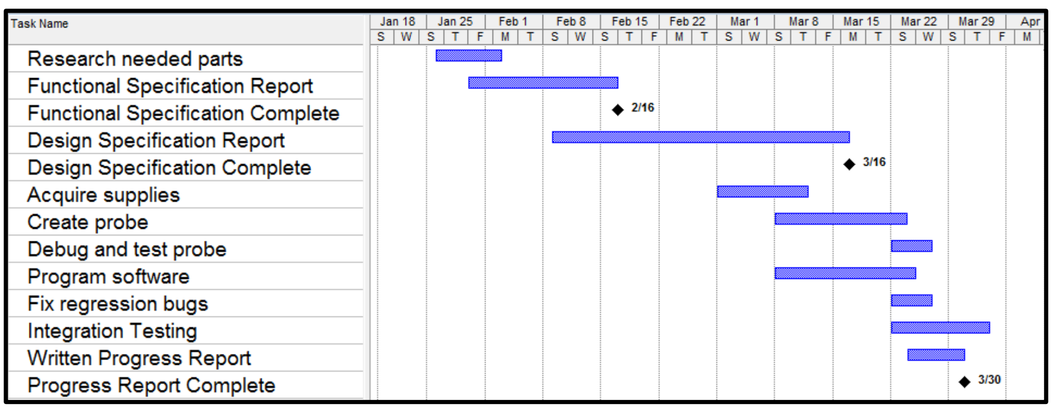

Figure 1: Project Timeline

3. Financial

Table 1 lists our current income statement. To date, the total revenue into the company is $1500 and the total expenses is approximately $1700; therefore, we are in debt of approximately $200. Various group members are covering this debt until reimbursement can be made. To handle the debt, we plan to apply for the Wighton Fund at the end of the semester. We have also 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: Current Income Statement

Cardiowave 2015 Income Statement						
Revenue		**Expenses**				
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
Revenue Total:	**$1,500.00**				**Expenses Total:**	**$1,704.04**
					Current Standing:	**$(204.04)**

4. Progress

To date, our progress has extensively consisted of planning, research, user meetings, documentation, and parts acquisition. In regards to planning and research, we have been in contact with industry professionals, such as Pavel Haintz from the Underwater Research Lab, Arash Taheri who has done a similar project, Ken Rutledge from CSA, and Andrew Rawicz. To better familiarize ourselves with current ultrasound systems, we were trained to operate an ultrasound system by Lukas-Karim Merhi. We have weekly official meetings with documented agendas and minutes. Outside of meetings, we communicate via a messaging application and meet up to work on the project as needed. Our documentation to date includes several project proposals, a functional specification and a design specification. As well, each member maintains a journal of their work. Table 1 lists the parts and material acquired so far. The next section details our progress with regards to design and experimentation.

5. Hardware Progress & Remediation

Table 2 lists the progress and remediation of the hardware portion of our product. The hardware component consists of circuitry and two transducers: one for sending (actuator) and one for receiving (sensor). In the event that unforeseen problems arise, we will seek advice from the industry professionals and stimulate designs before purchasing parts.

Table 2: Hardware Progress & Remediation

Progress	Remediation
We were having troubles driving the transducer because we could not receive the waves sent.	We asked the Underwater Research Lab and consulted with Arash. Both told us to drive the transducer by giving it a voltage pulse. As a result, we are using an Arduino to supply the pulses to drive the transducer.

We are unable to detect reflected waves from the transducer	We purchased a high-speed op-amp, which will amplify the reflected waves to a detectable amplitude.
We have been able to amplify the received signal upon physically stimulating the transducer. When incorporating the actuator transducer, we realized the original inverting amplifier circuit failed, as the op-amps don't operate with 15 MHz signals.	This led us to look into new op-amps that have higher gain-bandwidth products (>100 MHz). Before purchasing such op-amps, we modelled and simulated a circuit in multiple SPICE programs to ensure the components would work. We are waiting to receive the new op-amps.
The original amplifier circuit was built on a breadboard, which is incompatible with high frequencies	We will build the circuit on a prototype board, since breadboards are too capacitive for high frequencies.
We initially designed a band-pass filter to reduce noise from the received signal, but discovered the transducer has high SNR (Signal-to-Noise Ratio).	The original noise we were seeing was due to the breadboard and we have moved to a prototype board.

6. Software Progress & Remediation

We began programming the software using radio frequency (RF) data from the Ultrasonix CEP ultrasound machine as input. Using MATLAB, we were successful in interpreting the data to display an A-mode scan for each echo and its corresponding M-mode scan. In addition, we stimulated a "real-time" M-mode scan by displaying each envelope of the A-mode scan as the data was processed. With the success of processing the data, our focus shifted to displaying operating attributes and reading data from the probe. Operating attributes include the sampling frequency, frames per second, duration of testing, and location of artery walls and plaque.

Since then, the team has focused on getting the hardware to function and the software development has not been developed for real time application. Originally, we expected a smartphone application to be completed by our demo time. However, due to schedule slippage, we are putting the effort into developing a basic MATLAB GUI instead. The GUI reads data from the Tektronix Oscilloscope in the lab. This will still prove our concept, even though it may not be as polished as we would have liked.

Currently, the MATLAB GUI processes and displays the waveforms displayed on the oscilloscope, in real-time. However, there is a 7-8 second delay, which we are working on reducing. The GUI displays the raw input from the oscilloscope and the processed data at the same time. We still have to make the trigger for data acquisition with regards to the high voltage sent from the pulsing circuit. This will allow us to show the correct window of data on screen.

7. Conclusion

CARE is a portable cost-effective ultrasound system. Currently, we are two weeks behind schedule and over budget. We have had to redesign our probe several times, but are hopeful with our current design. In two weeks, for the demonstration, we will showcase the probe sending ultrasound waves through the body, receiving and processing the reflected signal, and transferring the data to the MATLAB GUI to be displayed.