Sleep Apnea Therapy Device – Progress Report #3

Client: Dr. John Webster
Advisor: Dr. Megan McClean
Team Members: Calvin Hedberg, Taylor Karns, Jen Rich, Ben Mihelich
Date: Feb 3rd – Feb 9th, 2017

Problem Statement

Clinically significant sleep apnea is a sleep disorder characterized by interference of breathing during sleep. Those who suffer from sleep apnea experience interrupted sleep which develops an increased risk of heart attack, high-blood pressure, arrhythmia, stroke, and diabetes. Continuous Positive Airway Pressure (CPAP) machines are the current standard for treatment. However, approximately half of all patients suffering from sleep apnea do not adhere to it well due to complications such as nasal congestion, headaches, and continued tiredness. Continuous dead space rebreathing is an alternative that has been researched and shown to stabilize central respiratory output in patients with mild to severe obstructive sleep apnea without the complications of CPAP. Thus, our team has been assigned the task of designing and fabricating a variable dead space device based on guidelines and research conducted by our client Dr. John Webster. This includes developing an algorithm such that the device can detect sleep apnea and consequently regulate the amount of dead space for proper respiration.

Last Week's Goals

- Meet on Sunday (2/5/2017) to brainstorm designs
- Create a design matrix from proposed designs
- Create a circuit on Altium or Eagle based on proposed designs

Summary of Team Role Accomplishments

- Calvin (Leader) - filled out the week's progress report
- Taylor (Communicator & BPAG) – contacted client to set up 2nd meeting
- Jen (BWIG) – updated the team website by adding the PDS
- Ben (BSAC) – prepared for BSAC meeting Friday Feb 10th

Summary of Design Accomplishments

The team met Sunday (2/5/17) and began to evaluate the current design and brainstorm additional designs to use for the design matrix that was to be created. From the evaluation we found a number of flaws and shortcomings with the current design. The first concern was the device's internal bladder leaking, which was observed to be happening upon a full inflation cycle. This is a major issue as the device should be able to control this volume and regulate it based on breathing data. If it spontaneously deflates it will make breathing more difficult for the wearer and may not function properly in combating sleep apnea. The second concern was with the comfort of the wearer which is a crucial design specification. The current prototype uses a cylindrical, hard plastic bottle which may prove uncomfortable for the wearer. To counteract these two issues we devised two new designs that incorporated a soft bodied container for dead space and a mechanical control of variating dead space.

The team met again on Tuesday (2/7/17) to create a design matrix. Using the same criteria as was used for the original design the team pitted the two new designs against the current one. The result was in favor of the new design that utilizes a soft body container and a rotational step motor to control dead space. The motor will rotate a cover to control the level of passage of air through slits that lead from the breathing tube into the container acting as the extended dead space.

Finally, Calvin and Ben met with the client, Dr. Webster, on Wednesday (2/8/17) to introduce the new design and reaffirm design specifications. The redesign was approved and suggestions were given on the types of motors to use. The suggestion was to use either a worm-gear motor or a magnetic stepper motor for more accurate control of the mechanical closing of slits. With this reaffirmation from the client the team is ready to begin ordering parts and prototyping.

This Week's Goals

- Prepare for Oral Presentation
- Create diagrams for new proposed designs
- Begin ordering parts to begin prototyping

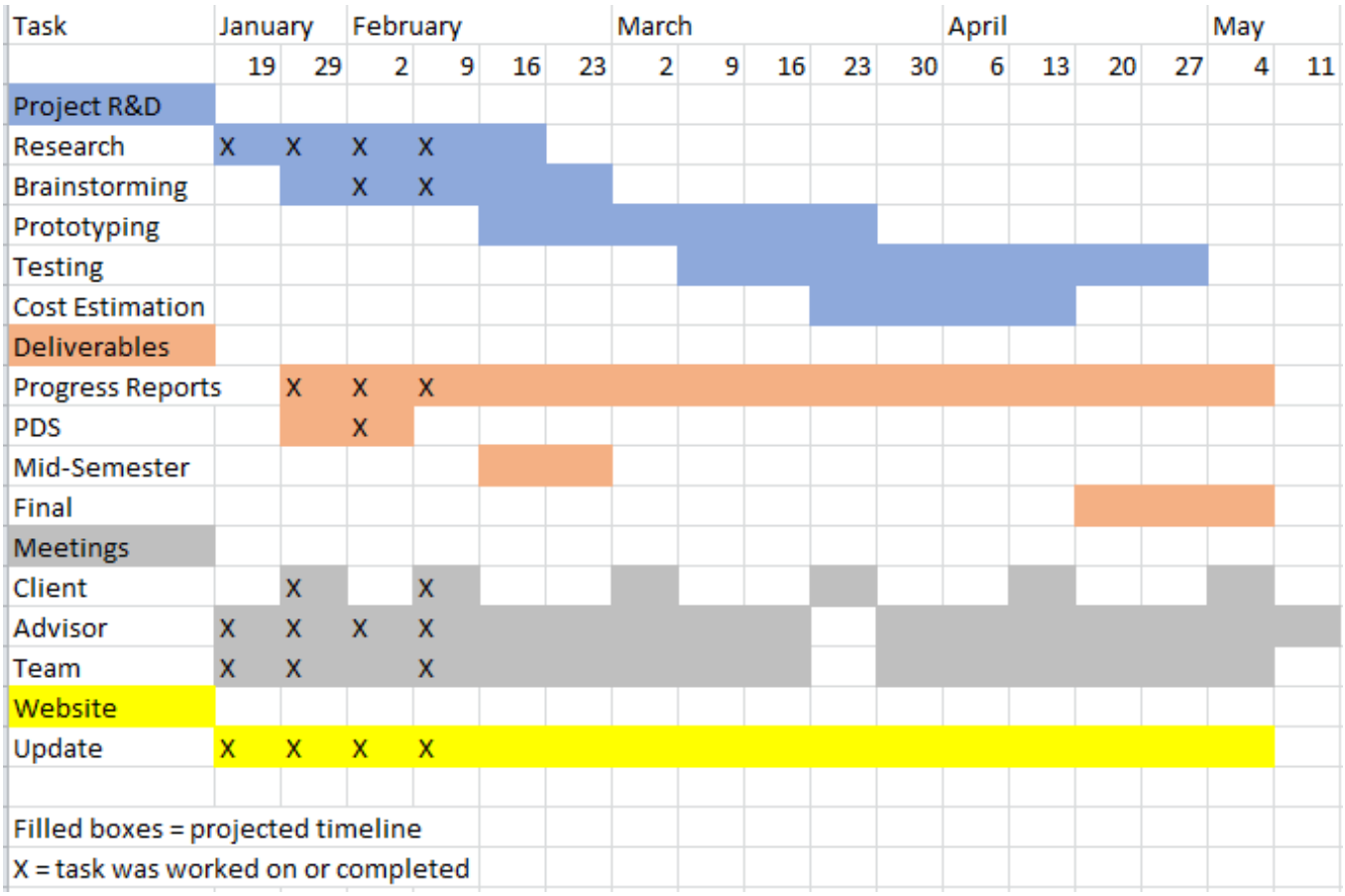
Difficulties with Project

The new design has posed a few problems that need some work to resolve. Finding the right type of motor at the correct size and voltage rating is proving challenging. The issue after that is redesigning the breathing tube to fit the motor. Finally, the algorithm will have to be modified slightly to adjust the system properly and save power during operation. The powering of the microcontroller is our biggest concern as it will continually need to be powered which could drain batteries rather quickly.

Activities

Date	Person(s)	Task	Time (hrs)	Semester Total
2/9/2017	Calvin	Researched motors and breathing rates during sleep	1.0	2.5
	Taylor			1.5
2/7/2017	Jen	Created schedule template, edited design matrix	1.0	2.0
2/7/2017	Ben	Researched motors and power sources for prototype	1.5	2.5
2/5/2017 2/7/2017	Team	Meeting – brainstormed designs Meeting - create design matrix and schedule	2.0 2.0	 5.5

Project Schedule



Expenses

None