Recap:

Overall

* Our group focused on the development of more advanced prototypes by 3D printing stethoscope parts such as the diaphragm
* Additionally, our team began acquiring and testing components that can replicate and surpass the features of the Littmann 3200
  + Modern microcontrollers can be used to record, analyze, and playback sound waves over Bluetooth antennas

Splits

* Successfully developed a functional 3D printed stethoscope diaphragm (Figure 1)
  + The additive manufacturing process allows for the modification of the design in order to save material, maintain functionality, and thus reduce cost while increasing performance (Figure 1)
    - Designs can be made using a sparse infill in order to save material and space (Figure 1)
    - Wall thicknesses can be increased to avoid acoustic loss and increase the performance of the stethoscope (Figure 1)

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| Figure 1: 3D Printed Stethoscope Heads |

* Researched sound acquisition, analysis, and playback on different commercially-available, portable microcontrollers and components (Table 1)
  + Microcontrollers like the Arduino Pro Mini and the Teensy 3.2 can sample audio at 44kHz, making them capable of even performing voice recognition (Table 1)
  + Both microcontrollers are also Arduino compatible, making all software developed thus far reusable
  + The Electret microphone comes with an embedded amplifier (Table 1)
  + Adafruit (electronics manufacturer and distributer) has published several guides that will be used as reference for our prototype
    - These guides include a portable Arduino “Voice Changer” and a “Fast Fourier Transform” analyzer using the Teensy 3.2

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| **Component ID** | **Component Name** | **Manufacturer or Distributor** | **Component Type** | **Measurement or Functionality** |
| DEV-11114 | Arduino Pro Mini 328 - 3.3V/8MHz | SparkFun | Microcontroller | Control circuits |
| ADA-2756 | Teensy 3.2 3.3V | Adafruit | Microcontroller | Control circuits |
| ADA-1063 | Electret Microphone with Amplifier | Adafruit | Microphone | Record Sound |

Update:

Overall

* Using 3D printing, our team has been capable of replicating stethoscope parts
* In addition to exact replicas, CAD modeling has allowed our team to introduce voids and compartments to house electronic sensors such as accelerometers and microphones to provide functionality to our acoustic stethoscopes (Figure 2)
* Our team has also began the acquisition of individual stethoscope parts, from familiar manufacturers such as 3M and Welch Allyn, in order retro-fit or adapt designs into products already in the market (Figure 3)

Moving Forward:

Overall

* Our team will begin design and printing a case to house control components of the stethoscope (Arduino, Bluetooth antenna, and battery charger) (Figure 2)
* Our team will generate the algorithms capable of acquiring data coming from the sensors (accelerometers and microphones)

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| Figure 2: 3D Printed Stethoscopes with embedded sensors |

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| Figure 3: Commercially-available stethoscope parts |