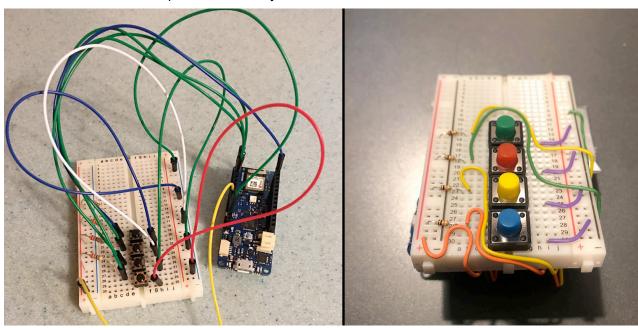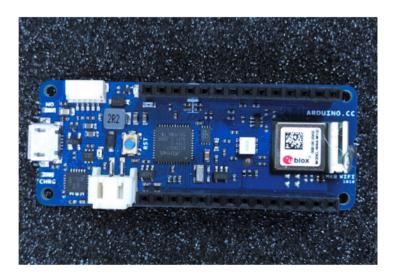# The Les Paulverizer

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The goal of this project was to create a Les Paulverizer, a device that is able to be attached to a guitar and be able to play pre-recorded tracks much like the original developed by Les Paul himself. Over the course of the seven weeks D-2020, our two subteams, software and hardware, worked to create a device that could send four different MIDI Signals over Bluetooth Low Energy (BLE) which could then be mapped to a DAW on MacOS.

From the software perspective, we decided to program using the Arduino MKR WiFi 1010. Compared to other options, it had the ease and libraries of programming an Arduino, built in BLE support, and a built in battery recharging circuit which made it very compact. Initially we approached the project by sending MIDI over USB and then transitioning over to BLE. The MIDIUSB library was very straightforward to use, and was the basis for sending MIDI over USB. Once we had completed this step, we moved over to BLE. During the process of programming the BLE we learned that there was an important distinction between Bluetooth and BLE. BLE did not require pairing and used less energy. Additionally the protocols were different. Since the Arduino MKR WiFi 1010 currently only supports BLE, we went with that protocol. The next issue was connecting the Les Paulverizer to an operating system. Initially, we wanted the device to work on both MacOS and Windows; however we ran into several issues with Windows that limited the scope of this project to just MacOS. Although officially Windows supports the BLE MIDI protocol, in practice the current implementation is inadequate and documentation is poor specifically regarding BLE MIDI device connections. Rather than opening a normal BLE port or MIDI port, it opens up a BLE MIDI port which is unsupported by most DAWs. Additionally on Windows, the device fails to connect via normal connections, but can be recognized by the Universal Windows Protocol API. To get around this issue, we programmed a second Arduino

MKR WiFi 1010 to act as a BLE receiver that converted BLE MIDI signal to MIDI sent over USB; however at the direction of our sponsor, we moved focused solely on MacOS. By the end, from the software perspective, our device acts as a MIDI controller that connects via BLE and in absence of BLE connects via USB.

As for the hardware side of the project, two Les Paulverizer devices were built using the Arduino MKR WiFi 1010 and other parts. The circuit is made up of a breadboard, four 220 Ohm resistors, wires and four digital buttons. The device is also powered by a 3.7 V 1200mAh lithium-ion battery. When all the components were decided for the project, the parts were ordered from various retailers online. After each device was built, it was decided to have one device put in a wood casing and the other kept out of a casing. This allows for other teams to easily modify the device in the future. There were numerous problems that we encountered throughout the project. One such problem was ordering the correct parts. In this case, the wrong Arduino board was initially gotten by one member while the other member got the wrong kind of switches. Since this project was all done remotely, it was a challenge to make sure that each Les Paulverizer device was built correctly. After going off pictures, a circuit diagram and holding multiple meetings, both devices were finally built correctly and work as intended.Another problem we faced was configuring the components in the correct way to allow both the buttons and the charging port to be accessible from outside the case. It took many sketches with trial and error to finally figure out what configuration will work.

Overall considering the remote nature of D-2020, we feel satisfied with the final Les Paulverizer we produced: a midi controller capable of sending four different MIDI signals over both BLE and USB. Despite this accomplishment we still feel there are some improvements that could be made in future that directly address the issues we ran into this term. First, Windows drivers could be written to enable BLe connectivity with only a single Arduino MKR WiFi 1010. Second, better casing could be designed to house the Les Paulverizer. Lastly, the entire design could be miniaturized to fit inside the body of an electric guitar. With these considerations in mind, we hope our Les Paulverizer serves as a good basis for any future improvements.