LOUIS

A Wireless Braille Keyboard

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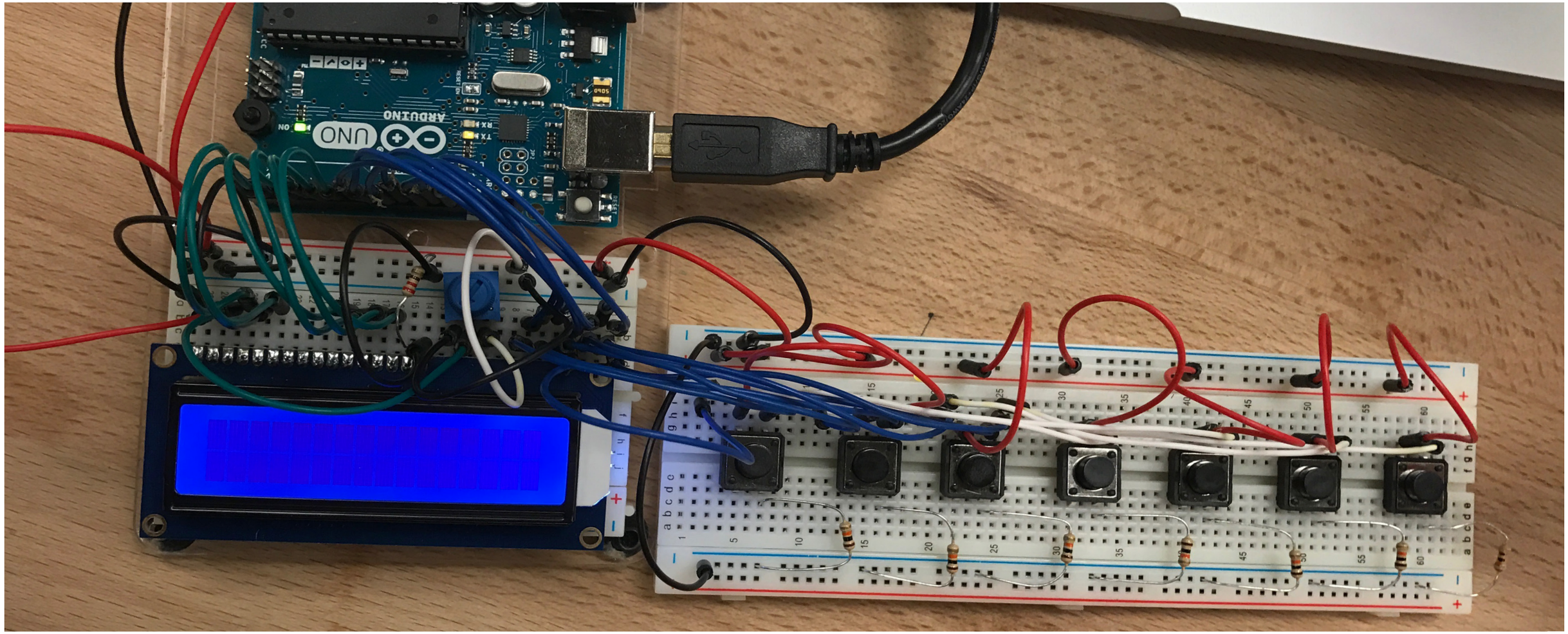
Final Report

Introducing Louis

Current braille keyboards are expensive and cumbersome, but provide immense functionality. Louis is an initial functional prototype for a Bluetooth LE HID braille keyboard that is portable, comfortable, and a potential inexpensive alternative. Louis is and exploration into developing physical form and create custom electronics to create a high fidelity prototype. In its finished state Louis can be utilized in discussion to generate future improvements and to showcase feasibility. This braille chording keyboard[1], explores a potential look and feel and also a preliminary technical implementation.

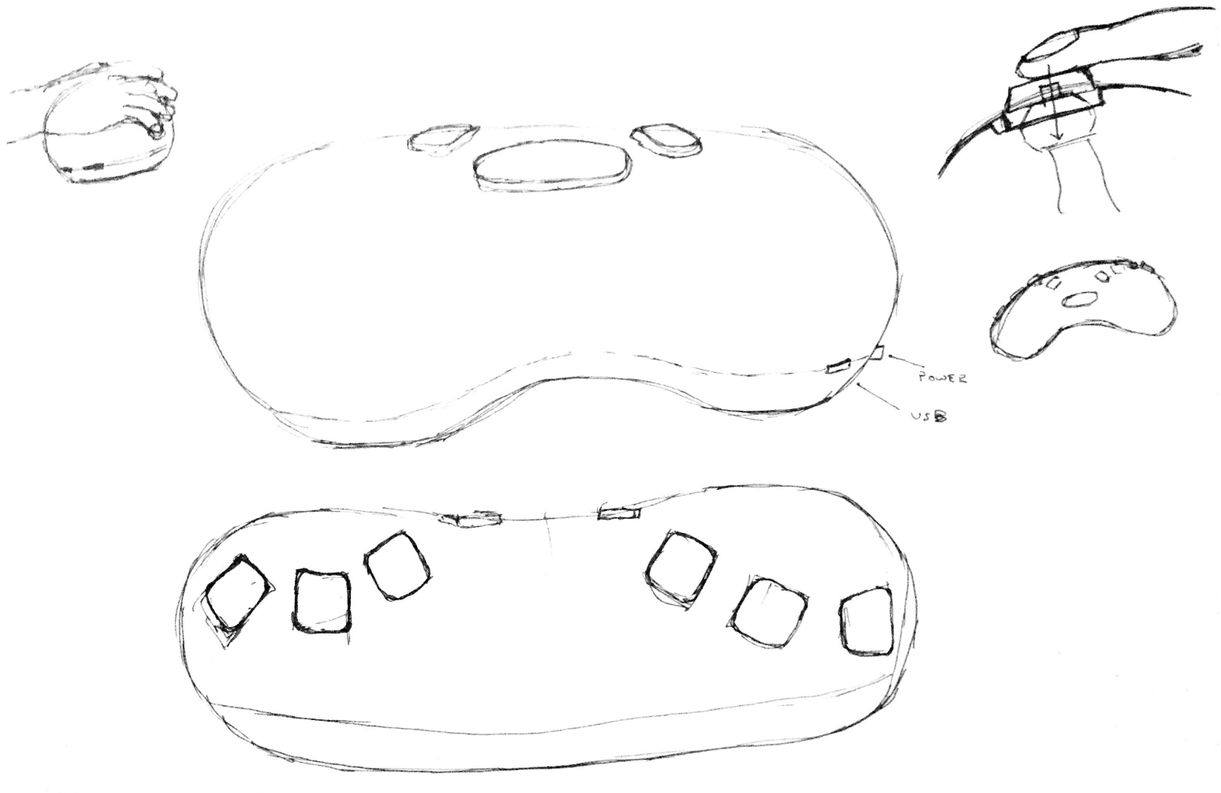
[1]**chording keyboard** : A keyboard that uses a set of keys, pressed in combination (a chord), to enter characters or commands.

DESIGN



Inspiration

Louis took root from a simple Arduino exercise. This initial implementation prototype sparked a desire to give form to the simple circuitry and to craft a functioning keyboard that can interface with a laptop, tablet, or smart phone. From its simple beginnings to its current state, Louis is a true exploration of iterative prototyping.



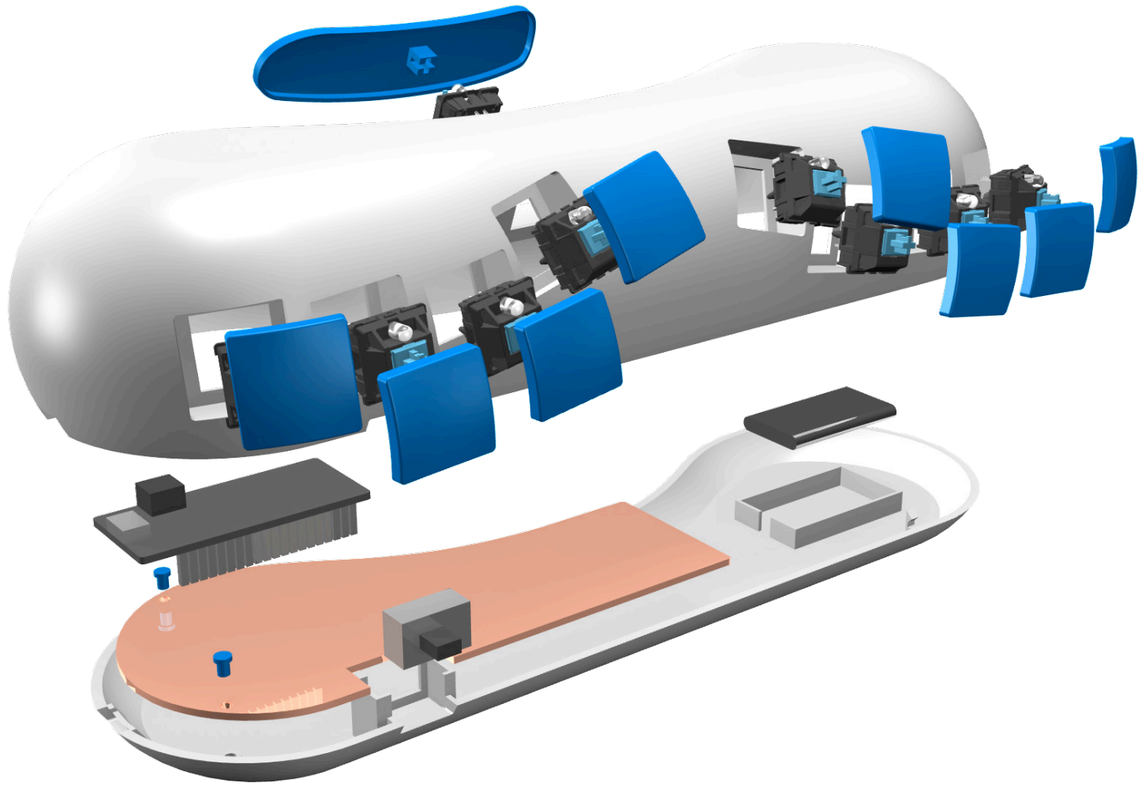
Left to Right, Top to Bottom

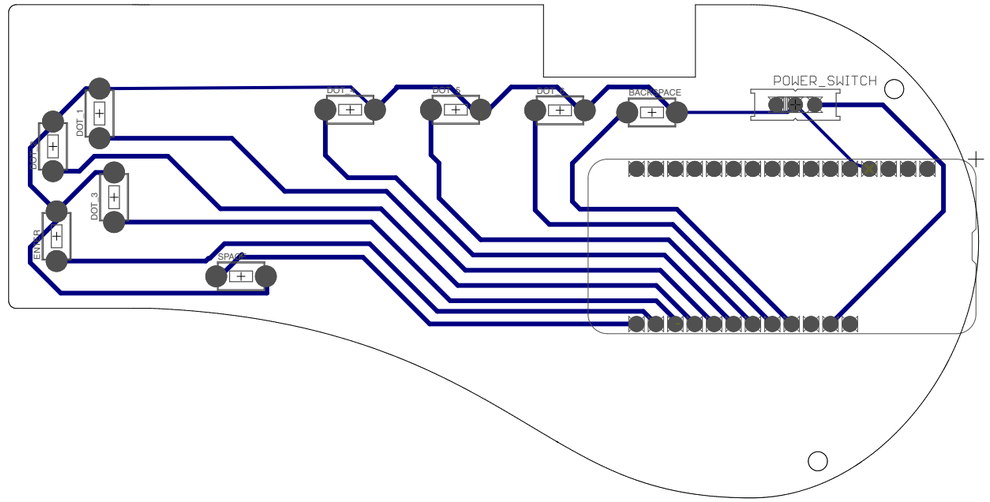
Initial Sketches, Initial Clay Model, Participant Evaluation Photos, and Second Iteration on Clay Model.

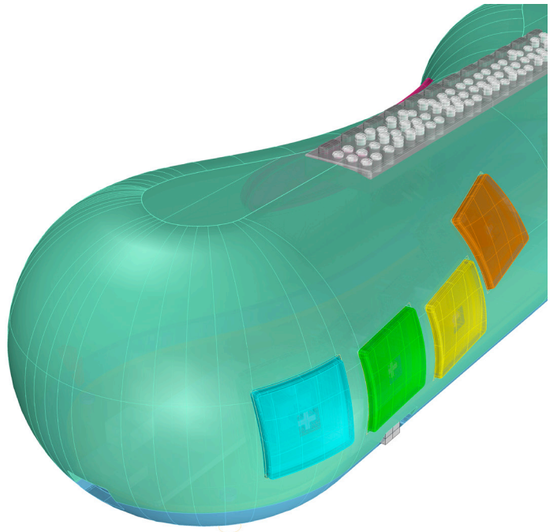
Exploring and Evaluating Form

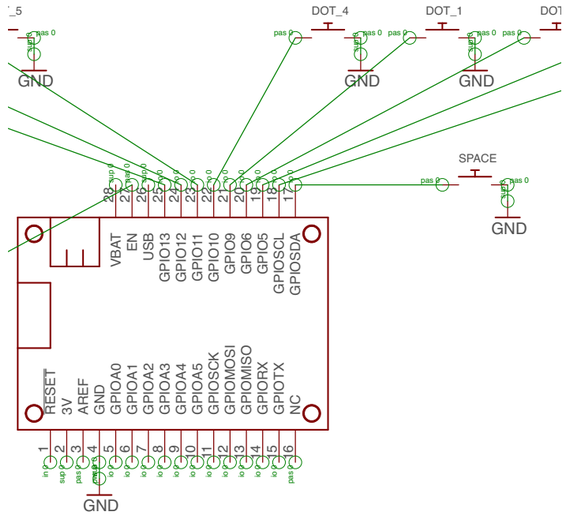
In respects to form, the goal was to create a comfortable keyboard that fit and supported the natural curvature of the hand. The entire device was designed to fit inside a backpack or medium to large size bag. After some initial sketches, these drawings were translated into clay. Using the clay model, three individuals[1] were asked to judge the comfort, support, and key placement of the model. Feedback was positive overall. Participants thought the form was comfortable and most of the keys were in a good location and orientation. All participants had the same concern, however, about the spacebar key placement. They felt the most comfortable positioning of the thumb was on the front face of the case. They all suggested moving the key to this location. This early evaluation helped avoid this issue after creating the higher fidelity version and the clay model allowed for quick iterations and modifications.

[1]Participants did not have visual impairments and hand size varied across participants.





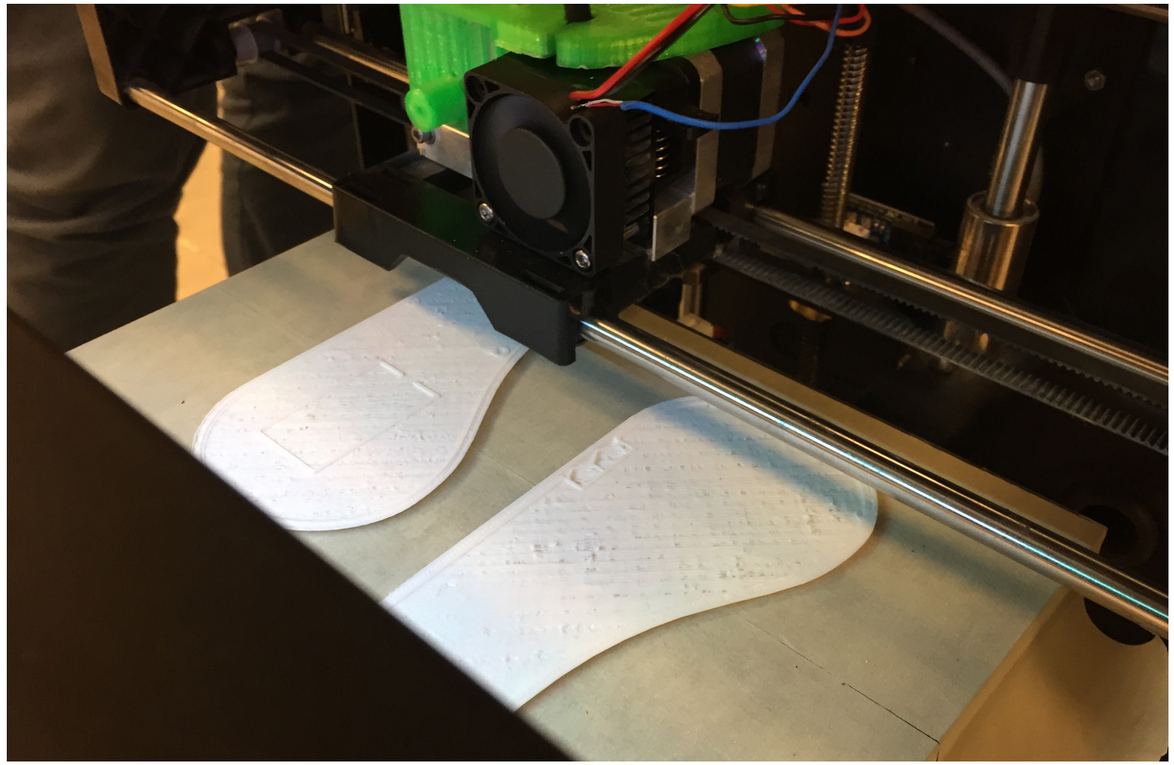


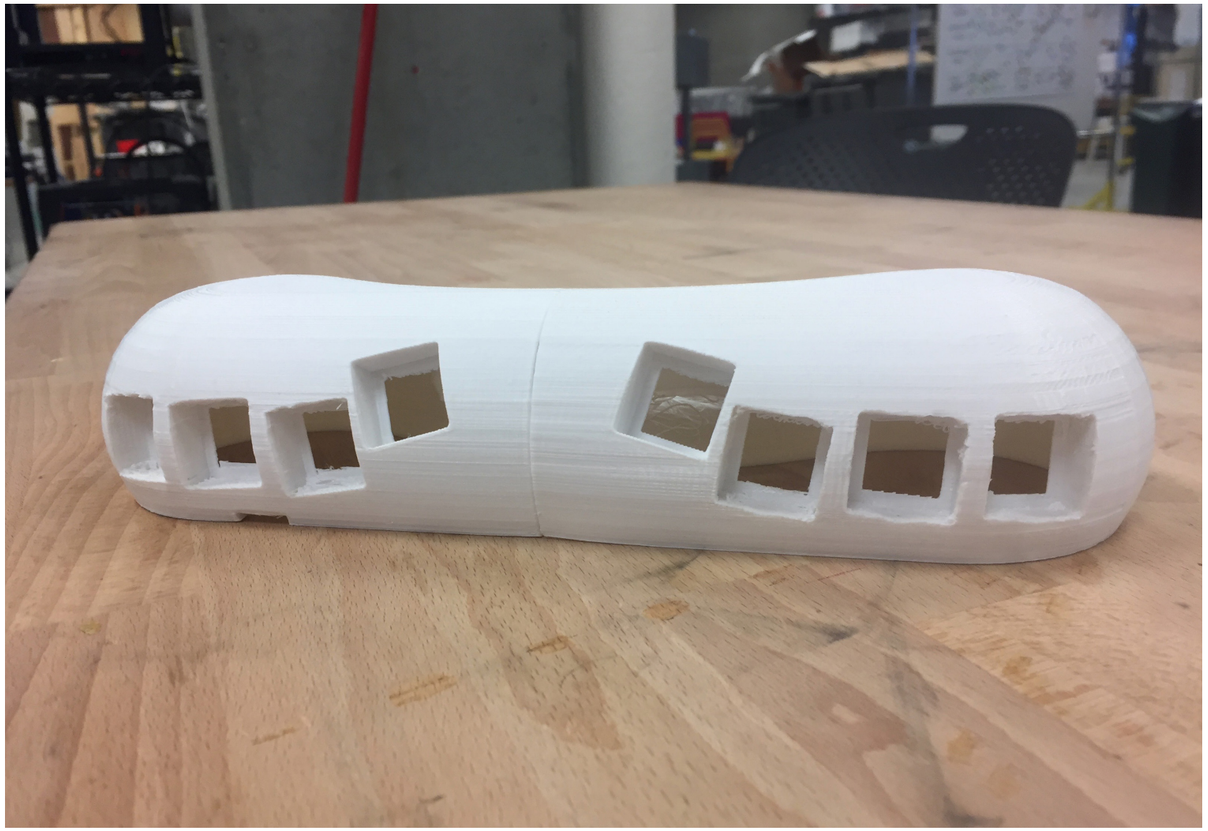


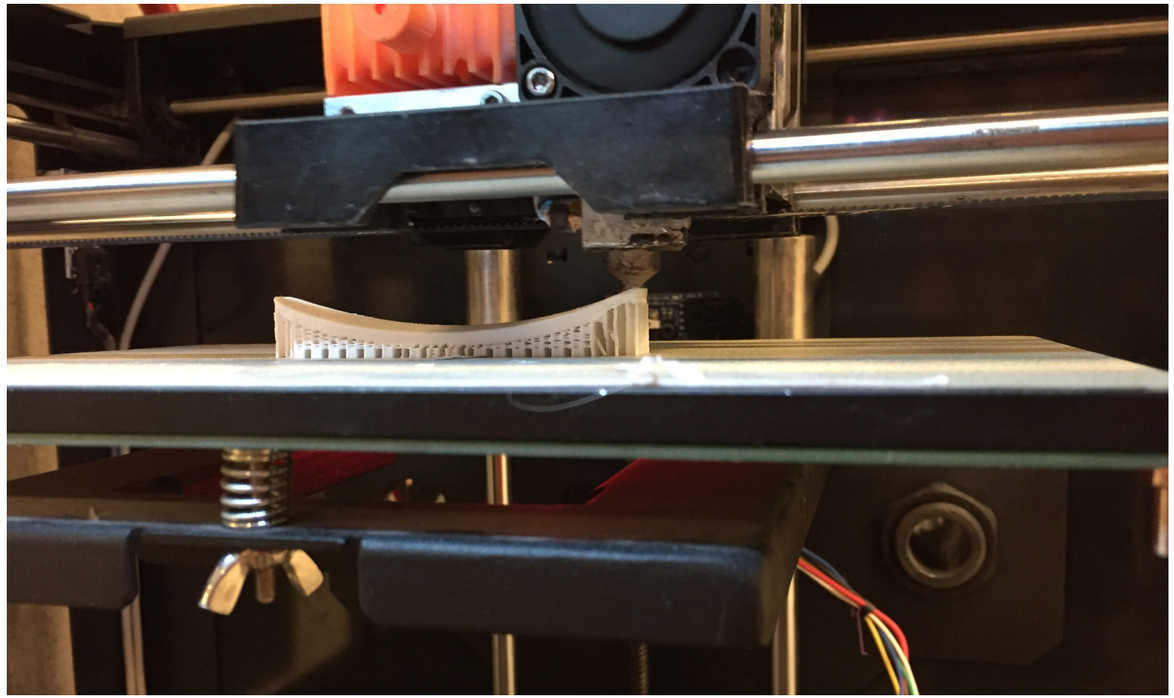
Digital Modeling and Electronics

With the clay model finalized, this form was translated into Rhino to create a digital model. The shape of the keys, the placement of the electronic components, and the mounting for the various keyboard switches were all incorporated into the digital model. Both the schematic and PCB design were completed using Eagle CAD. The digital model was used to create the outline of the PCB.

BUILD

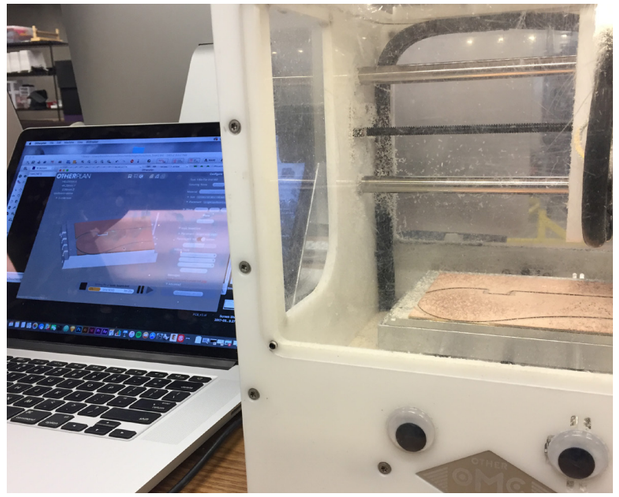


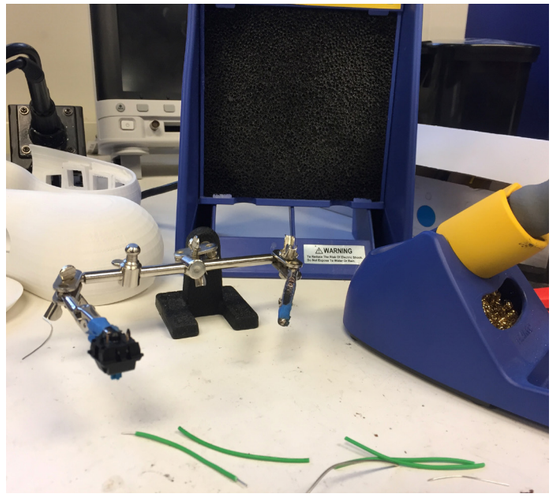


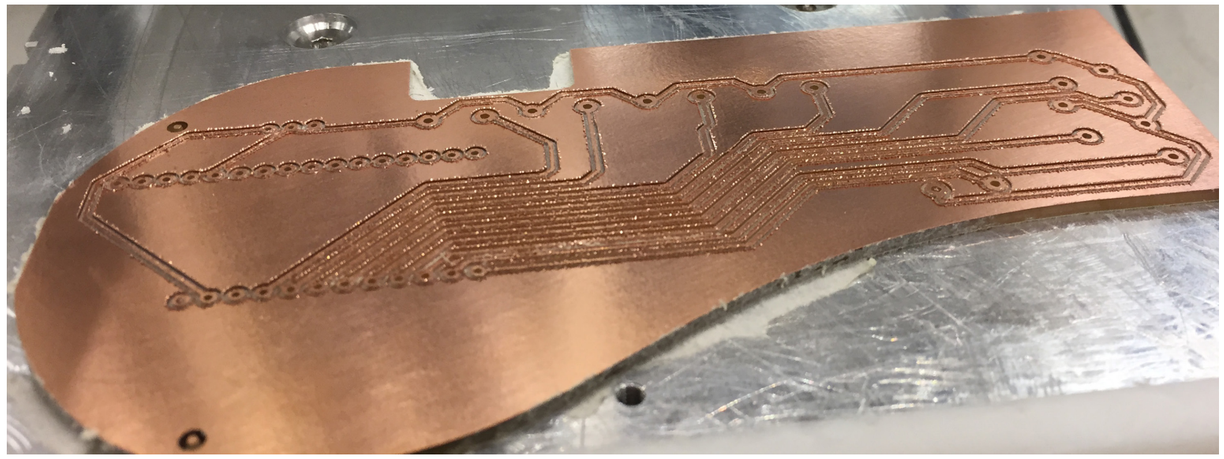


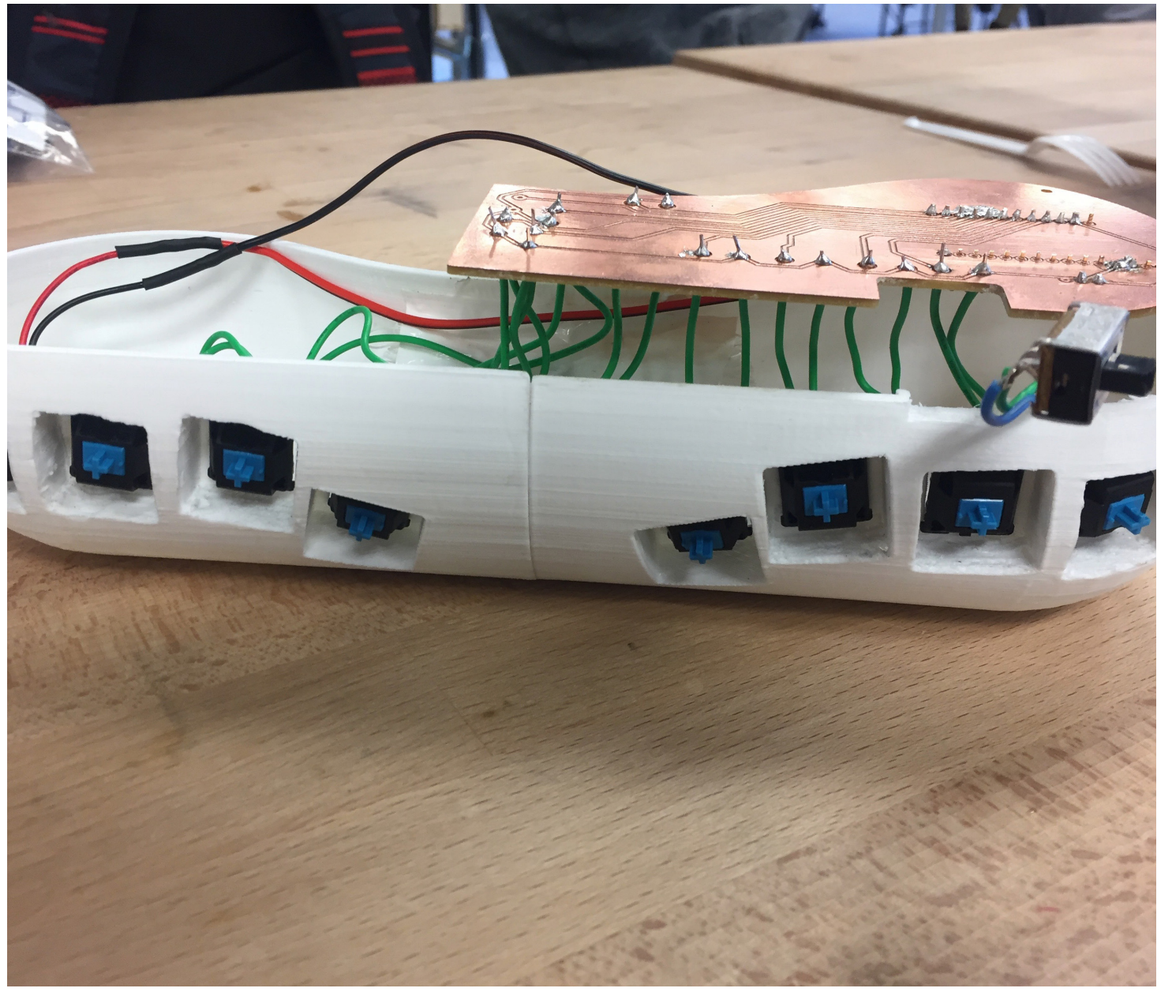
3D Printing

Using the digital model, the components were organized into three prints totaling 16 hours of printing. The 3D model for the case was split into quarters in order to accommodate the printers printing surface. These piece of the case were then glued together.





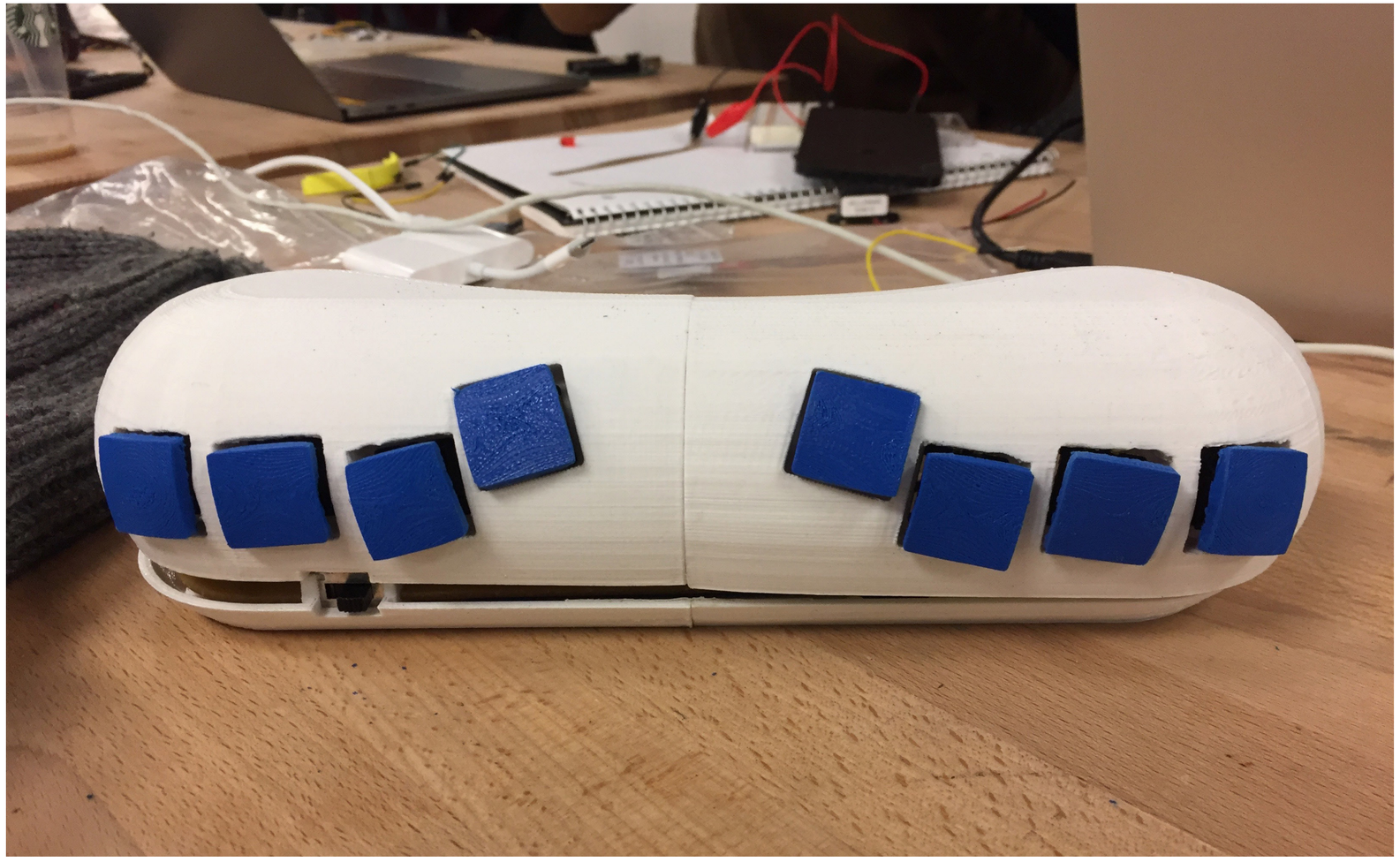


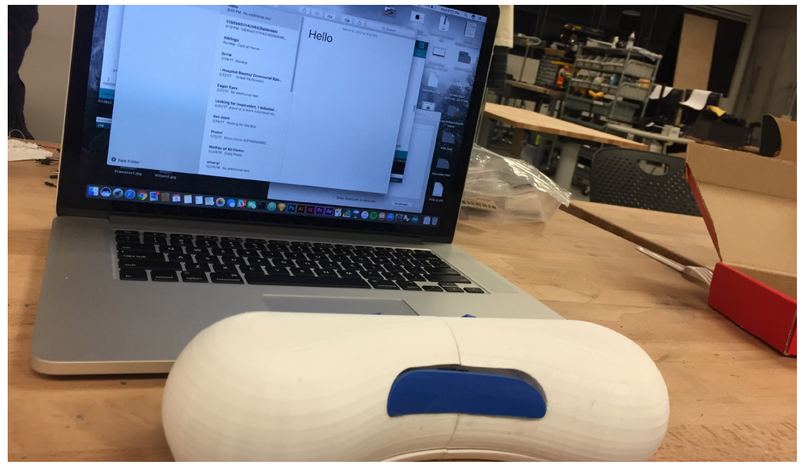


Electronics

Having limited experience with soldering and crafting circuit boards, this was one of the most challenging aspects of the project. Looking for reference, Adafruit.com provided a collection of tutorials[1]. This became an invaluable resource and discussed many of the features used in Louis. Using Eagle CAD to generate the PCB design based on the schematic, the Other Mill was used to cut out the pin locations, the traces, the mounting wholes, and board outline laid out in Eagle CAD. After a little cleanup of the traces, the Bluefruit microcontroller, Power Switch and Cherry MX keyboard switches were soldered to the board.

[1] https://learn.adafruit.com/custom-wireless-bluetooth-cherry-mx-gamepad?view=all





Bringing Louis Together

With the case, keys, and electronic components complete, Louis was ready to be assembled. Using the software from the original prototype and referencing the Adafruit tutorials, the software was quickly completed. Louis seamlessly interfaced as a keyboard for both mobile devices and laptops that supported BLE devices.

LEARN

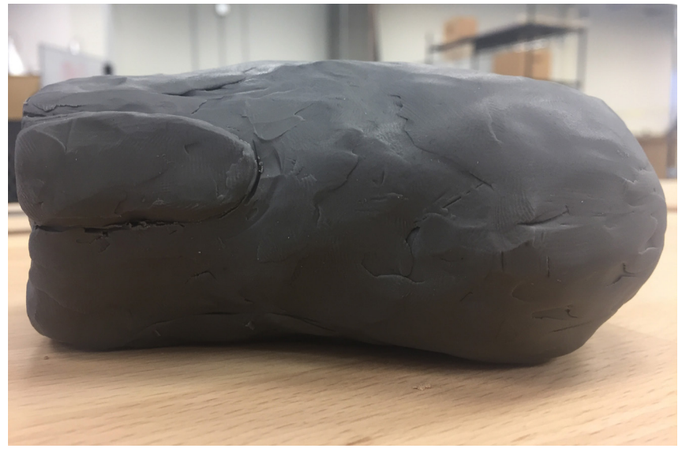
Reflection

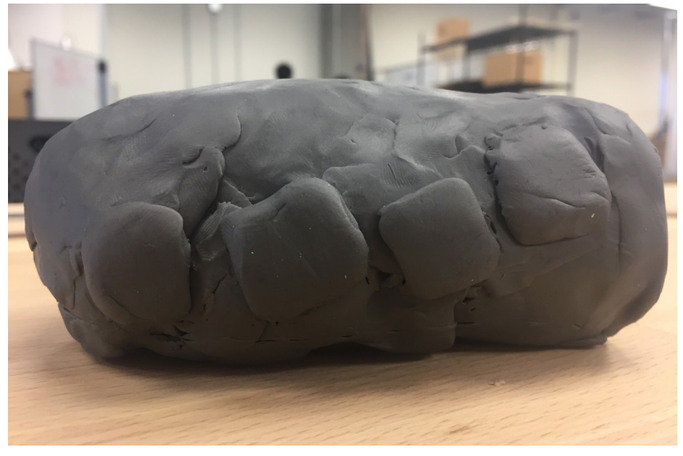
At its core, Louis was an exercise exploring the capabilities of prototyping. This experience not only showed what could be done, but provided an opportunity for the designer to expand their skills and discover their limitations. Louis also provided a deep exploration into high fidelity physical prototyping. In my portfolio of digital and software work, Louis stands out as an exploration into the full design and implementation of a physical prototype. These methods should be definitely used in the future if the goal of the prototype is to craft a prototype that is high fidelity and functional. Discussed here are reflections on different aspects of the project.

Exploration of 3D Form

The process began with sketching and modeling the physical form. The power of using clay as a medium to rapidly and easily create a form from nothing, became evident. Clay allows for quick modifications and provided an initial prototype to use for evaluation. Participants can interact with the object, give feedback, and the model can be quickly altered to incorporate that feedback. This will be a definite method of choice for work similar to this in the future.

The unique shape of Louis made translating the 3D form into a digital tool a challenge. Though the model was realized, the time invested into creating the model was high. The model also lacked some way of connecting the top and bottom halves of the case. A future design alteration might be to incorporate a lip and grove design to make this connection stronger and easier. The current design included two clips, but they were not large enough to keep the halves together. Clearance also became a concern throughout the digital design process. From past 3D printing experience, this was a concern that needed to be considered throughout the design of the model. The issue of clearance was most evident when creating the keys. Making sure the caps would freely move inside the switch cavity required an offset. Modeling the switch attachment for keyboard cap was also a challenge due to its small size. A tight fit was needed to make sure the keyboard caps would stay on the switch. Limitations and variations in the 3D printing quality , unfortunately, made each key have a different fit.

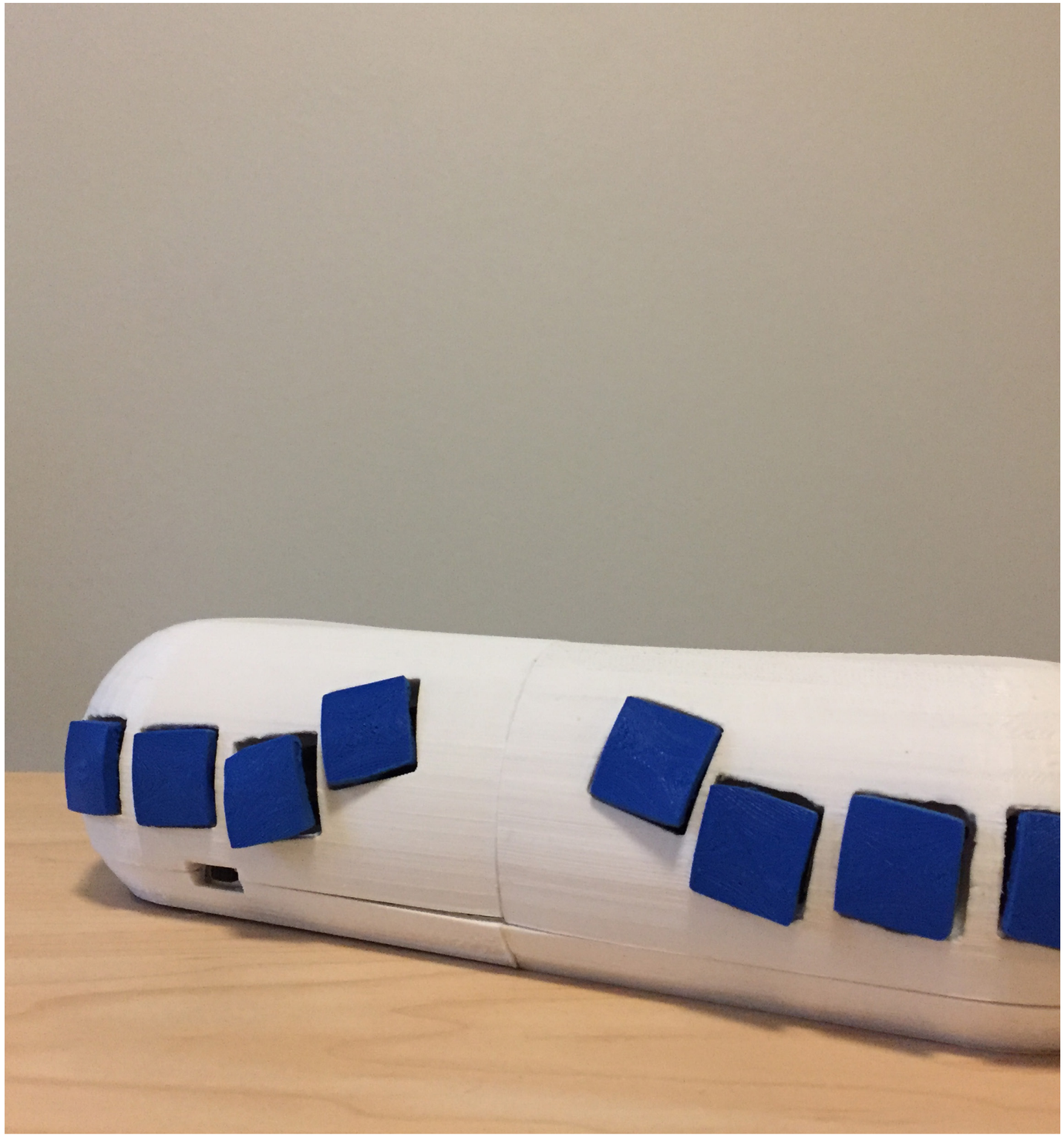




Execution of 3D Fabrication

3D printing is a powerful tool, however it comes with challenges. Considerations like resolution, printer capabilities, printer failure, and time commitment all have to be considered. Flexibility and adaptation are required by any designer looking to incorporate 3D printing into their prototyping process. Expectations for perfection are many times not compatible with 3D printing. Though perfection can be achieved, it depends on several factors that many times are out of the control of designer.

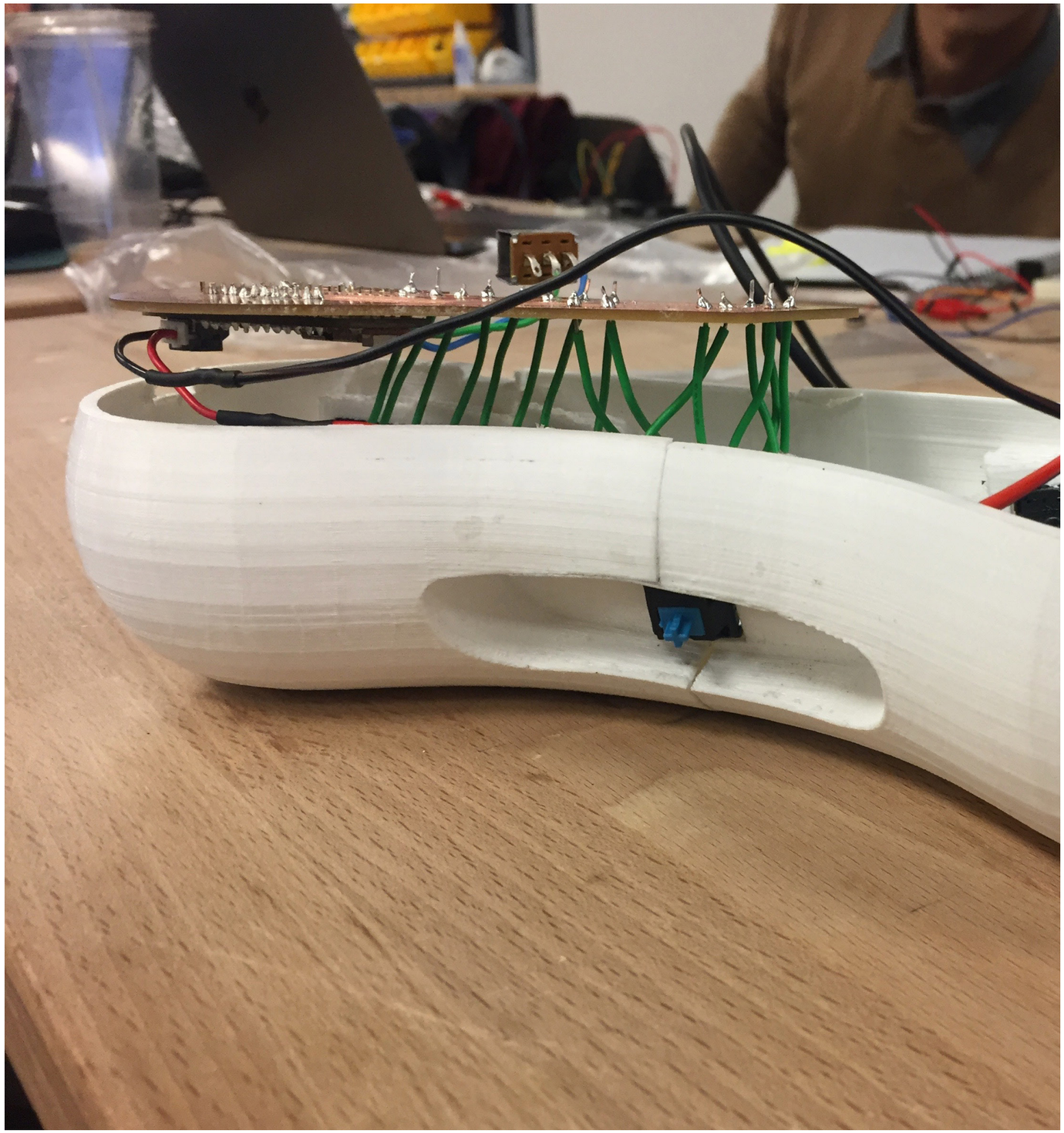
Louis was plagued with issues that had to deal with clearance and printer accuracy and quality. Overall, the execution of the 3D print did not meet expectations, but the prototype could still function and communicate the design. Small mistakes in alignment cascaded to create larger issues. For example, the cavity for the spacebar did not print perfectly. This caused the keyboard switch placement and orientation to be offset. Serious modifications to the spacebar was needed to accommodate this offset. Many of the keys needed to be sanded to provide perfect clearance. Even with these modifications the keys would sometimes stick. The interior cavities also needed to be clear of support material which was nearly impossible with the tools at hand. Another mistake was not labeling the keys as they were being removed from the printing platform. This made it very challenging to determine the appropriate key caps for each of the keyboard switches. The attachment of the key caps to the switches were very small and printing them caused lots of variation. This made some key caps extend to far outside the surface of form. Using higher accuracy printers, larger print areas, soluble supports, and even better materials might increase the quality and accuracy of the final print.



Execution of Electronics

This was the first time exploring the creation of custom PCBs for the designer and the second time the designer was exposed to soldering.

Using the Other Mill was approachable and a quick way to create a prototype of a PCB. The lower quality of the milling required extra clean up. This was necessary to insure there were no bridge connections. Using a more professional circuit that uses a laser would increase the quality of the board. The switches were also not designed to have wires soldered to them. A future design should use mounting plates for each of the switches so that the delicate pins don't break. These mounting plates would allow the builder to solder the switch to the board and then solder wire from the individual boards to the main circuit board. Alignment between the board and the case was also important for board mounted components that had a port connection. For example, the Micro USB port. The case was digitally modeled to have the port flush with the circuit board. This didn't happen due to soldering inaccuracies. Therefore, the case had to be sanded to enlarge the opening to allow for the cable to be connected to the port. Overall, more practice and confidence in soldering would help improved the quality of the custom electronic components of the design.



Feedback on Design

When showcasing the design at the final project showcase, several individuals came over to interact with Louis. For many individuals this was their first time using a chording keyboard. It was also an opportunity for people to see how individuals who have a visual impairment might interact with a computer. Many individuals complemented on Louis's comfortable design and saw the value of an inexpensive braille keyboard alternative. This shows that Louis not only met its design goals, but was an effective tool to communicate the design to others. Louis as a prototype was a clear success. In fact, many individuals hope that further exploration will be done on Louis.

There is one definite future step that must be taken and that it gaining feedback from individuals with visual impairments. Unfortunately, this could not be arranged in such a short time period. This kind of evaluation is an obvious next step to see how Louis might fit into these individuals' everyday lives and how it can be improved to meet their needs.

Future Design

The current design costs around $60 to create which is lower than current commercial braille keyboards. Many current keyboards cost thousands of dollars. Though these current keyboards have more features, Louis's basic text input capabilities provide a great basis to build upon at a low starting cost. The main feature lacking in the current design is feedback on past text input. This is normally done by a braille readout. Including this component would increase the price of the device because of the small elements used in the component. Other alternatives should be considered if future iterations are explored to maintain Louis's low cost goal. The software should also be improved to support characters that require multiple braille characters to represent one character on the computer and include braille characters that represent common words.

Louis is a high fidelity functional prototype that met all the goals set for the project. Louis shows promise for future development and provided an excellent learning experience for the designer. The techniques and skills needed to create Louis helped the designer explore new areas of prototyping and helped leverage past skills in a new context.