Building a Mechanical Keyboard

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***Abstract*—A keyboard is one of the most used tools in the modern workplace, and maybe even in the home [1]. Acquiring a high quality keyboard that is comfortable and durable is therefore a worthwhile investment. However, if there are very specific requirements for the keyboard, like size, layout or language, it is not possible to buy. In this paper the process of designing and building a personalized keyboard is presented.**

Introduction

In this paper the process of building and designing a keyboard will be presented. There are four main tasks when building a keyboard. Choosing a layout, choosing a switch-type, designing and creating a housing and finally the assembly process. The layout describes which keys have been included in the keyboard, and how they are to be arranged. When choosing a switch-type there are several things that have to be considered, like travel-distance, operating force and sound. The design of the housing is heavily influenced by the layout of the keyboard but also personal aesthetic preferences and creativity. Assembling the keyboard is fairly straight forward with a PCB.

Choice of layout

The keyboard layout describes which keys that have been included, and how they are arranged. The most common layout may be the ISO-105 layout defined by ISO/IEC 9995 [2], which has the QWERTY layout and includes a numpad and full function row. See figure 1. The QWERTY layout has become a controversial issue, because many believe that it is a sub-optimal layout, and despite attempts to introduce other layouts, it has been concluded that the QWERTY layout is the de-facto standard layout [3]. However there are many layouts to choose from, and a completely custom layout can also be designed. When building a keyboard, one may opt to use a ready made circuit board, where switches can simply be entered into their respective spots and soldered directly to the circuit board. Or an Arduino can be used, where switches have to be wired to the arduino and the arduino has to be programmed. Using a PCB is easier, but it limits what kind of layouts that can be chosen, since the layout needs to fit with the available PCBs. With an Arduino there is almost no limit to layout choices, and a completely custom layout can be designed. Several factors influenced the layout choice in this project. The numpad was deemed useless, so it was not included in the layout design. For ease of transportation and small desk spaces, the layout also had to be compact. The function row was kept for its use in controlling volume, and starting, stopping and skipping media. Because of a familiarity with the macbook pro 2010 keyboard after 8 years of use, the layout design is heavily inspired by this keyboard, see figure 2. The well known QWERTY layout was also chosen, as this is the standard for most keyboards and the most familiar. Figure 3 shows the layout of the keyboard. It includes all the keys found to be necessary, while being as compact as possible. However there are no ready made sets of keycaps available online that fits this layout. The layout uses Norwegian letters, and it has several custom keys with abnormal sizing that are necessary to make the design work. This makes it impossible to find a full set of keycaps that has this layout. However there are several companies that offer to print lettering on blank keycaps and put together a completely custom set of keycaps to order. A service like this was used to obtain the necessary custom keycap set for the keyboard.

Fig. 1. ISO-105

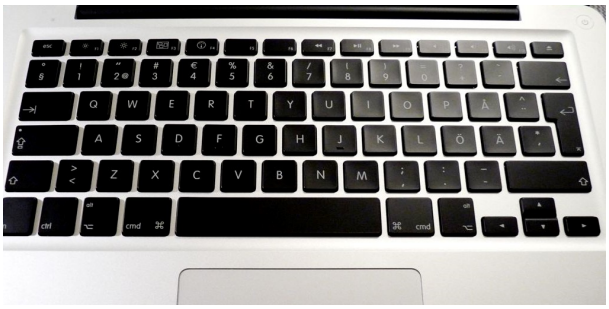

Fig. 2. Macbook pro 2010 keyboard layout.

Choosing a switch-type

An essential part of a keyboard is the switches. There are two main types of switches, mechanical switches and rubber dome switches. The rubber dome switches are usually used in cheap keyboards. They work by using a dome of rubber that provides resistance and a tactile feeling. Mechanical

Fig. 3. The keyboard layout that will be used for this project. Layout image was created in an online tool called Keyboard Layout Editor [6]

switches have individual keyswitches and uses metal springs. This gives a stronger feedback as you type, either feeling a bump or hearing a click. It feels more satisfying, and can be more precise, giving a much clearer feedback that you have actually managed to press down and activate the switch. When choosing a mechanical switch there are several factors to consider.

- Switch behaviour
  - Linear: The keystroke is consistent and smooth.
  - Tactile: A bump in the middle of travel, usually around the actuation point.
  - Clicky: A bump in the middle of travel accompanied by a sharp click sound.
- Operating force: the amount of force necessary to push down the switch. Can range from 45 cN to 60 cN.
- Travel distance: how far the switch has to travel to be activated

There are several companies that specializes in mechanical keyboard switches, with Cherry MX [4] being the most well known and successful. They have a wide range of switch types, marked by a distinct color. The keyswitch Cherry MX Silent Red [5] was chosen. This switch was chosen because it has a light operating force at 45 cN. With a light operating force fingers won't get tired when using the keyboard for a long time. The switch is silent, meaning that it has been designed to reduce noise and clicking sounds when used. This makes it possible to bring into an open office environment without annoying nearby people. See figure 4.

Designing a housing

Once the layout, keyswitches and PCB has been chosen, a case that will house all the components can be designed. Keyswitches are usually mounted on an aluminum plate with holes for each switch, where the switch has a clicking mechanism that holds it in place, called a mounting plate. This plate adds stability, and the pressure when pressing a key is applied to the plate instead of the PCB. It also hides the PCB. This plate can be designed using an online plate builder tool [7] by inserting the raw data from the layout design that was made in the online layout editor [6]. The plate builder gives a dxf file that can be imported into fusion 360 [8]. See figure 5. The housing was designed around this mounting plate. To make it as compact as possible, it was made to barely extend beyond the mounting plate, just enough to fit the PCB. Care

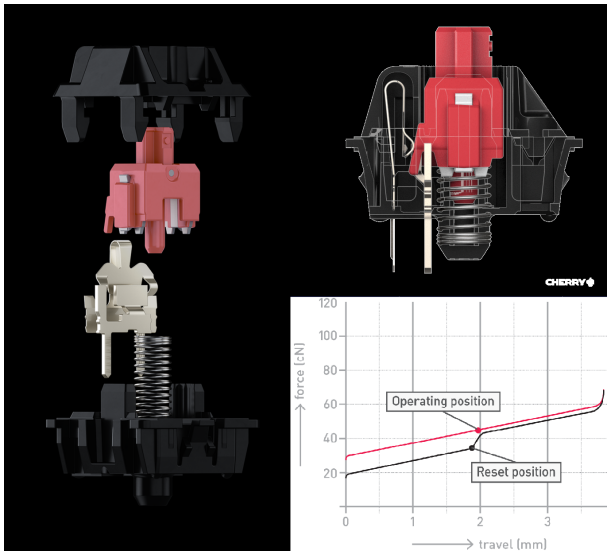

Fig. 4. Internal structure of Cherry MX Silent Red, as well as a graph showing its linear switch behaviour. [5]

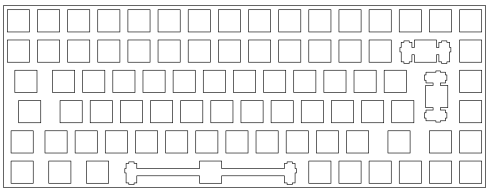

Fig. 5. Mounting plate

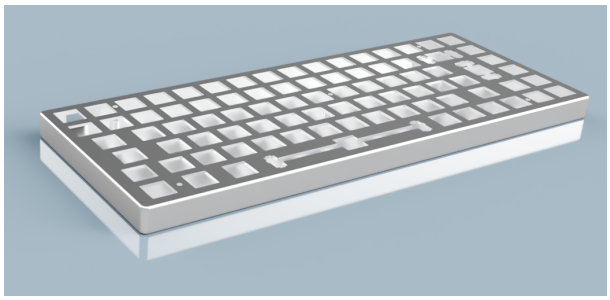

Fig. 6. Rendering of the keyboard housing

was taken to hide any seams on the underside, where they can't be seen. Figure 6 and 7 shows renderings of the finished design of the housing and lid. The housing was 3D printed using the Markforged Mark Two [9] with onyx material [10]. The lid was cut out in acrylic using an Epilog Zing Laser [11] engraver.

Assembling the keyboard

Figure 8 shows the assembly of the keyboard. The keyswitches is soldered to the PCB while the housing/mounting plate is in between the PCB and keyswitches. Then the bottom lid is attached and the keycaps are entered

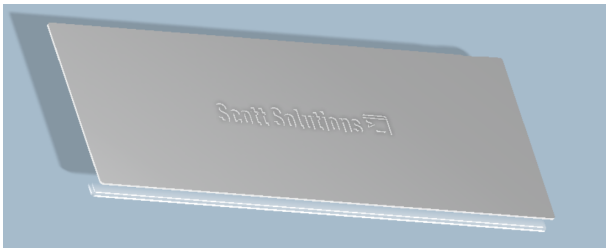

Fig. 7. Image of the lid that is attached to the underside of the housing.

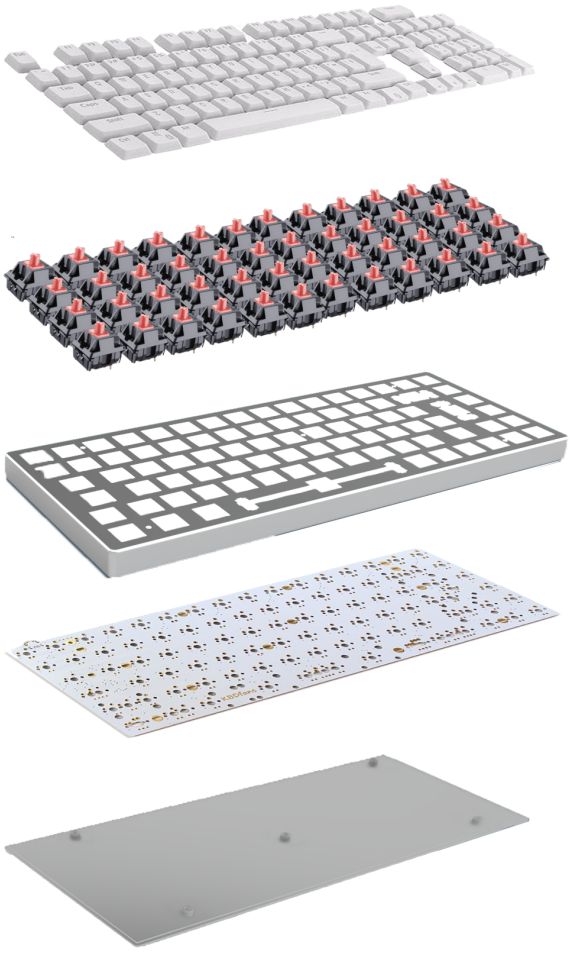

Fig. 8. Assembly of the keyboard. From top to bottom: Keycaps, keyswitches, housing, PCB and bottom-lid

into their respective spots. Rubber feet where attached to the bottom to give traction and stability.

Further work

The design is inspired by the macbook pro 2010, which uses sandblasted aluminum and simple curves for its housing, see figure 11. Further work would be to CNC mill the housing in aluminum using the Datron Neo CNC milling machine [12]. Then sandblast the aluminum to give it a similar look to the macbook pro. An aluminum housing will also add more stiffness and weight compared to the 3D printed onyx material. See figure 9 and 10 for final result of the assembly.

Fig. 9. Final result after assembly

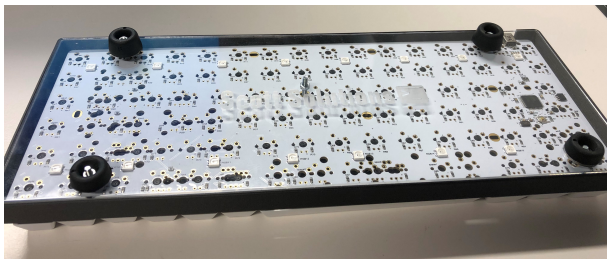

Fig. 10. Final result after assembly, underside.

Fig. 11. Macbook pro 2010 housing

Conclusion

A functioning custom mechanical keyboard was made using a 3D printer and a laser cutter, with a unique layout and high quality keyswitches. As design software and 3D printing technology has improved and availability of niche electrical components has increased, it is now easy for even the layman to build their own keyboard. There are plenty of options when choosing components, allowing for a high degree of customization, giving anyone the opportunity to tailor their keyboard to their personal preferences.

References

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