Optimal Design Report

Freely Adjustable and Accessible Keyboard and Arrow Pad for Client with Cerebral Palsy

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Optimal Design Project

1.1 Introduction

This project report will describe the design of a custom made keyboard for a child with cerebral palsy. The client this device is being designed for has athetoid cerebral palsy, and has trouble controlling his motor movements. He is a very smart child, but has trouble keeping up with his classmates because he is non-verbal. His only means of communication is by typing words on his computer. However, his cerebral palsy contorts his hand in a position that slows down his typing speed. This causes him to be slower than his other classmates, and fall behind in his schoolwork. The device being designed will be custom built to meet his requirements for a keyboard that will be easy for him to use.

To accomplish this, the keyboard must be in a vertical position, orthogonal to the desk. A stand will be used to hold up the keyboard, and it will have to be able to withstand the pressure of slamming keys without wobbling or falling over. The keys will be much larger than regular keys, so it is much easier for the client to hit the right key.

In addition to the normal internal architecture of the keyboard, LED’s will also be used to create a backlighting effect. The client is in elementary school, and having a keyboard that will look different in a negative way may make him stick out. By using LED backlighting, the keyboard will look "cool", and will help him fit in better.

In this proposal, the design of the keyboard will be described. The design of the stand for the keyboard will be explained, along with the layout of the keys on the keyboard. The switches being used in the design will be explained next, and it will be described how they will be connected to the control board of the keyboard. The design of the control board and the implementation of LED’s in the design will then be described.

This is the optimal design report, and there are minimal changes from the previous design. However, this design differs from the first two in many ways. Instead of implementing a joystick in the design, it has been decided that a arrow pad would be easier for the client to use. In the second design, Plexiglas was chosen to build the keyboard case from. It has been brought to our attention that Plexiglas does not have the durability that is needed, so in this design the case will be made from PVC. The diagrams of the stand are more detailed than in designs one and two, and much more analysis is performed. The diagrams of the internal structure of the keyboard are improved upon in greater detail. Lastly, means of testing the stand and the keyboard while they are being built are described, improving greatly on a topic that was basically skimmed over in the first two proposals.
Figure 1 below shows an outline for building the project.

Figure 1. Project Block Diagram
1.2. Subunits

1.2.1. External Hardware

The keyboard will be designed in the correct form to accommodate the client’s unique typing style. As can be seen on the next page in Fig. 2, the keyboard itself will have somewhat greater dimensions than a regular keyboard. It will be 55.9 centimeters long and 27.9 centimeters tall. When it is mounted on the stand, however, it will stand a total height of 38.1 centimeters above the desk. The keyboard casing will be composed of PVC, 5 millimeters in thickness, which will be able to withstand normal “wear and tear”. As can be seen in Fig. 2, there are far fewer keys on this keyboard than on a regular keyboard. This is a necessity when using extra large keys. If all the keys of a standard keyboard were to be included, the keyboard would have to be much wider and taller than 55.9 cm by 27.9 cm. This would make the keyboard too big, and would render it obsolete for our client. In addition, there are various keys that are not necessary to an elementary school child, such as the “pause/break” button or the “F#” buttons.

![Figure 2. Front View of Keyboard with Stand](image-url)
The keyboard will be designed to be 5 centimeters thick, which will provide enough room for the key matrix, circuitry, LED's and batteries. The keys will protrude out 1.3 cm, and all except “Enter” and “Space” will be 5.1 cm by 5.1 cm. The “Enter” button will be 10.2 cm by 5.1 cm and the “Space” button will be 15.2 cm by 5.1 cm. The stand will be circular in shape, and will be made using PVC. It will also need to be heavy so it will not move when the client is typing on the keyboard. To accomplish this, the base will be filled with heavy steel ball bearings. The bearings will then be secured inside a matrix using a gel that hardens after a certain period of time. The base will weigh down the unit and the added weight will make the base heavy enough that it cannot move freely on a desk during typing, but it will still be light enough so the keyboard can be picked up and moved when needed.

After the base has been constructed, it will need to be tested to make sure the weight is appropriate to make sure the keyboard does not move when being used. A scrap piece of PVC with the same dimensions as the keyboard will be temporarily mounted onto the stand. Five random individuals from the senior design class will then be asked to pretend to type on the “keyboard” for about 20 seconds. The movement of the stand, if any, will be noted. The subjects will then be asked if they noticed any movement, and if this movement is enough to hinder their normal typing speed. If the stand does move enough to cause a negative response, more steel ball bearings will be added to the base to increase the weight of the stand. Then testing will be performed again, and this will go on until it is confirmed that the base has no unwanted movements.

All of the dimensions mentioned earlier can be seen in Fig. 3. on the next page, which is a top view of the keyboard mounted on it’s stand.
The side of the keyboard on its stand can be seen in Fig. 4 on the next page. As is shown in this view, the keyboard will be held on the top of the stand. The stand will be supported by a diagonal member that will connect to the top of the stand, and will extend down to the end of the bottom of the stand. This member will provide support for the stand when the client is typing on the keyboard. Also seen in this image are the Cherry MX switches, which are mounted on a PVC plate. The switches will be discussed in much more detail in section 1.2.2.
The diagonal support member will not be a rigid member. Instead, it will consist of internal springs that will smoothly dissipate the force of the client typing. The spring constant, $K$, will have to be sufficient to handle the load of typing, and not be too small that the keyboard lurches back when it is pressed too hard. Figure 5a shows a free body diagram of the client typing on the top row, with a force of 20 lbs.
The vertical member of the support is mounted on a pin. Because of this, it moves freely and does not counter the force of typing. In Figure 5a. above, $F_s$ is the reaction force of the support, $F_t$ is the typing force exerted by the client, and $\theta$ is the angle the diagonal support member makes with the vertical support member. (In all the following equations, the centimeters are converted to inches so a final answer can be computed in lbs.) First, we must solve for theta. This can be done using equation 1:

$$\theta = \tan^{-1}\left( \frac{7}{13.5} \right)$$

Solving for theta gives us an answer of 27.4°. This means that $F_s$ acts along a direction 27.4° away from the y axis. Knowing that the stand is in equilibrium, the x force of $F_s$ must equal $F_t$, which is 20 lbs.
Equation 2.

\[ Fs(x) = Ft = 20\text{lbs}. \]

The force of Fs can now be solved for using equation 3.

Equation 3.

\[ Fs = \frac{20}{\sin(27.4^\circ)} \]

This gives us a force of 43.5 lbs. This is the maximum force the support will have to withstand, given that clients max typing force is 20 pounds. Knowing this force, the stand can be designed by using a spring with a K value large enough so that there is not much movement. The equation for a spring is given below:

Equation 4.

\[ F = -kx \]

K is the value of the spring constant, and x is the change in distance of the spring at rest. It has been decided that an x value of 0.25 inches is desired. This number can then be plugged into the equation, and k can be solved for.

Equation 5.

\[ k = \frac{43.5\text{lbs}}{0.25\text{in}} \]

The value of k turns out to be 174 lbs/in, so this means that the diagonal support member must have a spring with a K value around 174 lbs/in. Century Spring Corporation (www.centuryspring.com) sells a wide variety of compression springs. There are springs available with a K value of 180 lbs/in, and these would work well for our design.

Any force that is not parallel to the desk will cause a reaction force in the diagonal member that is smaller than the force calculated above. The reason for this is that the vertical member will help in dissipating the force. The vertical member may be on a pin joint, but it can still handle forces in the y plane. For example, if the client types downward on a key at an angle of 45° to the desk, the force must be broken up into x and y forces. The FBD for this can be seen in Fig. 5b, on the next page.
Equation 6 calculates the force in the y direction:

\[ 20\text{lbs} \times \sin(45) = 14.\text{lbs} \]

Equation 6.

Equation 7 calculates the force in the x direction:

\[ 20\text{lbs} \times \cos(45) = 14.\text{lbs} \]

Equation 7.

As can be seen from Equations 6 and 7, 14.1 lbs are directed downward (y direction), while 14.1 lbs are directed forward (x direction). The 14.1 lbs directed downward will be handled by the vertical member, leaving 14.1 lbs for the diagonal member. Since 14.1 is smaller than the 20 lbs considered in earlier equations, the required value of K will be less. So the maximum value of K was calculated when the client types parallel to the desk.

The diagonal member will be composed of two members, both made from PVC. One will be hollow, and the other will be solid and will attach to the back of the vertical member that attaches to the keyboard. Figure 6 on the next page shows a view of the diagonal member. The drawing is exaggerated, because the
solid tube and the hollow tube will be close enough so they rub together when moving. This will prevent the tube from buckling. The hollow tube will also be lubricated so the two tubes never stick together. When the member is built, it will be tested by pushing it down fifty times to see if it buckles or sticks. If it does not it will be considered usable and will be attached to the keyboard case.

Figure 6. Diagonal Support Member

Figure 7, on the next page, shows a much more detailed drawing of the diagonal support member, fastened to the stand. Both ends of the support member will be secured to the stand through pin connections. As can be seen in Fig. 7, the spring will be mounted on a cutout piece of PVC secured by a pin connection on the bottom and top of the hollow member. The other end of the spring will be attached to the second part of the diagonal member this attached to the vertical member of the stand. The spring will be securely attached by having it go through both ends, then using epoxy it will be glued down. To make sure the spring doesn’t detach, and one end of the diagonal support member does not pop out, testing will be needed. After the epoxy has set, approximately 24 hours, the member will be held vertical, so that the end that attaches to the vertical member will only be held in place by the spring. The spring will then be fully compressed, then let go. This will be performed 50 times, to make sure the spring does not come loose. If the member passes this test, it will be considered usable and will be secured onto the stand.
Figure 7. Diagonal Member Mounted to Keyboard Stand

As was mentioned earlier, the keys for the keyboard will be 3.8 cm x 3.8 cm. On the next page in Fig. 8 is a top view of a standard key, along with the “Enter” and “Space” key.
As can be seen, the “Space” key is going to be 15.2 cm long at the base, and the “Enter” key will be 10.2 cm long at the base. The top of each key is a little smaller than the bottom. The dimensions can be seen in Figure 8, above.

The keys will be purchased from PI Engineering, which supplies keys made for Cherry MX switches. Despite the fact the keys are larger, they snap into the switches, creating a strong connection. This will prevent the keys from not transmitting downward force with an angular hit of the key cap. The result would be the same if the client were to hit the center of the key as opposed to hitting an edge or corner. Figure 9 on the next page shows a picture of a keycap (shaded rectangle) connected to a Cherry MX switch.
To make sure the keys will not fail when being hit, testing will have to take place. Once the keycaps have been securely fastened, the key will be compressed and decompressed in the center continually for a time of 1 minute. Then this will be done again, except the key will be hit at one of its four corners. Once this has been done for all four corners, and it has been determined that the keycap is fastened securely, the keys will be connected to the control board.

1.2.2 Cherry MX Switches and Matrix

The Cherry MX switches, the PVC backing and the wiring of the switches to the control board will make up the internal layout of the keyboard. Each key will have an individual switch and within each switch there is a spring. When the key is pressed, the spring is compressed and the circuitry beneath the switch is completed, allowing for a flow of current to pass through. These switches have an actuating force of approximately 2N. The maximum force they can withstand is not defined in the data sheets, however it is estimated that a force of at least 100N can be sustained by a switch (well suitable for the purposes of our device). A diagram of the Cherry MX switches used is shown in Fig. 10 on the next page. Each switch will be mounted on PVC, and connected below the PVC.

![Diagram of Cherry MX switches](image)

Figure 10. Cherry MX switches, side and top view. The dimensions are displayed both in inches and in (millimeters).
Figure 11 below shows an image of the Cherry MX switch mounted on a PVC backing.

![Cherry MX switch with PVC backing and photo]

Figure 11. Cherry MX switch with PVC backing and photo

Figure 4, earlier in the proposal, shows a side view of the PVC backing inside the keyboard. Using Visio, images of the Cherry MX switches were placed into the drawing, showing how they would fit. However, Visio has no way to make white backgrounds transparent, so the figure looked very rudimentary. Figure 11 shows a close up view of how the switches will be mounted onto PVC, and Fig. 4 shows a rough overview. The back layer will be solid PVC, with minor holes cut out to have the row and column inputs open for soldering. It will be secured using epoxy and screws. The top layer will have to be altered in the machine shop to have precisely cut holes for every switch to fit into. It will then also be secured to the keyboard casing using screws and epoxy.

Testing is necessary in the fabrication of the PVC layers. Precise measurements must be made to make sure they are being cut exact. After the first hole is cut in the top PVC layer, a Cherry MX switch will be snapped into place, to make sure the hole is the correct size. Every hole after this will be treated the same way, to make sure there are no mistakes. Once all the switches are snapped in, and the PVC frames have been mounted in the keyboard casing, it will be necessary to test that the PVC frames are securely in place. Significant pressure will be applied on all parts of the top and bottom frame, for a total of five minutes. If the PVC backings do not move, they will be considered to be secure, and no adjustments will be needed.

In order to compensate for the switches, LED’s, and other electrical components, a 5 volt minimum source will be used. Using a basic electrical engineering equation on the next page:
\[ P = (v)(i) , \]

\[ P = (5v)(10\text{mA}) \]

\[ P = 0.05 \text{ Watts} \]

where \( P \)=Power (Watts), \( v \)=voltage (volts), and \( i \)= current (mA), we are able to adjust the settings of the keyboard.\(^2\) The wattage necessary may vary depending on the number of electrical components needed in the keyboard. It is important to contain the proper current voltage and current flowing through each component within the schematic.

These specifications seem appropriate for this device. Figure 12, on the next page, shows an example of how the Cherry MX switches will be connected together. The switches will be mounted onto PVC backing, as mentioned earlier. One side of each Cherry switch will be wired into a Column input on the microprocessor. The other side of each switch will be connected to a standard signal diode (1N 4148) and will then be connected to a Row Input on the microprocessor. The diode’s are used to isolate each switch, so if more than one key is pressed down at the same time, the signals will not interfere with each other and cause unwanted symbols to appear. Figure 13, two pages down, shows the layout of the switches inside the keyboard frame, and how the wires will be set up inside the frame. In the image, the square box in the bottom left corner represents the control board with the microprocessor. Also, the circles represent the Cherry MX switches.

![Figure 12. Cherry MX Layout](image-url)
Figure 13. Internal Structure of Keyboard
When any of the switches in Fig. 13, on the page above, are compressed, the circuit is completed and a signal is sent to the microprocessor.

Each key on the keyboard represents a specific code number. When the microprocessor receives the signal it converts each signal to a specific output character or action. Also within this step, the microprocessor is able to filter the vibration (bounce) that is created when the switch is initially triggered. The microprocessor is able to perform the signal conversion based on the codes assigned to each switch. The codes are usually given in standard ASIC (Application-Specific Integrated Circuit). Figure 14 below demonstrates a standard keyboard layout with the different codes for each key. The alternative keyboard design will contain less keys to code, but due to the ABCDE formatting and its unique arrangement, the coding will have to be altered with the microprocessor is programmed.

![ASIC coding of the standard keyboard](image)

Figure 14. ASIC coding of the standard keyboard.

After the signal's conversion the microcontroller stores the information in its memory buffer. It is then forwarded to the keyboard controller, part of the integrated circuit that is able to pass on the information to the operating system. A typical design for the microprocessor and controller circuitry can be seen in Figs. 15 and 16 on the next page. The keyboard controller will be purchased by PI Engineering and explained in more detail in the next section.
1.2.3 Keyboard Control Board

For this design, the keyboard will use a Control Board purchased from PI Engineering. Figure 17 below shows the design of the control board.

Figure 17. Control Board Layout
The thirty-pin header on the bottom of the board receives the current from the various switches when they are triggered. The holes labeled with a “C#” or “R#” represent the columns and rows of the keyboard respectively. The control board is connecting the CPU through a USB connection, which also provides the 5V power source. In the center of the board is a microprocessor. This device will be programmed to fit the keyboard’s specific needs. It will have to accommodate for the forty-seven keys installed, which will contain their individual scan codes similar to that of an ASIC standard keyboard. SW1 is the switch used for the programming the microprocessor. L1 and L2 represent LED’s. When using regular keys L1 will illuminate, however, when the shift key is initiated, to allow for capital letters, L2 will light up. The five pins in J2 represent the USB connection. The three resistors and capacitors located in J6 allow for a number pad to be installed. Our design will incorporate an arrow pad, and this will be discussed in section 1.2.5.

This integrated circuit is 2 inches by 2 inches and has four mounting holes that will be useful in the construction of the board. As mentioned earlier, the control board connects directly to the computer using a USB connection. The Cherry MX switches will connect to the control board through a double row Female Header Receptacle (see Fig. 18 below). Once the switches are all wired to the control board (see Fig. 13 for wiring layout), the microprocessor will have to be programmed to interpret each of the incoming signals.

![Figure 18. 30 pin Female Header Receptacle](image)

Testing will be essential when hooking the switches up to the control board. After all the switches are wired in place, the voltage at each switch must be checked. Using a digital multimeter, the voltage going to each switch will be
checked. Then, each switch will be compressed, and it will be confirmed that the correct current passes through when the switch is triggered.

Once the microprocessor has been programmed, the keyboard must be tested to make sure each key is correctly designated. This will be an ongoing process. After each switch is programmed, the key will be tested. Testing will not be saved until every switch is programmed, to ensure that the programming is correct from the start.

1.2.4 LEDs

In addition, the design will incorporate LED’s for a background lighting effect and aesthetics. LED’s are semiconductors and contain a material that has varying ability in conducting electricity. The material used is usually aluminum-gallium arsenide, AlGaAs. There are two layers of the LED, one containing negatively charged particles and one containing positively charged particles. When current passes through the LED properly, that is the positive charged particles are connected to the negative end of the battery, the zone in between (depletion zone) gets larger. This effect coupled with a specific arrangement of electrons produces light. LED’s will be used in the design the keyboard to provide an interesting effect that will make the keyboard look "cool". The power for the LED’s will come from the control board, which is powered from the CPU through USB. LED’s do not use up a lot of power, so there will be enough power to run the keyboard and the LED’s at the same time. The LED’s will be positioned along the edges of the keyboard to provide an impressive lighting display. The LED’s are going to be incorporated into our circuit prior to the switch on the key matrix. This will allow the LED to remain lit as long as there is power, neglecting the act of typing. The circuitry arrangement can be seen below in Fig. 19. The signal after the diode is then forwarded to the microprocessor, which is eventually relayed to the operating system.

![Figure 19: Circuitry Example](image-url)
1.2.5 Arrow Pad

The arrow pad will be used to replace the standard mouse. It will consist of 8 keys, all of which will be the same size used in the keyboard. It will use Cherry MX switches like the keyboard, and the switches will be mounted in the same way. The arrow pad will connect to J6 of the control board, which is an input area for number and arrow pads. J6 is located on the keyboard controller. This port will feed the supplementary pad its power, and enable the signal from the pad to translate through the USB attached to the keyboard controller as well. The arrow pad is functions in the same manner as the keyboard, and it will be built the same way. All the testing done on the keyboard will also be done on the arrow pad. The arrow pad itself will be 17 cm x 17 cm. Figure 20, below, shows a top view of the auxiliary pad.

Figure 20. Top View of Arrow Pad

Figure 21, on the next page, shows a side view of the arrow pad. All the dimensions are included in this drawing.
2. Realistic Constraints

This project incorporates ASEE engineering standards concerning economic, environmental, social political, ethical, safety, manufacturability and sustainability factors, along with realistic constraints, into the design of the keyboard and arrow pad. Although computer keyboards are incredibly common today, this keyboard is different in that it is being custom built for client, and will be significantly different than the average keyboard.

Economically, the keyboard will be somewhat more expensive than an average keyboard. The keyboard must be made to last a long time, so flimsy or fragile parts cannot be used throughout the design. To save money, the parts must also not be too expensive. The keyboard was designed using parts that are good in quality but not too expensive. A good example of this is the Cherry MX switches. They are inexpensive, but can withstand normal keyboard wear and tear for years, making them a good choice. The stand in the design was modeled after a “common” flat panel monitor stand that can be ordered at a relatively inexpensive cost, if it is too much to order a custom stand. There are keys that are built for large key keyboards that come in the dimensions specified in the design, so these can be ordered. LED’s were chosen to give the keyboard an aesthetical appeal, because they are inexpensive and have a decent lifespan.

The keyboard and arrow pad will be used in a classroom environment, so there aren’t many environmental concerns that have to be considered. The average operating temperature is expected to be 70°F, which normal electrical components should have no trouble operating in.
When designing the keyboard in conjunction with the arrow pad, sustainability was a big factor. This keyboard and arrow pad will have to last the client throughout his elementary, middle and high-school education. He is in fifth grade right now, so this means it will have to last him seven years. To prevent broken parts, durable PVC and plastic parts are being incorporated in the design of the keyboard. The keycaps will be detachable; therefore easy to clean. Simple computer wipes, a damp cloth, or q-tips will be sufficient enough to clean the device.

Manufacturability of the keyboard is a serious constraint, because most keyboards are manufactured hundreds at a time. Manufacturing a single keyboard is difficult, because it requires custom built parts that may be hard to create. The switches used in the keyboard are very common, and should be easy to use in the design of the keyboard. As mentioned earlier, the keys themselves may be ordered from a company that builds large keys, avoiding the trouble of having custom built keys made. The stand may follow the same path, again avoiding the trouble of ordering custom built parts. The keyboard base may be custom built, but this should not prove a huge constraint in the manufacturing of the keyboard. Most of the other parts are very common, and should not be a problem.

The keyboard and arrow pad should pose no ethical constraints for the project. In no way does the project directly affect the health or well-being of the client. The keyboard and joystick do not attach to the client in any way. USB technology was used to make the keyboard and joystick portable enough for our client’s use. Durable plastic was also incorporated into the design, so that no parts could accidentally break off and pose a hazard to people nearby the keyboard.

By using such a different looking keyboard, it was considered that the client may feel socially awkward. This is why LED backlighting was decided upon when designing the keyboard. With these added to the keyboard, the project will not be an eyesore to anyone who looks at it. Instead, LED backlighting will have quite the opposite effect. Instead of being socially awkward, our client’s keyboard will look “cool”, and other classmates may even be envious of it.

3. Safety

Safety was of course a major concern in the design of this project. It would be horrible if in any way this project caused physical harm to the client or anyone else. Precautions were taken in the design of the keyboard and arrow pad to make sure that the project meets safety requirements and in no way can pose a safety threat.
Mechanically, the keyboard could pose a threat if it is typed on with significant force. If a piece of the keyboard broke off, it would be a dangerous projectile that could cause harm. To avoid this from happening, the keyboard was designed with durable plastic and Plexiglas that can withstand mechanical abuse. The Cherry MX switches used for the key matrix have internal springs, and smoothly absorb the energy caused by typing on the keys. The safety aspects of the keyboard integrated with optimal mechanics is essential in preventing the keyboard from falling apart.

Another safety concern is the fire hazards that the LED's pose. By running at lower power, the LED's will not generate enough heat to pose a fire hazard. In addition, the LED's will not be placed within a considerably close proximity to any electrical or plastic parts. By doing this, it can be ensured that no parts will melt or get burned, which could then pose a threat to the client.

The electrical connections are all sealed within the keyboard case, so there is no danger that the client will somehow get electrically shocked from the keyboard. The power is provided through a USB connection, and these wires are sealed and also pose no danger. It is important to ensure the keyboard is sealed properly for protection and sustainability.

All the corners of the keyboard will be rounded to prevent any sharp corners puncturing the skin. The wires will be insulated to prevent any electrical problems that could pose a threat to the client. Along with the keyboard, the arrow pad is made in the exact same manner, which is very durable and will not pose any threat to the client. In this project, safety is addressed and the keyboard and arrow pad will not cause harm to its user or anyone else.

4. Impact of Engineering Solutions

Designing an alternative keyboard for people with cerebral palsy can have global, economical, environmental and societal impacts. This effect can hopefully benefit patients with cerebral palsy while adding to the biomedical research currently used. Such impacts can enhance engineering solutions for people with similar conditions.

In a global viewpoint, the freely adjustable and accessible keyboard can provide people all around the world with an improved communication device. The disorder affects approximately two to four individuals for every 1000 births. It is estimated that over 750,000 people living in America alone have some degree of cerebral palsy. The worldwide statistics of people with cerebral palsy have yet to be calculated with such elevated levels. This keyboard, if mass produced on the market, can have an enormous impact on the international level. Many countries have organizations trying to prevent or treat people with cerebral palsy. The Spastic Children's Association of Singapore (SCAS), established in 24.
1957, provide treatment, therapy, and information to families dealing with cerebral palsy. However, most corporations focus on preventing the disorder through chemical tests and alterations than treating the ones currently affected. The projected keyboard can provide a solution to many children worldwide.

From an economical perspective medical treatment for people with cerebral palsy can be very expensive. Not only do they have to afford direct medical attention, physical therapists, occupational therapists, speech pathologists, but also assistive devices such as a wheelchair (usual electric) can increase cost of living. Frequently, parents can not afford to provide their children with technological devices to aid them in school. The keyboard being designed, will be inexpensive whereby all children with that condition will be able to possess one. When produced on a large scale, keyboards can be fairly cheap, from your basic keyboard at approximately 15 dollars to your more advanced keyboard between 50 and 100 dollars.

The freely adjustable and accessible keyboard and arrow pad not only is durable, inexpensive and efficient but it is environmentally safe. All parts used in the design process are non toxic. Most of the composition is electrical and the other half is either plastic, chrome or PVC. These materials eventually have to be recycled or disposed. The plastic, chrome and PVC parts can be melted or reformed when they are discarded to create new products. The electrical components, when obsolete, can be discarded or recycled.

This product can not only become of use to the client himself, but also other people with similar disabilities. The device can offer a faster, easier means of communication for those with cerebral palsy. In addition this keyboard can indirectly affect others. People involved in the client’s life, whether friend, teacher or family member, will be able to interact easier and understand his thoughts better.

Other products available on the market result in one of two situations. One of the current devices is inexpensive; however it lacks durability and accuracy towards helping the client’s problem. The other devices that the client debates using, is either too expensive, or does not fit his custom requests. The product we are developing is not only within a reasonable cost, but it is durable, and is the most beneficial to the clients needs. Provided there are other patients with a similar disability and similar complications with communication, this device can become a universal tool to help people with athetoid quadriplegia. Furthermore, the keyboard may aid people that have diseases or disorders that limit them in the same manner as with cerebral palsy. For example, people that are partially paralyzed or have Parkinson’s may be able to find more ease in typing with the freely adjustable and accessible keyboard.

As specified by the client, it was mandatory for the keyboard to be socially acceptable. The keyboard is designed using LED technology to provide an
aesthetically pleasing backlit board. The client was concerned the device would put any emotional stress, by making him stand out in a negative way or embarrassing him in front of the other students. The unique design complimented with a modern backlighting tool provides the optimal socially accepting device. The portability, both in size and in weight, enables the device for easy transport. Though help is necessary, there will be less reliance on people assisting in his communication process.

5. Life-Long Learning

One of the most important aspects incorporated in this project is life-long learning. Many of the techniques used in designing this project require extensive research due to their unfamiliarity. The project concentrates on numerous electrical engineering and computer programming aspects. The one computer programming class, CSE123, electrical engineering class, ECE 210, and instrumentation class BME 252 was not sufficient enough to design such a device. It was essential for the team to completely understand the workings of the standard keyboard before being able to design the alternative device. Books, and online resources as well as taking apart an old keyboard, played a major role in this process. Each step involved in the workings of the keyboard were studied piece by piece, from the time the button is hit on the key matrix to the eventual command or content sent to the computer.

Furthermore, there has been limited experience with microcontrollers with exception to the one used in BME 252. Likewise research was necessary and the additional from help from the computer science department. Whether our team decides to use MPLAB to program the microcontroller to perform its specified tasks or to use LabVIEW, there will still be fresh pertinent information learned.

Besides the engineering aspect of the design project there were still other life-long learning experiences. Researching the appropriate parts, finding the correct vendors and order them was all foreign to the team. More importantly was the customization of the keyboard to fit the clients needs best. To fully comprehend the client’s situation a meeting was arranged with the physical therapist, occupational therapist, speech pathologist and other members of his support team. They were able to provide us with the obstacles and daily problems the client faces. By emulating his every-day tasks and investigating his primary needs, a custom design was able to be formulated.

An important life-long learning tool is realizing your mistakes and adjusting to them. In this alternative design we made many changes. The original plans used rubber dome switches and Bluetooth connections, but it was realized that these would not be plausible to use in the design. Bluetooth connections do not provide power themselves, and individual connectors were not found available online. It was also found that rubber dome switches could not be used, because
they require a pre-built layout that cannot be custom ordered. Cherry MX switches were an obvious alternative, which was learned.

Working with a partner for this project is very important to the experience. When entering in a career or research opportunity in the “real world” there are going to times where one has to rely on other people. This idea of group work is significant to a company or team’s success. Everyone has to be thinking on the same wavelength, cooperate fully, and contribute to their best ability.
6. References


