Optimal Design Report:
The Modified Joystick

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1. Optimal Design Project

1.1 Introduction

The following project report presents the design for a control device which will aid a client with quadriplegic athetoid cerebral palsy in his communication. The control device is meant to aid the client in the operation of his current augmentative communication device, the DV4® produced by DynaVox technologies. The client’s condition restricts his fine motor skill capabilities and causes him to experience problems in maintaining posture and involuntary muscle movement. This limits his options, as the use of the DynaVox DV4® touch-screen is made overly difficult by his lack of fine dexterity and the use of an ordinary touchpad or mouse control is complicated by his extraneous hand movements. The additional involuntary movements have also presented a problem using certain joystick controls in the past, due to the constant wear and tear presented by the client’s unintentional strength in the movement of the joystick. The design analysis and schematic figures of a possible design for a more effective device will be presented along with descriptions of product components and functionality of the overall device.

The device will consist of a single joystick that is both durable and dependable under rigorous constant daily use. The joystick will be able to operate under constant hand pressure and be will be molded to the client’s hand for comfort and more accurate selection options. The main function of the joystick will be the operation of the DynaVox DV4® communication system, however, the input/output connection will allow it to be used universally among electronic devices that require the use of cursor controls. The joystick will receive power from the existing power supply of the DynaVox DV4®. The following block diagram, Fig. 1, represents these functions as to the paths of the electrical signals of the joystick system.
Figure 1: Block Diagram of Joystick Electrical Signals
The design that will work the best for our client is a single-shaft joystick handle that has two buttons strategically placed, one on the top of the handle and one on the right side of the handle. Either button can be operated by the user’s thumb, which is the most dexterous part of his hand. They will be one-touch select buttons and will spring back to the original position until pressed again. The joystick will also implement the use of the client’s head switch, which he currently uses to scan through the menu of the DynaVox DV4®. However, in this case, all buttons, including the head switch, will act as the left finger button on a PC mouse. It will activate the image that the cursor is hovering over on the computer screen. This will allow the user to choose which setting is most comfortable for him at that particular time, and only one of these buttons will be able to activate at a time. There will be a 3-position selector switch set on the top of the joystick base, which will allow the user to select which button will be used for cursor selection.

The electrical design implements an inductively coupled unit, which uses a field to convert mechanical displacement to electrical output. The curvilinear motion of the joystick is converted through a process involving a drive coil, ferrous shaft, and four secondary coils. Other design features and additives are discussed further in the report.

Many changes were made throughout the design process. After meeting with the client, his specific needs and wants were assessed and the joystick design was modified to best suit his situation. The first alternative design consisted of a potentiometric controlled joystick that worked in the right hand of the client. This joystick controlled the DynaVox DV4® and the electric wheelchair, alternating between the two functions with a spring loaded alternating button. The joystick had two buttons on the handgrip shaft. One controlled the alternating function between the DynaVox DV4® and the wheelchair control, while the other acted as the select button on a PC mouse, but only when the DynaVox DV4® was selected.

As e-mail correspondence continued with the client, more changes were made to the joystick so that it would be safe and functional. The second alternative design added an emergency stop button to the top of the handgrip on the joystick. This feature cut off all power to the wheelchair and the DynaVox DV4® communication system, so that in the event of an emergency safety would not become a concern in the operation of the electrical components of the joystick. Also included in the design was the addition of a green colored light emitting diode (LED) on the front of the joystick shaft to allow the client easier knowledge of which device the joystick was controlling at that instant, reducing the confusion of whether the joystick was controlling the DynaVox DV4® or the electric wheelchair.

The third alternative design eliminated many unnecessary components of the joystick for the client and consisted of many longer-lasting components. This
design eliminated the left side button on the joystick, the emergency stop button on the top of the joystick, the green LED, the potentiometric mechanical system, and the control of the wheelchair. The client specified that the joystick need only be of industrial quality, contain minimal rubbing parts, only control the DynaVox DV4®, and have more then one option to select images on the DynaVox DV4® computer screen. The modified joystick now uses an inductively coupled system to detect field variations, which do not have any rubbing parts that could wear out over time. There is one button on the top of the handgrip, one on the right side of the handgrip, and a connection for the head-switch, which the client already has. This joystick is now a left-handed joystick and has a toggle switch to select which button is activated for the DynaVox DV4® cursor control.

Additionally, in the optimal design, there will be more changes made to the joystick to make the usability better for the client. The joystick will be made larger than previous ones to provide better gripping capabilities and controllability for the client. There will also be a viewing screen that is added to the opposite side of the existing DynaVox DV4® so that the people that our client is communicating with are able to see the words and sentences he is spelling out before the DynaVox DV4® reads it out loud. This option allows others to stand opposite the client, be able to foresee what he is trying to say, and speed up the client’s communication process, which is the main focus of this project.

1.2 Subunits

The overall joystick provides the form and function that the client will be able to use and adapt to very quickly. The front view of the joystick, as shown in Fig. 2 (all figures that follow, with dimensions included, are labeled in inches), depicts a simple, classic design for the joystick, but contains many variations that cater to the client’s needs. As we start from the bottom and work upwards, the base casing is made of aluminum. This will be a square shaped box that will only have a seam surrounding the top cover. The box will be a total of 2.5 inches (6.35 cm) in height and will be 3 inches (7.6 cm) square. The thickness of the aluminum will be approximately 0.13 inches (0.32 cm), to provide the durability and strength it needs for daily use. As with all seams and holes in this aluminum casing, they will be sealed with a black rubber gasket that is specified to keep out moisture and water from damaging the internal mechanisms of the joystick.

The gasket will be made of a high-grade solid neoprene rubber, with temperature allowances of -30 to 200 deg. F (-34 to 93 deg. C). This gasket will be a single piece that also includes the accordion-like joint cover. In making this rubber one solid piece, it prevents any liquids from seeping through the cover of the joystick box, around the screw holes, the circumferencing seam, or top hole where the joystick shaft exits the box. The aluminum casing will be fabricated at the on-campus machine shop and will be spray painted black to match the rest of the wheelchair accessories.
Figure 3 is the top view of the base unit cover. In each corner of the lid, there is a Philip’s head screw that secures the lid to the base unit box and creates a tight seal anywhere the aluminum and the gasket meet. This figure also shows the approximate diameters of the three folds of the continued rubber gasket. The lower-most fold is 2.0 inches (5.1 cm) in diameter while the other two folds decrease in diameter by 0.5 inches (1.3 cm) as they ascend the aluminum shaft of the joystick. The gasket finally ends in a tight 0.32 inch (0.8 cm) diameter opening to seal and fit snugly around the aluminum shaft.
Figure 4 shows the bottom of the base unit. Each of the wires that exit the box will be round and will be able to fit snuggly through the 0.25 inch (0.6 cm)
holes drilled in the base of the box. One wire will go to the DynaVox DV4® communication system and the other will go to the head-switch. The head-switch is a product that the client already has and wants to have worked into the joystick design. The head-switch is manufactured by the Ablenet Corporation and is called the Specs® switch access tool. It is a 1.38 inch (3.49 cm) diameter circular switch that is mounted to the client’s wheelchair headrest via a 24 inch (60.96 cm) Velcro strap. Figure 5 shows a rough diagram of the top view and Fig. 6 shows the side view of the Specs® switch. In addition, each wire that exits the aluminum base unit will be surrounded by a neoprene gasket. These gaskets will again provide a water-tight seal for the internal mechanisms of the joystick.

Figure 5: Top View of Specs® Switch

Figure 6: Side View of Specs® Switch

The shaft of the joystick will be made of an aluminum rod. The rod will extend from the induction coils inside the base unit, almost halfway up the handgrip on the joystick. This aluminum rod will be 0.32 inches (0.8 cm) in diameter and will be kept its natural color and finish. This rod will be about 3.5 inches (8.9 cm) in length. It will be 1.0 inch (2.5 cm) in length between the base of the handgrip and the top of the aluminum base box. The neoprene accordion
gasket will extend 0.75 inches (1.9 cm) up that exposed shaft, leaving 0.25 inches (6.4 cm) with no covering. This will allow the rubber folds of the gasket to expand and be compressed, moving up and down the aluminum shaft, without becoming damaged. Figures 7 and 8 show the dimensions of the aluminum shaft and rubber gasket as they would be on the actual joystick.

The handgrip portion of the joystick will be cylindrically shaped. It will be 1.5 inches (3.8 cm) in diameter and 3.5 inches (8.9 cm) in length. The handgrip will come in two halves and will be screwed together by two hexagonal bolts. The handgrip is made of a thick-walled glass-reinforced nylon. This type of material is used in industrial applications and can withstand constant abuse. The rugged design is rated to work in outdoor application and be weather and corrosion resistant. This glass-reinforced material has also been pre-stabilized with a UV resistive material to prevent long-term discoloration due to sunlight and the breakdown of the nylon based material.

Figure 7: Side View of Joystick
Included in the design of the joystick will be four finger grips on the back of the joystick handle. These finger grips will be indentations of 0.56 inches (1.4 cm) in height as seen in Fig. 8. The finger grips will start about 0.5 inches (1.3 cm) from the top of the handgrip, spaced one next to the other, leaving a 0.76 inch (1.9 cm) portion of the handgrip as a smooth round cylinder before meeting the aluminum shaft.

![Back View of Joystick](image)

The handgrip will be mostly hollow, as will be the aluminum shaft, to provide a passageway for the button wires to connect between the base unit and the handgrip. There will be two buttons located near the top of the handgrip. One will be in the right side of the handgrip and the other will be on the top of the handgrip. Both will each be 0.63 inches (1.6 cm) in diameter. The side button will be adjacent to the finger grips and will be 0.5 inches (1.3 cm) from the top of
the handgrip. Figures 2 and 8 show the front and back views of the joystick and a visual placement of the two buttons. Referring to Figs. 2 and 8, both buttons will act as the select function on the DynaVox DV4®. In other words, it will be the index finger click button on a right-handed mouse. The client will be able to select options of the DynaVox DV4® using the thumb of his left hand. The joystick is only a left-handed joystick. The button on the top of the handgrip will perform the same function as the side button and the Specs® switch. Only one of each button can be used one at a time, so the new selector switch located on the base unit of the joystick will control the selection of any one button. As seen in Fig. 9, there will be the buttons on the right side and the top of the handgrip which control the selection options on the DynaVox DV4® communication system.

![Figure 9: Top View of Joystick](image)

Each button will be a single select button and once it is pressed, it will spring back to its original position. This will provide the similar functions of a standard computer mouse button.

The two buttons on the handgrip will be of identical dimensions and color. The base of the buttons will be black, to match the joystick handgrip and base unit. The buttons themselves will be bright red in color to be easily seen by the user and will have a rounded top so they are easily pressed by a thumb, the side of the hand, or any other part of the hand. Figure 10 shows the dimensional drawings of the two buttons. The total diameter of the buttons are 0.70 inches (1.78 cm) and the total depth the buttons will be set into the handgrip is 0.45 inches (1.1 cm). The leads on the base of the buttons will be approximately 0.19 inches (0.5 cm) in length. The actual diameter of the red button itself is 0.63
inches (1.6 cm). This button type and size will provide the user with ease of operation while not being so large that the buttons can be activated by accident.

Figure 10: Joystick Button Schematic

Figure 11 is a schematic of the new 3-position selector switch. This will act as the selection of which button the client prefers to use at that time. When depressed on the left side, the Specs® switch will be activated as the only mode of selection on the DynaVox DV4®. When centered, as shown in Fig. 11, the selector switch will only activate the button on the top of the joystick, and similarly, when depressed on the right side, only the right side button on the handgrip will be activated to control the DynaVox DV4®.
The dimensions of the selector switch will be 1.0 inches (2.54 cm) long, as shown in Fig. 7, 0.63 inches (1.6 cm) wide, about 0.45 inches (1.14 cm) deep into the base unit, and have four electrical leads that are 0.19 inches (0.48 cm) long. Each lead will connect with one of the buttons and additionally connect with the DynaVox DV4® communication system. There will always be one button activated at all times, depending on the position of the selector switch. This is shown in the following block diagram (Fig. 12).
One of the desired features of this joystick device is that it will be positively spring-centered, in that the joystick handle will spring back to the central position once the applied force has been released. This function will be implemented through a spring-shaft apparatus which is shown in Fig. 13.

Figure 12: Selector Switch Block Diagram
Figure 13: Inner Shaft and Spring of Joystick

This figure shows the bottom portion of the joystick’s handle shaft, part of which is concealed by the rubber gasket. At the top of the apparatus is a circular polymer lip which has been bolted to the shaft. Surrounding the shaft is a helical coiled spring. Below the spring is a polymer cylinder with a bottom lip. This cylindrical part is free to slide along the surface of the shaft. This allows for the extension and compression of the spring as the joystick handle is moved in various positions. In addition to the portion of the apparatus shown in Fig. 13, the remaining portion of the entire spring-centering apparatus is shown in Fig. 14. This portion is a circular plate-like part with four raised ridges spaced equally around the circumference of the plate.
The cross section of the plate is shown in Fig. 15. The shaft of the joystick is threaded through the central hole of the plate and is secured at the bottom. The plate is then secured inside the joystick base at a fixed position. The bottom lip of the spring-shaft apparatus is free to slide along the ridged surface of the plate. The spring is always meant to be in compression, in order to have a constant resisting force present in the joystick handle. When the handle of the joystick is moved in any direction, rather than allowing for extension of the spring, the bottom lip presses against the raised surface of the plate, causing a greater compression of the spring. When the applied force on the handle is released, the spring releases to its position of least compression, which is located back at the center.

The spacing between the ridges is not necessary, but adds to the user-friendly features of this joystick. The spaces are placed at exact 90° angles and are oriented along the x- and y-axes. As the bottom lip of the shaft slides over the raised surface of the plate, a slight disruption occurs in the fluid motion of the handle as the lip catches in the gaps. This catching that occurs indicates to the user that the joystick is positioned exactly on either axis.
Due to involuntary movements the client frequently experiences, a method to prevent the accidental movement of the joystick was devised. This design implementation prevents the joystick from moving if a force less than 3 oz, or 0.188 lbs. is applied to the joystick. This prevents sudden motions of the cursor from occurring if the joystick handle is bumped or jerked slightly unintentionally. This design method is explained by the following calculations and procedure.

Figure 16: Spring Constant Analysis

Figure 16 represents the possible field of motion of the joystick and the extent to which the spring can be displaced in normal movement. As the motion of the joystick handle is angular, the maximum extension of the spring will take place when the handle is at a 45° angle. The length of the maximum spring expansion was then determined by the following calculations:

\[
\cos (45^{\circ}) = \frac{1.00\text{in}}{\text{Max Expansion Length}} \quad (\text{eq. 1.0})
\]
Max Expansion Length = \frac{1.00 \text{ in}}{\cos (45^\circ)} \quad (\text{eq. 1.1})

Max Expansion Length = 1.9 \text{ in}

The maximum length that the spring will stretch during use is 1.9 inches (4.8 cm). In order for the spring-centering technique to work, the spring must always be compressed. However, the spring does not need to be in a heavy state of compression, therefore a spring with a length of 2.00 inches (5.1 cm) will be compressed to fit the apparatus. The minimum displacement of compression ($x_{\text{min}}$) is 0.1 inches (0.3 cm). This value was determined simply by determining the difference between the total length of the spring and the maximum expansion length of the spring once it has been compressed into the apparatus. The maximum displacement of compression ($x_{\text{max}}$) is 1.00 inch (2.5 cm). This value was determined by finding the difference between the total spring length and length of the spring at a 90° angle to the base of the joystick, which is the minimum length of spring extension. The minimum amount of force required to move the joystick handle from its rest position will occur at $x_{\text{max}}$. Since it is desired that the minimum applied force is 0.188 lb. and the maximum length of compression is known, a spring must be used with the appropriate spring constant to satisfy these conditions. This appropriate spring constant value can be determined by assuming that the compressive force acting on the spring is equal to 0.188 lbs, the desired minimum force of application. The spring constant can then be determined by the following equation:

\[ F_c = \frac{1}{2}k \cdot x_{\text{max}} \quad (\text{eq. 2.0}) \]

\[ k = \frac{2F_c}{x_{\text{max}}} \quad (\text{eq. 2.1}) \]

\[ k = 0.376 \text{ lb./in.} \]

Once the spring constant value is calculated, the required specifications of the spring are known to fulfill both the spring-centering function and the minimum applied force requirement.

The inductively coupled movement of the joystick is responsible for the movement along each of the x- and y-axes. The motion of the joystick handle causes a simultaneous movement of the primary coil, causing the variation of electric field. The variation in the field is responsible for a change in the voltage in either direction and is translated to mechanical displacement in the wheelchair mechanics. The electrical components for this function can be simply represented by the diagram in Fig. 17.
In Fig. 17, the inductively coupled system is based on a variable-transformer type relationship. Attached to the base of the inner shaft of the joystick is a primary coil. This coil hovers between four secondary coils, each of which is placed at a positive or negative end of the x- or y-axis. The primary coil creates a field between itself and the secondary coils. Through the movement of the joystick shaft, the induced pick-up from the secondary coils is varied proportionally to the amount of movement. The closer the primary coil is to the secondary coil, the stronger the pick-up signal is. As would be expected, the farther the primary coil is from the secondary coil, the smaller the pick-up signal is. The pick-up signal is then converted to a digital signal through an analog-to-digital conversion circuit. The digital signal can then be read by the computer, thus allowing the translation of the joystick’s movement to the movement of the cursor.

This inductively coupled joystick has no contacting or wiping parts, giving it an advantage over the potentiometric or opto-mechanical joystick. This is an advantage because there is a higher life expectancy of the joystick’s mechanical parts and the complexity is much less. The only moving parts of an inductively coupled joystick are the shaft, centering cup, and helical compression spring.

A microprocessor will be used to convert the field signal changes from the joystick to digital signals where they can be recognized and used by the
DynaVox DV4® via a USB cable. This microprocessor and circuit board will integrate the field changes from the joystick to cursor movements on the DynaVox DV4® screen, and it will detect the button signal which will be used to select objects on the DynaVox DV4®.

Attached to the DynaVox DV4® via an additional USB cable will be a PDA. This device will act as a second viewing screen for the DynaVox DV4®. This viewing screen will be mounted on the reverse side of the existing DynaVox DV4® and will allow others to view the text line of the DynaVox DV4® screen as well. A LABView program installed in the PDA will convert and transfer the onscreen word selections of the DV4® to this PDA screen. The PDA will have dimensions of 5.5 by 1.5 inch (13.97 by 3.81 cm) for the viewing screen and total dimensions of 6.0 by 2.0 inches (15.24 by 5.08 cm). Figure 18 shows a rough schematic of the front view of the PDA.

![Figure 18: Front View of PDA Used as a Viewing Screen](image)

**2. Realistic Constraints**

The joystick design incorporates many engineering standards into its design while functioning at environmentally and economically safe standards. This joystick uses the latest materials which provide a life-long sustainability and operational functionality. The high-grade aluminums, glass-reinforced nylons, and plastics being used are rated to withstand extreme cold and warm conditions without failing or becoming damaged over time. These materials provide the user with the reliability that is desired with any product on the market today. As with any product that is purchased by a consumer, this joystick will last through many cycles of usage and withstand the constant motions and forces applied to it. This type of reliability is environmentally conscious due to its minimally replaced parts that require earthen mining and depletion of the earth’s natural resources.
Economically, the price of the parts and manufacturing of the joystick are minimal and within any reasonable budget. If manufactured, purchased, and shipped in bulk, the prices would be reduced due to their availability. This project is mostly focused on the customization of a functional joystick for specific needs and abilities of a client. As most joysticks are generalized and multifunctional, this joystick will provide the client with a more compact and longer-lasting device that will control a DynaVox DV4® communication system. While other joysticks are not customized, this one will be specific to the client’s hand motions, forces placed on the joystick, operational capabilities, and size constraints.

Previous joysticks supplied to the customer were of residential grade and did not provide the client with the proper sustainability or functions which he desired. This joystick will be manufactured with constraints and usage specifications based on an industrial joystick. Following the analysis of the clients needs, the lighter weight and cheaper joysticks did not provide the client with the proper functionality needed under the daily stresses he inflicted on the joystick. With a more reliable joystick, like the ones used in industrial applications, the client will be able to use and abuse the joystick as is done in most industrial applications, without it failing or breaking under the stress and pressure. Compared to purchasing a new joystick every six months, because it broke due to the client’s high tone and forceful motions in his hand, this single joystick will outlast the previous ones twenty-fold, preventing the client from the indirect costs of time, stress, and pain, not to mention the direct cost of having to purchase a $510.00 (USD) joystick biyearly.

This device only consists of a single joystick that will be powered via DynaVox DV4® communication system. It needs no other power source or rechargeable battery to power its functions. It will act similar to a personal computer mouse and give the client the assurance and reliability he desires so as not to worry about the joystick ever failing while at an inopportune time.

The inductively coupled joystick is safeguarded against stray electrical fields, which could interfere with the signals of nearby electronic devices or possibly cause harm to the user. This will be made possible because the system will include a synchronous detection system. This means that the detection from the four secondary coils must equal the induced signal provided by the primary coil. This also allows the effects of the adjacent coils to be ignored.

The joystick does not have any major ethical issues associated with it because it does not attach to the human body in any way and does not harm any living creatures in its manufacture process or testing process. The joystick will only be operating one existing device and will have to be incorporated into this function seamlessly through USB ports and standard electrical connections. These electrical connections will be at a safe distance from the body where they will not ever come in contact or harm the user. All components of the joystick are
composed of insulating materials where they will not transmit or conduct electricity and harm the client. The metal portions of the joystick will not contain any currents or be a possible risk to the client for conducting electricity or stray current, because they will all be either be surrounded by a rubber, nylon, or insulating material.

Designing the joystick to have a low profile and be unobtrusive was a main concern because as there are many other obtrusive devices already attached to the wheelchair and another was not needed. Socially, the joystick will be of neutral colors and will not make the user feel ostracized because of its looks. However, it will provide the user with a greater ease and functionality of the DynaVox DV4® communication system. The client will be able to scroll, select, and put together sentences with greater efficiency and with much less effort than previously possible with his head switch functioning as a scroll device. The client will be able to make normal conversation, and communicate at the same rate as any other normally speaking peer.

3. Safety Issues

Safety is a major issue in the project design. The optimal design of the joystick is a simple, but effective, mechanical device that is operated through the force and movements of the hand. The hand and hand movements are very sensitive and in the case of our client, a young boy with cerebral palsy, are limited. Just as a person who uses a keyboard typing all day long, a person who used a joystick might get wear spots on areas of their hand where they rub against an unpadded surface all day, or even acquire carpal tunnel syndrome from pressed nerves on hard surfaces. To account for this pressing or rubbing of the wrist against the base of the joystick, a fabric-covered jelly-like pad will be glued to the top of the aluminum box that contains the workings of the joystick. This pad will also provide support for the hand so that it does not become tired or weak as it needs to be held on the joystick grip for long periods of time.

All materials, from the aluminum base, to the glass-reinforced nylon joystick handle are safe to the client and are non-allergenic to the client. All corners on the device will be rounded off to prevent damage or the puncturing of the skin. All materials that are used are UV resistant and can withstand extreme weather conditions from intense heat to cold winters. The plastics, rubbers, aluminums, and circuitry are rated to be fail-safe from -40 to 185 deg. F (-40 to 85 deg. C). In addition to temperature resistance, the materials are sealed at all seams and will be resistant to water and moisture penetration. Moisture is one of the leading causes of corrosion and mechanical and electrical failure in electronic devices, especially for our client who resides by the ocean, where the humidity and salty air can easily condense in a closed casing and corrode the electronics of the joystick.
All wires containing electrical signals going into the joystick and leaving
the joystick will be insulated and covered in a plastic or polymer coating to again,
prevent corrosion, and protect them from getting frayed or splitting at inopportune
times. The seam where the lid of the base unit meets the vase will be sealed
with a rubber membrane and the holes where the USB for the DynaVox DV4®
control exit will be sealed with a rubber gasket to prevent air and moisture
penetration into the electrical components of the joystick.

4. Impact of Engineering Solutions

This product, as one might imagine, will have an enormous impact in
many socio-economic aspects. A device such as this has potential to become an
aid for not only the client specifically, but for many others who may share similar
conditions to the client. This device will greatly simplify the operation of
computers and other electronic devices for the client and will enable him to
communicate and interact with others more effectively.

One of the main concerns of the client is his ability to communicate at a
normal pace and interact with his peers. Alternative options that the client has
used have allowed for faster communication but have been unreliable and
expensive. Other alternatives have been durable and inexpensive but only
allowed for slow communication. The design of this device presents a reliable
and durable product and will enable the client to communicate at a normal pace.
In making such things possible, this joystick device will greatly enhance the
client’s communication experience both socially and academically. If this device
can prove to be this beneficial to one person, one can only imagine the benefit it
can have to others with similar disabilities.

Those with such disabilities will find that several of the limitations that they
may face, such as limited communication abilities or large financial expenses
from expensive communication tools or devices, can be eliminated through the
benefits this device offers. By decreasing or eliminating such communication
limitations, this device offers the client, and others who may share similarities to
the client, a much greater opportunity to interact as members of society on the
same level of those without any communication disabilities. Such a device can
greatly enhance the market for accessible devices.

The device is also designed to use durable, yet low-cost materials,
therefore promising to be a relatively inexpensive product. Another major
concern of the client is the product cost and durability. The client has had past
experience with joystick products which were in the price range of $490 - 510
(USD). These joysticks, however, did not hold up to the desired function under
the client’s rigorous movements and would not last very long (approximately six
months) before wearing out or breaking. The durability of this design offers a
much more reliable product which will withstand the high impact forces of the
client’s extraneous movements and the high strength of his regular movements. This will therefore benefit the client economically, as well as other prospective users, as it will be reliable for a long usage life and cost effective. All materials used to construct the device are also non-toxic and safe for all users, as well as environmentally safe.

5. Life-Long Learning

In the process of learning how a joystick works, new knowledge and techniques were acquired. Researching the mechanisms and designs of joysticks revealed that there were many types, shapes, and functions to how a joystick works. The basic type of joystick is one that is based on inductively coupled movements, converting displacement voltages to electrical signals. This type of joystick has its advantages and disadvantages in our client’s situation. The induction coils have no physically moving or touching parts that can wear out over time. They provide a simple and effective mechanism for a joystick, while keeping cost low and productivity high. There are magnetic field changes that induce signals that move desired objects.

Joysticks come in different shapes and sizes, depending on the application it is used for. A large joystick with a large spring constant can be used in an industrial application. But, a smaller joystick with a smaller spring constant can be used for a more residential application like video games and light-use wheelchair controls. When a residential-use joystick becomes worn out more quickly than it is designed for, a mix between the two designs is desired to cater to the perfect long-life and high use application as in our client’s situation.

Where the inner mechanical workings of the joystick can be specified to a certain application, the handgrip can also be customized for certain applications. Joystick handgrips can be molded to fit a person’s hand exactly, or they can be made like a simple rod. There are designs that are fixed at angles when in their standard resting position, used for industrial cranes and forklifts. There are also designs that do not self-center after being released and need the physical pull-back of the joystick to re-center. Joysticks that are self-centering are ones that are used in applications where, for example, the joystick is pushed forward, machine moves forward, then when the joystick is released, it re-centers and stops its movement all together. Joysticks that do not self-center keep moving until they are physically put in the position to stop.

Other joystick-like devices are ones that use of a roller ball, similar to an opto-mechanical mouse and there are devices that could be modified that use the client’s head or eye movements and control a cursor via pupil movement or a dot that is placed on the client’s forehead movement. After talking with our client, the best design was to use a more reliable, customized joystick that performs many functions, due to the client’s body movement limitations. As learned
though this process, a new design is not always better for the client, but one that is not on the market today, or one that has been customized to fit his own needs may work best.