Alternative Design #1 Report

Shampoo/Conditioner Identification Device &
Backpack Lever Arm System

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1. ALTERNATIVE DESIGN PROJECT #1

1.1 Introduction

For individuals with physical and psychological limitations, creative healthcare products can be used to help them independently perform certain tasks. The client’s specific symptoms have resulted in the inability to make certain distinctions, and have led to an increased dependency on others. Mrs. Smith desires to be more self-reliant in terms of being able to differentiate between shampoo and conditioner bottles in the shower. Even with mild cognitive impairment and reduced visual acuity, Mrs. Smith wishes to remain independent in carrying out her daily routine.

Similar to the initial design, the alternative product will be able to connect to each bottle, customizable to a variety of sizes. When squeezed gently, it should emanate an auditory voice signal - “shampoo” or “conditioner!” Even though the fundamental concept of this device is the same as the previous design (translation of a mechanical stimulus into a sound output), the process through which is done involves a different electrical design. Here, instead of a touch-sensitive pad, there is reliance on the fact that the client will be able to depress one of six buttons in parallel. This is a very simple electrical design, in which each button is represented by a switch in the circuit. Pressing any one or more of the six buttons will close result in a short, and complete the circuit.

The advantage of using this alternative is the simplicity of design. In comparison to the initial design, there is no need to customize already available touch-pads to fit the size of a belt that will wrap around a bottle. Generally, the touch-sensitive pads available (‘scat mats’) are placed straight, on a horizontal surface. In the case of wrapping them around a shampoo/conditioner bottle, the group would have to make sure that the strain induced by this type of placement would not trigger an output of the signal. With the current alternative design, it is assumed that Mrs. Smith will be capable of pressing any one of the six buttons on the belt of the bottle. It is possible, as the buttons will be of substantial size, light-weight, and clearly perceptible.

A small speaker (similar to small, attachable iPod speakers) will be incorporated into the belt. Soft insulation will be used to cover any wires to avoid any exposure of visibility from the outside. Furthermore, this will be covered in a nylon casing for its waterproof properties. By placing small
speakers on the belt of the device, there is no need for an additional output system, which may be expensive, inconvenient, and more space–inefficient.

**Figure 1.** Flow Chart for device operation

### 1.2 Subunits

#### 1.2.1 Parallel push–button

The basic control for this system will be composed of a 6 parallel push-button switches in parallel. These switches will all be connected to a 6 volt battery source that will run the entire system. There will also be a voltage dividing system that will accurately output 5 volts. This system will be composed of a 10 ohm resistor in series with a 50 ohm resistor. The voltage between these two electrical components should be a consistent 5 volts.

**Figure 2.** Setup of the 6 parallel push-button switches
When any of the 6 buttons are pushed, the input signal is initiated and the microcontroller will send a signal to the synthesizer which will output a vocal prompt. The design should be quite effective because it will allow for a button every 60 degrees around a bottle of shampoo or conditioner. In this way it will be easy for the client to activate the device at her convenience. The advantage of using push buttons is that they only activate on the push sequence and they will not continue to be activated if they are not released.

In order to have the sound output the group plan to use two different chips. One of the chips is the microcontroller and the other will be used to output a particular voice prompt. The microcontroller will be a BASIC Stamp II made by Parallax. The voice prompt controller will be a V8600A Speech Synthesizer by RC Systems. The output from the V8600A chip will be sent through an amplifier and finally out to a speaker. This setup is shown in the figure below.

![Figure 3. The flow chart for operation of the chips](image)

The BASIC Stamp II is a 24-pin DIP module that is used as an elementary microcontroller in most application. The Stamp II is essentially designed to be an easily programmable brain for most electronic project. Its voltage requirements also fit the projects parameters because the range is between 5 and 15 volts. The chip is designed to control an array of electronic devices including relays, sensors, motors, etc. The programming of this chip is done using the PBASIC language, which requires no compiler to be implemented. The group will most likely also purchase a Board of Education Development Board (USB) from Parallax that will enable us to prototype the design and program the chip easily. When the switches are activated the microcontroller will output an English ASCII text string to the Speech Synthesizer [2].
Figure 4. BASIC Stamp II

Figure 5. Internal Schematic of the BASIC Stamp II
The V8600A Speech synthesizer is one of the most convenient and compact speech synthesizers on the market. It is ideal for the application because it only uses 5 volts to power the entire chip. The V8600A is designed to be piggy-backed onto a host PCB, such as a microcontroller. An eight-bit bidirectional data bus and read/write control pins enable the V8600A to allow for easy manipulation of the chip's parameters via the microcontroller. The voice output is controlled through software. The speed and pitch can be dynamically controlled by embedding the parameters in the text input. The volume will be controlled by using a 10kΩ potentiometer connected between the line pin and ground. Adjusting the potentiometer clockwise will increase the volume and counterclockwise will decrease the volume [3].

Figure 6. V8600A Speech Synthesizer

Figure 7. Internal Schematic of V8600A
The microcontroller and speech synthesizer should work well together because they both have the same voltage requirements. The main advantage of not controlling the voice prompt by the microcontroller is that it has less potential of complications. The memory on the microcontroller only needs to have one object stored, the ASCII text for “shampoo” or “conditioner.” The rest of the system is controlled by the speech synthesizer. This is far superior because the V8600A is a dedicated to only one task, voice output. So any manipulation of the output can be controlled through this device by embedding commands through the input text.

1.2.2 Belt

Taking into consideration the environment in which the device will operate, there are certain requirements that have guided us in choosing the appropriate materials for the belt. Given the properties of water and proximity to electrical parts, all measures should be taken to ensure that any possibility of contact is eliminated. This will be carried out through a waterproof casing to maintain client’s safety. In addition to making the device shock-proof, corrosion resistance is absolutely necessary for daily use and long-term product life. In making sure that these requirements are met, there is a need to ensure that the weight of the entire device is still kept within a reasonable limit. A device that is light in weight would reduce risk of injury to the client, in-case the bottle/device falls.

An appropriate material to use in the manufacturing of this device would be similar to that of a hose. The ‘Gilmour 4-Ply Medium Reinforced Rubber/Vinyl Bulk Hose’ is only 5/8 inches in diameter, increasing the total diameter of the shampoo bottle 1.25 inches. This is a manageable width, and will not make the device too bulky. In terms of material properties, the hose is made of rubber, and soft PVC. This satisfies the requirement of making the belt resistant to water, and corrosion. The high strength of the hose will ensure that the electrical components inside are protected. In addition, since hoses cater to water running at high speeds, the type of environment subject to the hose-made belt will cause negligible weathering.
Six holes can be made along the line of the hose and evenly spaced to incorporate the buttons. The buttons will be covered by an additional insulating layer from the inside to ensure that no water leaks into the inner circuitry, located within the hose (belt). An additional hole will be made for the small speaker output, from which the client will receive an auditory signal.

To be able to customize the belt to various bottle sizes, the group will create a watch belt type of mechanism. Here the hose (belt) will extend, as if it were a strap. The strap will have additional small holes and a buckle (the same concept as a watch belt) to change the bottle – diameter on which the belt can fit.
Speakers

The speakers that will be attached to the Shampoo/Conditioner bottles need to be small and light to eliminate burden during the operation of the device. The IPod NANO portable mini speakers seem to be very suitable for this project because of their petite size and low voltage requirements.

They have a dimension of 8cm in length, 5cm in height, 2.4cm in width, and a light mass of 38 grams. Since to minimize the total amount of weight of the device is one of the main goals of this project, the power source for the speakers becomes very important. These speakers only require two small AAA batteries.

In additional, they are compatible with all audio output signals, and costs about $17 per piece. These great qualities are ideal for the Shampoo/Conditioner Identification device.

Figure 10. IPod NANO Portable Mini Speakers

2. REALISTIC CONSTRAINTS

Engineering Standards must be taken into consideration when designing and developing new products. Some of organizations that specializing in creating and monitoring engineering standards include American National
Standards Institute (ANSI), American Society for Quality (ASQ), Association for Advancement of Medical Instrumentation (AAMI), International Organization of Standardization (ISO), and National Institute of Standards and Technology (NIST).

The Shampoo/Conditioner Identification device must meet or exceed the engineering standards and guidelines provided by the standard organizations because not only do they ensure the safety of the users, but they also enhance the quality of the product.

Several standards that are relevant to this project specifically are ISO 9001:2000 Quality Management Systems (Requirements which provide systematic methods for managing all aspects of manufacturing a device), EN 1441:1997 Medical Devices (Risk Analysis), and EN 868-1:1997 (standardized packaging) [1].

In terms of economic constraints, the primary limitation is the allotted budget of $750. The device designed should be as affordable as possible, as it may hold potential to serving a larger population of senior citizens at some point. Families that require this device will vary in income levels. The solution will satisfy this fundamental condition.

The shampoo and conditioner identification device is essentially an adaptation of six buttons, combined with a voice-emanating mechanism. Striving for the highest quality; the group will design and assemble the device in manner with which it is economical to produce.

With reference to the environment, all measures will be taken to ensure that the device causes negligible or no harm to the surroundings. Specifically, this involves adequate disposal of batteries, and the waterproof nature of this system (to avoid leakage of toxic substances from the battery into the surrounding). Construction materials of the device will account for the client’s health and safety.

In terms of sustainability, the device will have to be capable of withstanding a variety of temperatures and a moist environment, which it will be constantly exposed to. Selection of appropriate materials for this device will be essential for corrosion resistant properties. In case of unintentional damage, the device must have accessible electrical test points for checking or repairing its operation.

Considering the properties of this device and its application, its manufacturing will involve a detailed consideration of each component. The
safety measures described earlier will be central to the manufacturing decisions. Other factors will be based upon ergonomics and client convenience. The group expects the circuitry and design to be relatively easy to replicate, in case a larger market opens up for this type of product.

In addition to using insulating and airtight material in a wet surrounding (to make the device shock-proof), weight is also an important consideration in eliminating burden while operating and reducing the chance of an injury. In addition, by utilizing low-voltage power sources, and making sure that all electrical components work according to the simulated model, the team will ensure that the working life will be optimized. Materials with rough edges or sharp protrusions will not be incorporated to abide by the underlying values, which is to guarantee the safety of the client.

There is one social constraint, which is that the device must be detached and attached to different shampoo/conditioner containers. This will require someone to periodically visit Mrs. Smith and do the needful. Therefore, a minute element of dependency on another individual still exists.

3. SAFETY ISSUES

The main safety concerns of the Shampoo/Conditioner Identification device are due to the unusual environment that it will be operated in - shower. The entire device will be casted with insulating material to prevent electric shock. The weight of the device is another critical safety constraint because it will be used in a wet and slippery environment. Hence, the device will have to be light enough to avoid potential harm. It will also be easier to maneuver if the device does not add excessive volume or weight to the shampoo and conditioner bottle.

The device has a lot of electrical components, so the reliability of these parts will be very important. The batteries which act as the power source of the entire device will need to be small yet powerful enough to prevent operational failure, which consequently may result in injuries to the user.

4. IMPACT OF ENGINEERING SOLUTIONS

It is clear that engineering solutions impact humanity at multiple levels, and can be seen in almost any activity carried out on a daily basis. Not only does engineering have the potential to transform the way in which humans live
their lives, but also advance knowledge and practices in a manner that is
insurmountable.

Based on an optimal design for the shampoo/conditioner identification
device, it is obvious that a significant impact can be made at a global level, for
clients with cognitive impairment, or reduced visual acuity. Memory loss is a
major symptom of patients with Alzheimer’s disease, a health condition that is
most common in individuals above the age of 65. At present, more than 5
million Americans are estimated to have Alzheimer’s disease. By the middle of
the century, it is estimated that 14.3 million Americans will have the disease.
Therefore, it is clear that a large market for this kind of device will develop
over the course of the next few decades.

In addition, this device may be used for patients with low visual acuity,
which may be caused by a disorder, or during healing time after ophthalmic
surgical procedures. Patients (especially those that are single) may need
temporary assistance in recognition of items within their household. Thus, a
device such as the shampoo/conditioner identifier will provide assistance in
doing so. The current project is catered to the identification of specific bottles of
hair products for use in the shower. However, it is definitely possible to
diversify applications using the same concept. A recognition device can be
used in the kitchen for beverage bottles or food containers.

When discussing engineering solutions in an economic context, it is
natural to analyze the market and customer base. Generally, a conservative
estimate is taken, in which it is projected that 10% of the customer base will be
using the product within five years of release. However, this may change
depending on company strategy and the method of marketing used. There
would be two customer bases, one that would need this device permanently
(individuals with Alzheimer’s disease), and post-ophthalmic surgery patients,
that would require it temporarily. Thus, it may be beneficial for a company that
was responsible for manufacturing and selling this product to have two
separate marketing and sales strategies. In the first case, the product would be
sale. In the second case, the product would be rented out to the consumer.
Depending on factors such as total costs, and the profit margins desired, a price
for both schemes could be determined.

However, it is necessary to evaluate whether this type of product would
be useful on a global scale (taking into account cultural practices). In
developing countries such as India, it would be hard to imagine this sort of
device being successful. In India, it is customary to see elderly parents living
under the same roof as their son and his family. It is also common to see
domestic help around families that are middle to upper class. Therefore, even if
this device was made affordable, the group feel that cultural norms would
prevent it from being a financially lucrative product to produce in this type of market.

In an environmental context, engineering solutions such as this do not seem to pose much of a threat. In terms of manufacturing a device such as the shampoo/conditioner identification device for a market of this size, the amount of pollution caused to the environment (land, air, water) is negligible in comparison to production of other products, in which harmful fumes or toxic wastes may be emitted. An optimal design plans to use a small voltage of 5 volts. This will be operated by a dc power source (battery). Inadequate disposal of the batteries is the only other cause of concern to the environment. However, it is unlikely that this problem will be significant enough to threaten natural surroundings in any way.

5. LIFE-LONG LEARNING

For this project, the majority of what the team has learned involved other peoples’ experiences in designing the same device. In spring 2007, one senior design group created a shampoo/conditioner identification device for the same client. However, their design did not meet the specifications of the client, and unfortunately, could not be utilized. Through comments from the adviser, reviews from the client, and research, the group have learned about what constitutes an excellent design and what sort of features can lead to problems.

Last year, although the previous design group incorporated a clever idea, it did not meet the expectations of the client. The instrument functioned in a manner that involved lifting the bottle off of a base, which then output an auditory signal. This was not what the client had asked for, since Mrs. Smith wanted to rely on a mechanical stimulus (squeezing the bottle) rather than having an adjunct base, for which she would need to find a vacant space in the shower. In addition, the device attached to the shampoo/conditioner bottle in order to make this work exceeded the weight limit, in terms of what was reasonable for the client to handle.

Primarily based on a critique of last year’s product from an engineer, the team has decided to eliminate the need for a base, by making the entire device fit on a customizable belt. In addition, the team has made sure to take the client’s exact request into considering, that is, the application of pressure to the bottle should result in the emission of an auditory signal.
In terms of new skills acquired, one of the team members is currently enrolled in the machine shop course at the University of Connecticut. The remaining two plan to take this course at some point over Christmas break. So far, this course has been helpful in learning how to cut and shape metal to various specifications. By emphasizing accuracy of design (to the nearest thousandth of an inch), the team is confident that this course will prove to be valuable, when it comes time to actually develop the device. Indirectly, these skills are also helping this semester, as it is possible to imagine which tools/instruments can be used to make a device of certain dimensions.

6. REFERENCES

[1] Tech Street:
http://www.techstreet.com/cgi-bin/detail?product_id=24975

[2] Parallax Incorporated

[3] RC Systems
**Backpack Lever Arm System**

**1. ALTERNATIVE DESIGN PROJECT #1**

**1.1 Introduction**

For individuals with physical limitations, which may be caused by debilitating health conditions, innovative biomedical devices can be used to aid them in carrying out certain tasks. The client’s specific symptoms have resulted in an increased dependency on others; he desires to be more self-reliant in terms of accessing his possessions without external assistance. Specifically, this refers to being able to place and remove objects from his back pack, which is usually attached to the wheelchair.

Similar to the initial design, the backpack lever arm be designed to take advantage of the client’s functional right arm. However, it will be different in the manner in which the backpack is moved towards the client’s midline. This involves a different mechanism of motion, and does not utilize some components of the initial design, such as the motorized wheel. In addition, the device will be stored and folded (in entirety) at the back of the wheelchair. In comparison to the initial design, the current alternative has a potential to be more convenient in terms of usage. This refers to the fact that there will be no peripheral obstacle (as well as visual hindrance) to the client even during times that the device is not being utilized. One aspect to take into consideration is that this design will require a greater amount of space around the client (for functional operation as well as the safety of others).

The foldable arm will involve one hinge joint at an appropriate position on the arm to allow for horizontal planar motion. The arm will have one joint, connecting two limbs. One limb will remain attached to the back of Mason’s wheelchair (at a height level that approximately 6 inches above that of his armrest). The first movement will involve rotation about one hinge to bring the moving limb in a position that is perpendicular to the client’s armrest. At this point, the backpack will be to the right of the client, above his armrest. A metal piece at the center of the moving limb (to which the backpack is attached) will move in and out (perpendicular to the arm) to bring the backpack close to the client’s midline. This refers to the upper-abdominal – lower-thoracic level. This will serve as the final position of the device. From here, the client may remove or place belongings as he wishes.

To describe the functioning of the device in sequence, it starts with a user stimulus. When Mason wishes to obtain items from his backpack, he will
turn Switch 1 located on a wireless remote controller (which is attached by a Velcro strap to his right arm chair). The limb that is not physically attached to the wheelchair will rotate about a hinge, 270 degrees in a counter-clockwise direction. Once it has reached this position, it will be parallel to the client’s armrest, but a certain distance away from his midline (to the right of his body). Once the arm has reached its final position and locked into place, Mason will turn Switch 2 to have the perpendicular metal piece with the attached backpack move outwards, bringing the backpack to the client’s desired position.

Once he has removed/replaced the desired items from his backpack, Mason will turn Switch 2 on the wireless remote control. This will reverse the movement of the perpendicular piece. Finally, he will turn Switch 1 to rotate the collapsible arm about the hinge (270 degrees) in the opposite (clockwise) direction to attain a folded position.

**Figure 1. Flow Chart for device operation**

### 1.2 Subunits

**Figure 2. Circuit Diagram of the Complete Backpack Arm System**
1.2.1 Motor

The motor that will be used to rotate Limb Two around the Hinge is a stepper motor. It is the 10A-TTL-3SW-42 by Excitron. This motor is very versatile and will allow us to make precise movements without the need of an angle measuring device. This motor moves .9 degree per step. The motor also comes with a controller so it will allow for careful manipulation of the angles needed.

![Figure 3. Schematic of the Step Motor (10A-TTL-3SW-42) [4]](image)

1.2.2 Lever Arms

The foldable arm will involve a single-hinge joint at an appropriate position on the arm to allow for horizontal planar motion. The arm will have
one joint, connecting two limbs. Limb one will remain attached to the back of Mason’s wheelchair (at a height level that approximately 6 inches above that of his arm rest) and the other (Limb Two) will rotate to the right side of the wheelchair. The backpack is attached to a short rod that is hidden inside of free rotating limb. It will be fastened via an attachment accessory, such as a clipper.

To describe the functioning of the device in sequence, it starts with a user stimulus. When Mason wishes to obtain items from his backpack, he will turn Switch 1 located on a wireless remote controller (which is attached by a Velcro strap to his right arm chair). Limb Two will rotate about the hinge 270 degrees in a counter-clockwise direction from the back of the wheelchair to the right side. Once the limb has reached its final position and locked into place, Mason will turn Switch 2 to have the rod to bring the attached backpack to his midline via a perpendicular motion to the second limb.

Once he has removed/replaced the desired items from his backpack, Mason will turn Switch 2 on the wireless remote control. This will reverse the movement of the rod and bring it back inside of Limb Two. Once this has been achieved, Mason will turn Switch 1 to have the collapsible arm rotate about the hinge 270 degrees in the opposite (clockwise) direction to attain a folded position.

The followings are visual representations of how the device is supposed to function. Figure 3 illustrates the Lever Arm System and its rotation mechanism. The upper block diagram indicates the movement to bring the backpack from its initial position at the back of the wheelchair to the front – to the client’s mid-body level. The lower block diagram shows how, upon stimulus, the backpack returns to its initial position behind the wheelchair, followed by folding of the arm into a convenient and ‘collapsed’ position.
Figure 4. Rotation Mechanism of the Lever Arm System
In terms of exact location and of the device, dimensions of the client’s wheelchair, the Quickie-500, must be taken into account. The seat has an adjustable width of between 12”-14”; the depth of the seat is adjustable between 10”-15”. Taking these figures into account, it becomes easier to specify lengths of the individual arm components. In this design, the first limb of the arm, which is attached to the back of the wheelchair is 14 inches in length. Limb Two will be about 15 inches in length and 4 inches in width. The rod that is hidden inside of Limb Two will be 4 inches in length, and when it moves out, it is capable of bringing the backpack close to Mason’s mid-line. The height of these steel rods (used to form the limbs) will be 2 inches.
The foldable arm itself will be made of low carbon steel because of it is light, malleable and inexpensive. These properties are extremely critical because the addition of the device should not affect the balance of the wheelchair. The project has a relatively low budget of $750, therefore the inexpensive nature of low carbon steel is also important.

1.2.3 Wireless Remote Control

As the instrument is user-controlled, it requires an input from the user. A remote control with the two separate switches will be incorporated in the design. It will have wireless technology, so it can be put on any part of the wheelchair that the client finds comfortable. This will involve a wireless component to the design, as separate signals will be sent from the switches (on the remote) to the rotational arm as well as the motor. In creating a wireless interface, the team plan to use a BlackFin® Processor from Analog Devices, as well as LabView to enable this technology. The majority of the work will occur in creating a wireless transmitter.

1.2.4 Clipper

The H.B. Clipper Quickdraw will be used to hold the backpack in place. In addition to being capable of supporting a heavy load, this will enable convenient attachment/detachment of the backpack in case there is a need. In terms of materials, the clippers are made of stainless steel, which is corrosion-resistant. This will improve the safety and product life the device. The two clippers are connected by a strong, 13 cm nylon string. Since this device is meant to be used for climbing, it is capable of handling various degrees of strain, as well as different climatic conditions. This durability will prove to be a positive feature of the device. In addition, it is essential to realize that the H.B. Clipper Quickdraw is light in weight, and will not significantly add to the weight of the entire device. It is a mere 4.8 oz, which is great when attention is directed to the amount of strength that it adds to the entire system.

In terms of the exact location on the backpack lever arm, the H.B. Clipper Quickdraw will be placed on the metal piece, moving in and out of rotating limb. One clipper will be used to attach the backpack whereas the other will be used to attach to the metal piece.
1.2.5 Supports

The supports used to attach the device to the wheelchair are a vital part of the system. It is absolutely necessary that they be placed at locations in which the moments can be minimized. In addition, materials that form the support must possess high mechanical strength. After an analysis of the client’s wheelchair (based on pictures sent by the client’s family as well as a review of on-line information posted by the manufacturer), it seems that two supports are optimal. One will be placed around the ‘Tilt-In Space Mechanism Release Lever’ at the back of the client’s wheelchair, whereas the other will be placed through the vertical adjustment holes at the right-hand side. If the wheelchair needs to be adjusted, the support can be removed and a height that the client feels is appropriate.

The first support (attached to the back of the wheelchair) will allow the arm to collapse and fit comfortably in a manner that does not cause any physical hindrance or obstruction to the client. The second support (located in the adjustment holes, which is used for the adjustable armrest clamps) and the
rotational hinge will be subject to the greatest moment, due to the distance which the backpack will travel from that area.

![Figure 7. Tilt-In Space Mechanism Release Lever](image)

3. REALISTIC CONSTRAINTS

In today’s day and age it is not enough to just build an object, but the group also must take into account the affect it has on its surrounding. Engineers are instructed to make sure that the products they design meet specific standards. Above all else their creations must do not harm. They must also be efficient and affective for the potential users. In order to ensure that
new products on the market adhere to all of the requirements there are engineering standards that are predetermined.

These guidelines are setup up by the government and engineering organizations. Some of organizations that specializing in creating and monitoring engineering standards include American National Standards Institute (ANSI), American Society for Quality (ASQ), Association for Advancement of Medical Instrumentation (AAMI), International Organization of Standardization (ISO), and National Institute of Standards and Technology (NIST). The approval of these groups is vital in the potential market reaction to any new product.

For the Backpack Lever Arm System this means that it must meet all the standards of any product on sale today. Since this is not just a prototype that will be used for testing, but instead a device that will directly impact the life of another person it must meet or exceed the benchmark that consumers have come to expect. The most relevant standards that this project must meet are specifically the ISO 9001:2000 Quality Management Systems (Requirements which provides systematic methods for managing all aspects of manufacturing a device), EN 1441:1997 Medical Devices (Risk Analysis), and EN 868-1:1997 (standardized packaging). However, these are not the only constraints that have been put on or project [5].

In terms of economic restrictions, the primary limitation is the allotted budget of $750. The device that we plan to create must be affordable because it may hold potential to serve not only Mason, but other people living with cerebral palsy. The consumer market for a product such as this will greatly vary in financial flexibility. So the challenge is to design a device that is both effective and cost conscious. In this way the team will ensure that the product will have a wide consumer bas.

The device is essentially an electrically operated mechanical limb, capable of moving Mason’s belongings to an accessible position. Given that the group is combining two types of engineering into one device we must take care to ensure that these vastly different fields mesh together properly. This is not an easy task as there have been many instances where the outcomes of endeavors such as this have been less than ideal.

Given modern understanding of the impact humans have on the environment, all measures will be taken to ensure that the device causes negligible or no harm to the surroundings. For the device specifically, this involves adequate operation and disposal of batteries. It also means that materials used to build the device are recyclable and are safe for not only the
client, but the environment he plans to use the device in. Since this device will be operational in a school surrounding, construction materials and design will account for the client’s health and safety as well as those around him. In terms of sustainability, the device will have to be capable of withstanding a variety of mechanical loads and weather. This device will travel with the client everywhere, which means that it must operate without fail in any condition. Given that the intended family lives in Canada, withstanding different weather conditions will be vital for long-term functionality. The prevention of corrosion and weathering by selection of appropriate materials for this device will be essential. In case of unintentional damage, the device must have easily replicable parts and must also go into a fail safe mode in which it can cause not harm anything it comes in contact with.

Considering the properties of this device and its application, its manufacturing will involve a detailed consideration of each component. The safety measures described in the previous paragraphs will be central to the manufacturing decisions. Other factors will be based upon ergonomics and client convenience. Although the circuitry may be easy to replicate, the actual design should have the ability to be customized to each client’s physical conditions.

In addition to using insulating material (to prevent shock in a wet surrounding), weight is also an important consideration in eliminating unnecessary strain on various components while the device is operating. This will not only reduce the wear but also go a long way in reducing the chance of injury. In addition, by utilizing low-voltage power sources or even the wheelchairs own battery the team will ensure that the working life will be optimized. By making sure that all electrical components work according to the simulated model, the team can safely recommend the use of the device. Materials with rough edges or sharp protrusions will not be incorporated to abide by underlying values, which is to guarantee the safety of the client.

There is one social constraint, which is that the device will need to be lubricated periodically to ensure smooth functioning of incorporated joints. This will require someone to visit or client and carry out normal maintenance. However, the group feels that this should not be much of an extra burden because any electric wheelchair typically requires this type of servicing. Therefore, only a minute additional element of dependency on another individual will have to exist.
3. SAFETY ISSUES

Due to the nature of the environment in which the device will be utilized, and the unique requirements of the client, the safety of the device must be ensured. Both mechanical and electrical components need to be extremely reliable. The device might be exposed to rain or many other unexpected weather conditions, thus an insulating material will be used to prevent electric shock and corrosion. All the sharp edges that the device might have will be covered with soft material to avoid potential injuries to both the user and surrounding people. Since the device will be operated in a school setting where it is crowded, the range of operation is limited. The rotation mechanism of the Lever Arm system requires a relatively large space, therefore the free rotating limb needs to be light weight and as short as possible. The wireless technology is also very essential because Mason has to have full control of the device at all times to prevent possible harms and damages to him and others.

4. IMPACT OF ENGINEERING SOLUTIONS

Obviously any engineering solution that has been developed throughout history impacts humanity in many ways. These solutions are used so frequently that the group can forget how much of they affect daily lives. In the modern age not do new products have the ability to make life easier, but they also are a testament to the technological advances that have been made in time.

With an ideal design for the backpack lever arm system a huge difference can be made in the client’s quality of life. However, the impact can stretch much further to change the life of his family and potential many other individuals living with cerebral palsy. This global influence can even encompass persons with varying levels of cognitive impairment or physical limitation. There are close to 100 million people with disabilities living in America today [1]. Of those roughly 500,000 have cerebral palsy.

Involuntary movements and poor motor skills are the typical symptoms of cerebral palsy. At present, about 2 out of 1000 children born in this country have some form of cerebral palsy [2]. The trend is slowly decreasing, but the trend is still prevalent. Therefore the need for a device such as the one purposed in this text would greatly benefit this community. How every this device can be implemented by anyone who uses a wheel chair and has trouble with manipulation of heavy objects.
This device will bring independence to any client who wants it. Clients who live by themselves will benefit from the ability to transfer objects to a position where they can use them. The current project will be catered to or specific client and will be used to move a backpack to a comfortable position for him. However, it is definitely possible to diversify applications using the same basic concepts. A transfer device can be used in the home, office, workplace, or educational facility.

When discussing engineering solutions in an economic context, it is natural to analyze the market and customer base. Generally, a conservative estimate is taken, in which it is projected that 10% of the customer base will be using the product within five years of release. This means that the potential number of clients for the product will be somewhere in the range of 50,000 people. This number may vary depending on the way that the product is marketed. As stated before the customer bases for the device should be quite extensive because of the potential applications. Depending on factors such as total costs, and the profit margins desired, a price a proper marketing approach could be decided upon.

The next step in to look at when bringing a new product to consumers is the global potential. The main issue to consider is financial flexibility of people outside the economy. This problem however, should not be too detrimental as the estimated cost for the project will certainly be less than $750 US. This is a price that should be relatively affordable for a majority of people outside the United States. The last impact that needs to be addressed is that of the environmental aspect.

In an environmental context, engineering solutions such as this do not seem to pose much of a threat. The materials planned for this device are all either made from recycled material are themselves recyclable. There is also no extra environmental concern about batteries since we plan on use the battery already implemented on the wheelchair. An optimal design plans to use a small voltage of 12 volts. Therefore, it is unlikely that this problem will be significant enough to threaten natural surroundings in any way.

5. LIFE-LONG LEARNING

Life-long learning is a process that every individual experiences, whether by choice, or sub-consciously. It has the potential to strongly influence one’s perspective; here, what we learn through research and the input of others can significantly impact decisions that are made with regard to design.
Based on input, questions, and suggestions after the first round of senior design presentations, we have decided to modify certain features of the backpack arm. The most important feedback involved how to design the instrument to function according to the proposed sequence, from the wireless controller to the final movement of the backpack.

Initially, the team had decided to use LogicWorks to create logic circuit to incorporate into the design. After advice to pursue another method of control, we have decided to use a pic-microcontroller for ease of design. This should help the group in terms of being able to effectively control various components of the device. The pic-microcontroller also eliminates the need to work out how logic components can be incorporated into a small circuit design. Therefore, relying on the experience of the design adviser and teaching assistant, the team has chosen the option of using a pic-microcontroller.

The team also received input that having one switch control the device is better than two, so that the client does not have to work with separate components, or remember what specific switches correspond to. Although the team understand the implications of this suggestion, the group wish to give the client greater control over the device. Rather than having a single switch and one complete motion through which the backpack moves from the rear of his wheelchair to the front, the group believes that the client should have the option of keeping his backpack in close proximity, but not all the way at his midline. This way, if the client merely wishes to get something from a side pocket, or keep valuable possessions within his sight, switch 1 can be kept (on) and switch 2 can be left (off).

In addition, the team feels that the client will be able to handle two switches since he has sharp cognitive skills, and a fully functional right arm. However, in the future, if correspondence with the client indicates that one switch would be optimal, there is a provision to change the design.

The team also learned that safeguards should be incorporated in case the client turns switches in the wrong direction. However, since the movement of the device is bi-directional, the team don’t think this should be a major concern. The device can only move in one of two directions; if the client sees that the device has moved in a direction that was not desired, this could easily be corrected by turning the switch in the opposite direction. There is no potential form harm. One aspect to take into consideration is if the client does not turn the switches in the correct order. If switch 2 is the first to be turned on, then the piece that moves perpendicularly to the moving limb will cause the backpack to protrude out from the back of the wheelchair. Although this is not of any hazard to the client, sufficient space at the back of the wheelchair will be
required to avoid physical contact with individuals within close proximity. This is currently being investigated by the team.

6. REFERENCES

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