STUDENT PROPOSALS FOR THE DESIGN OF ELBOW ORTHOSES FOR MR. B AND MR F.

ENGINEER 1P03, Fall 2012 — Engineering Profession and Practice
Professor Robert V. Fleisig, Ph.D., P.Eng.

McMaster University
ENGINEERING

Abstract

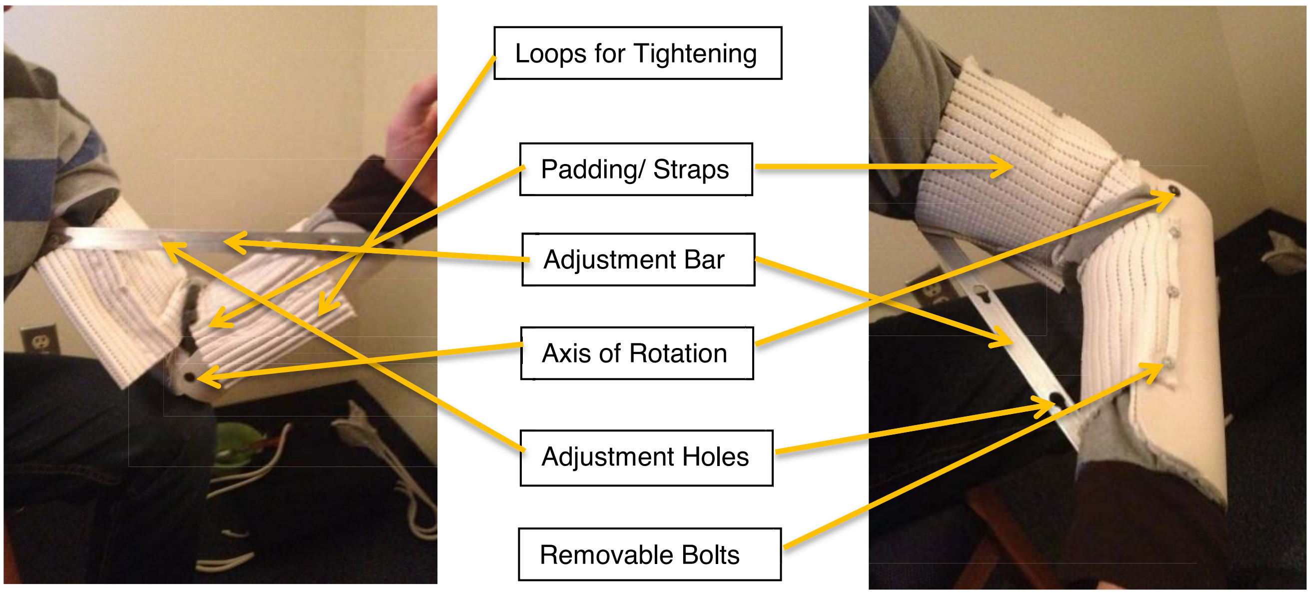
Engineering Profession and Practice (ENGINEER 1P03) is a term-long course for first year engineering students at McMaster University. The course introduces the engineering profession, and includes ethics, health and safety, sustainability, design skills and team skills. The course is taken by every student in Engineering 1 (Level 1 Engineering). In 2012, there were 811 students enrolled in the course.

Each year the course culminates in a final design project where the students work together in teams of four or five to design a solution for a problem for a real-world client. The project lasts six weeks, and a two-hour tutorial session is dedicated each week to team project work. In addition to the in-tutorial work, approximately twelve lecture lessons are used to support the project, and include presentations by users, stakeholders and specialists.

In 2012, the student teams designed elbow orthoses to assist clients of the Hand Therapy Clinic, Hamilton General Hospital. The students worked in their teams to define the problem, generate the objectives and functions of the design, create a list of design alternatives and build a working prototype. The teams then presented their design and justified their choices, with the best projects presented in front of the client and faculty members at the annual showcase. This document is a compilation of abstracts belonging to the entire class.

Project F Elbow Orthosis

Brachio Forti
F01 - T01 – 1



Problem Description

Tara Packham an occupational therapist from the HHSC Hand Clinic at the Hamilton General Hospital, has a patient codenamed “Mr. F” that has suffered serious burns on his upper back, arms and face. Tara requires a relatively inexpensive and specially tailored elbow splint that is engineered for the use of the patient. The burns have caused the user to develop heterotrophic ossification (fusion of the arm bones at the elbow) thus restricting the range of motion in his arm. The patient has undergone surgery but he has not regained his full range of motion. As well, the patient has difficulty applying force with his fingers and hand. In addition, the user has very sensitive skin that blisters easily from straps or any pressure on the skin. Moreover the user would like to remain as independent as possible with the use and adjustments of the splint. Thus, the design will be constructed according to the user’s needs.

Design

Our design (as shown above) is composed of a pivoting 2 piece shell. The first piece for the upper arm goes along the tricep just below the shoulder and connects to the forearm part that extends to base of the user’s hand and pivots on an axis at the elbow. The orthosis is made of thermoplastic and insulated with padding for comfort. The total orthosis is extremely lightweight as there are no heavy adjustment tools. The size of the shells depends on the user’s arm size as the thermoplastic is to be molded to their arm. The straps and padding are completely removable for cleaning and the adjustment bar is to be attached on the inside of the injured arm connecting the 2 shells of the orthosis, which will allow the user to apply the splint without having to reach over his arm.

Functionality
Our elbow orthosis will allow the user to apply a force in order to go through a variety of adjustments of flexion and extension. The unique slide and lock system allows the bar to lock in place therefore locking elbow.

Materials, Components, and Assembly
One of our goals for this project was to try and make all of the materials used in building, ones that we knew the hand clinic already had or could easily acquire. That is why all of our materials were purchased at the dollar store or home hardware. This makes not only our materials extremely basic but also the assembly of our device. The total assembly was built in approximately 2 hours, however we could easily see how this could be reduced with more practice and knowledge of the materials (thermoplastic). Because of our device's simple design our orthosis can be made basically on intuition, and with the experience that the hand clinic's OT's already have this should be extremely easy. The only part of our device that cannot be found at the hand clinic is the metal bars that we use to adjust the users arm. However, these bars are fairly easy to make and once they are manufactured they can easily be transferred from patient to patient as they are removable and don't need to be specific to a user.

Cost
One of the most important aspects of design is cost, as it can be the deciding factor in a good design and one that isn't reasonable. For our elbow splint the total cost was around $80.00. However, the largest component of this was spent on the large sheet of thermoplastic that we purchased that could very easily be used to build multiple splints. This cost was almost $70.00 in comparison to the $10.00 we spent on the remaining supplies (nuts, bolts, straps, padding, and metal rod).

User Acceptance and Compliance
The only way to improve the user's range of motion (ROM) is if the user wants to wear the orthosis. For our user we wanted to make the splint as comfortable as possible while still being able to provide enough force to increase Mr. F's ROM. Our splint allows the user to be fully independent, as he is able to take the orthosis on and off by himself in a relatively short time. As the user has very sensitive skin our split is padded 360^0 around the users arm as our straps are made out of the same material as the padding used on the inside. We understand that the burns on our user also pertain to their back on the other side. This is why we have made the adjustment tool on the inside of the arm so the user doesn't have to reach over to the outside in order to adjust. Also we have taken into account the application of the splint and this is why our straps have large loops that the user can slide his fingers into instead of having to pinch and pull a strap over Finally, the slide and lock system eliminates the risk of the bar falling off and possibly harming the user. For the cosmetic part of the splint we have also designed a second bar that is shorter so once the arm reaches a specific magnitude of flexion the large bar is replaced with a much shorter one that eliminates the large portion of bar sticking out.

Benefits
Although marketability is not an aspect of our project the elbow splint must be something that the client wants to use and sees the need and the use of the splint. What sets our splint apart from the others that are available is its simplicity. We wanted to make a splint that was able to meet the majority of the user's needs without 'shooting for the stars' and designing something that worked but wasn't feasible in our design space. This is why our elbow design uses the adjustable bar as it doesn't require Mr. F to apply force to a small area. For this same reason we also have added loops to tighten instead of the conventional way of pinching and pulling the straps over. From prior experience we also thought of the maintenance aspect of the splint. This is why our straps and padding are removable making our split 100% cleanable to avoid bacteria spreading and odour. From our simple but unique 'slide and lock' system the user doesn't have to apply force in a small area, which would irritate his sensitive skin.

Mosthis Orthosis

Team Name
F 01 - T 01-2

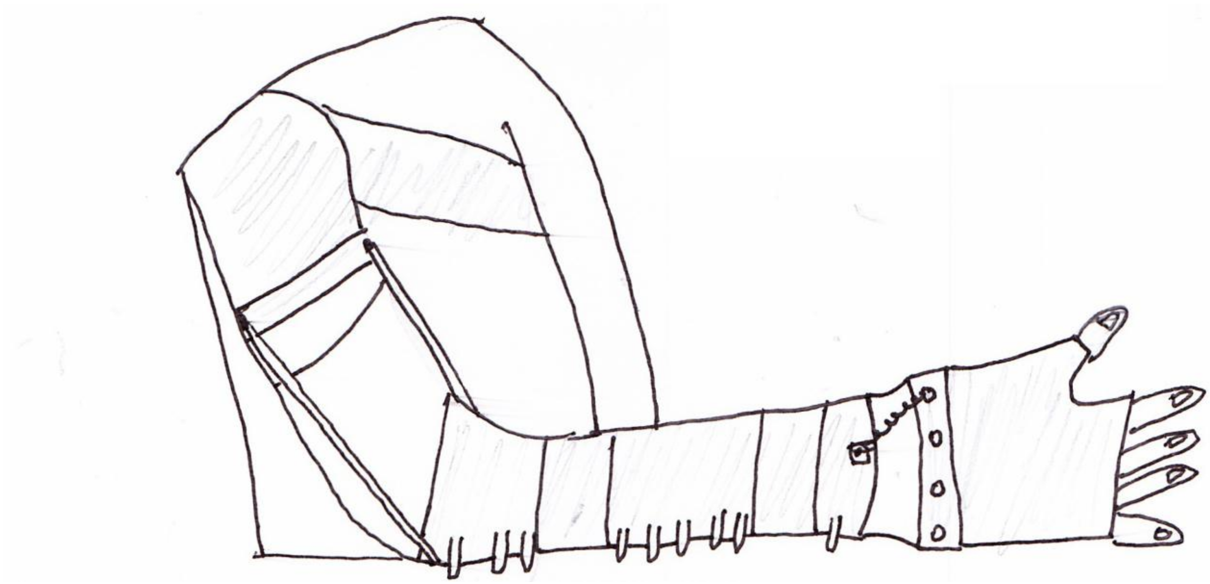


Fig. 1 Final design drawing

Problem Description

The team was presented with a problem from Mr.B, a motorcyclist. Mr.B has recently been injured in a motorcycling accident resulting in severe deformities to his right arm. Mr.B's dominant hand is on his right arm resulting in constraints to his daily life as he cannot fully operate due to his injury. Mr.B currently uses a sling to hold his arm up as his shoulder suffered a number of lacerations; therefore it cannot fully support the weight of his arm. Mr.B also experienced degloving of his hand which was partially resolved by a skin graft. Mr.B wants to be able to supinate, pronate, and extend his arm by locking it at different positions. He also wants the orthosis to be allowable in prison in case he is incarcerated. Mr.B wants to be able to adjust the device by himself as his left arm is in perfect condition. The device should accommodate different forms of ROM such as vertical, horizontal and rotational motion in order to perform a multitude of different tasks and increase his control over his finer movements. The device should not disassemble easily as it should not be weaponizable which is more likely if the device can be disassembled quickly/easily by others. Optimally the device could be used by other citizens in a similar situation where they are being either incarcerated or have a similar problem with their shoulder. The client, Tara Peckham, has stated that the device should also be feasible to construct in the hand clinic and at minimal cost.

Design

The final design is composed of three main parts that assemble into the brace. The first part is about the wrist where a thermoplastic surrounds the hand below the fingers but above the thumb. On this piece there are circular raised sections going around the whole of the piece. These raised sections or bumps will be where the user attaches the spring to in order to cause supination and pronation. The next section is the forearm brace which extends from just below the wrist until just before the elbow encompassing the arm. At the section near the wrist a spring will be attached to the brace with one end of the spring free to attach to the first section's notches. This will be how supination and pronation occurs. The remainder of the brace will be built with a thin thermoplastic that will have Velcro straps that allow for adjustability. The interior of the brace will be lined with foam to ensure comfort. On the opposite side to of the brace (when the arm is in anatomically correct position) hooks will be built to allow for the bungee cord to be attached. These hooks will also be made of thermoplastic. The final section attaches to the bicep region of the users arm and then surrounds the upper torso and underneath the opposite shoulder in order to relieve pressure from the brace. On the bicep a thermoplastic will encompass a small section secured with Velcro. This part will have a bungee cord extend from a hook on the upper brace (made of thermoplastic) to the hooks on the forearm brace. This will be how flexion and extension are performed. Cloth straps extending from the bicep region of the brace will then go about the torso and underneath the opposite shoulder in order to relieve the pressure from the arm.

Functionality

The final design accomplishes the majority of the problems the client wanted solve. It performs flexion, extension, supination and pronation. The only thing the design lacks is the absolute guarantee that it is non-weaponizable.

Materials, Components, and Assembly

The client would need to purchase thermoplastic, Velcro, bungee cord, a spring (or multiple springs of different tension dependant on the progression of the user) and a cyanoacrylate (superglue). Thermoplastics can be bought from specialists. The remainder of the materials can be bought from any Home Hardware store. To create the device it would take a single person roughly two hours to produce the brace. There are three main steps for the creation of the brace; mold the thermoplastics, glue the Velcro and assemble the device. To mold the thermoplastics they would need to be done in three different sections (bicep, forearm and hand). The thermoplastic would need to be molded to the user's arm and then any additional parts would need to be accounted for (ie. hooks and bumps). The Velcro would then need to be attached to the device. A single piece of Velcro would be placed on the bicep region that secures the thermoplastic to the arm and the cloth serve to relieve tension/weight from the arm. Velcro would also be secured to two parts of the forearm brace one near the elbow and one near the wrist. Tools required for to create this would be a utility knife to cut the Velcro and thermoplastic, scissors to cut the thermoplastic and a method for heating the thermoplastic. The device is adjusted by the user by having the molds of the thermoplastic specialised for them and then having the Velcro straps for any further modifications. The user should be instructed to use it for daily use and for supination, pronation, flexion and extension.

Cost

The approximate cost (1 full sheet of thermoplastic), spring, Velcro and cloth is just under 100$.

User Acceptance and Compliance

The user has been considered so that the brace is comfortable, relieving pressure from the shoulder and the padding thereby increasing compliance. The user puts it on in three sections working from the top (shoulders) and then down; this is reverse to take it off. The user uses it by adjusting the degrees of motion about the wrist/forearm and the flexion/extension. Cosmetically, the final design is not ideal as it still looks very much like a brace, but is cleaner looking due to high quality materials. The main safety concern is in the weight of the shoulder which has been taken care of through the effort to relieve tension/weight from the shoulder. From our objectives tree, every objective has been met with this design.

Benefits

Our design is better as we considered and solved the problem with supination and pronation.

The Rigid Feather

DWLP Engineering
F 01 - T 01 - 3

Problem Description

The problem presented to DWLP Engineering involves Mr. B who was recently involved in a motorcycle accident. As a result he experienced a compound fracture in his right arm, and a subluxed right shoulder. The client is also unable to move his arm due to a torn brachial plexus. However, his elbow is still fully functional when assisted with his left arm which was undamaged in the accident. Tara from Hamilton General Hand Clinic has asked the team to try and produce a dynamic elbow orthosis for this client. The devices which are previously available are either too expensive or do not fit the specific needs of this client (i.e. do not account for subluxed shoulder). This device must be able to lock the client's arm at any given angle, and the device is to be used indefinitely in order to support his elbow while his nerves and muscles repair. Mr. B must also be able to put on the brace by himself as he lives alone.

Design

The Rigid Feather by DWLP Engineering consists mainly of two (2) thermoplastic braces, one for the bicep and one to be formed to fit the forearm; and two (2) custom fit aluminum shafts. The design offers very easy adjustment by simply loosening the wing nut, moving the arm to the necessary angle and tightening the locking mechanism. The elbow orthosis will weigh approximately 0.7-1.1 kilograms (1.5-2.5 lbs) depending on the type of thermoplastic chosen by the client. The final design will be three-quarters of the length of the clients forearm starting at the wrist, which is shorter than shown in the image above. However, the rest of the design is the exact same as the above diagrams, the bicep brace is molded to fit the clients bicep, and the length of aluminum will be unique to every similar case.

Functionality
The Rigid Feather is a lightweight design made specifically so that it would not be physically taxing on the clients subluxed, and repairing, shoulder. The elbow orthosis is able to immobilize the clients arm throughout a full range of motion. The design also allows for both pronation and supination of the wrist as the client had asked.

Materials, Components, and Assembly
What materials and components does it require? The Rigid Feather consists of the following components all available at the local hardware store:

- 1, 6" Holed Aluminum Shaft
- 1, 4" Holed Aluminum Shaft
    - The hardware store will cut these for you
- 2 pieces of Thermoplastic
- 2 lock washers
- 1 Round Headed Bolt
- 1 Wing-Nut

All that is necessary to construct this simple, yet effective, design is a single adjustable wrench. The design takes approximately 10 minutes to construct, including the time needed to mold the thermoplastic. While molding the clients thermoplastic braces, place one of the aluminum rods into each plastic thereby forming a single component, this will make the device both more comfortable and simple.

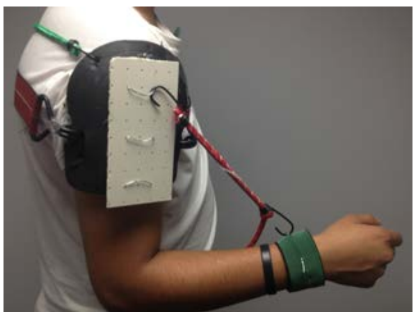
Cost
The total assembly cost for the prototype of the Rigid Feather was approximately $20. However, the final product would be able to be produce costing less than $15 to the hand clinic.

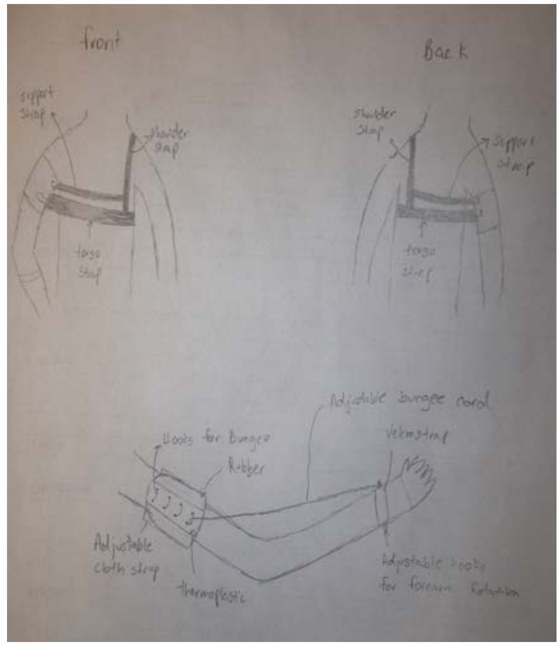
User Acceptance and Compliance
How has user compliance been considered? Mr. B has two options when removing and applying the orthosis. The first way being the more simplistic of the two, simply straighten the device and slide over his arm until he reaches the designated spot for his brace. The other being to remove the wing-nut, separate the device into its two components, and slide them on individually. The ability to get the device on and off in multiple ways is very convenient and only adds to the comfort of the design. Also, because the device is molded to the clients arm with thermoplastic it will be a perfect and comfortably fit each time. There are only three steps in order for the user to adjust the angle at which he/she needs: first, loosen the wing-nut, next, adjust angle with left arm, and then simply tighten the wing-nut again. Because of the highly effectiveness and ease-of-use of The Rigid Feather, the client will absolutely want to use this orthosis. When wearing this design, it not only acts as an elbow orthosis, but also as a brace for his healing compound fracture. Although this was not a stated objective, it is an added benefit which the client will be glad to have.

Benefits
Cost, comfort, ease-of-use, safety, dependable, and effective. These are all areas at which The Rigid Feather excels in. Because of this high level of success in said categories, it makes this orthosis the only choice for Mr. B. There is no existing design which treats a subluxed shoulder and compound fracture like The Rigid Feather does, and that is what makes it superior to all opposing orthosis.

Bungee Orthosis

CAN-ENG
F 01 - T 01 - 4





Problem Description

Tara Peckham, from the Hamilton General Hand Clinic, sees many patients on a daily basis who each have their own specific needs. Among her patients is Mr. B, whose problem is of a unique nature and requires special attention. Mr. B is a 23 year old male who has severely injured his right arm. His right arm suffered a compound fracture dislocation of the shoulder, a degloved wrist with tendon and nerve lacerations, and severed the brachial plexus. His elbow joint remains functional, and his wrist and finger muscles are still responsive, but his shoulder has very few working muscles and has an incomplete joint that is unresponsive to nerve impulses.

Mr. B is also awaiting trial for drug possession and in the event he is incarcerated the device should be not be able to conceal a weapon or become a weapon itself.

Tara has also made it clear that Mr. B would like the brace to avoid adding additional stress to his shoulder. Mr. B would also like for the brace to be able to adjust its angle in order to accomplish different activities, as well as lock those different positions.

Design

In order to stabilize the subluxed shoulder there is a shoulder pad that is connected to the injured shoulder with a strap. On top of the shoulder pad there is a piece of thermoplastic, with multiple hooks attached. The shoulder pad is connected to a strap that goes around the torso, under the left armpit, and connects to the back of the shoulder pad. There is a second strap that is connected to the torso strap at its front and back by going over the left or stable shoulder. The hooks of the thermoplastic are connected to the hooks on the forearm strap, with a bungee cord as shown in the images provided. Device comprises of lightweight materials with almost no metal and limited plastic pieces and hence weighs less than a kilogram. The main components of the device are concentrated at the upper arm and shoulder and the device's entire length spans about three-fourths of the arm.

Functionality

The splint can lock at various positions to let Mr. B use his hand, as well as vary the forearm rotation. The splint is very light weight and takes into account his already subluxed shoulder. He can also work on active assisted range of motions (AAROM) due to the elasticity of the bungee cord.

Unfortunately, the design can be weaponized. The bungee cords can be used in as a weapon, ex. strangling. If he were to be incarcerated, the splint would not be permitted in general penitentiary.

Materials, Components, and Assembly

The device requires one foam knee pad with one 7"x3.24" thermoplastic pad and five straps material can vary and multiple hooks made of plastic. They can be obtained from dollar store and home depot. Equipment needed is glue gun, pliers, scissors and an X-acto knife. It takes a maximum of 2 hours to fully construct the device. Begin by inserting hooks into the thermoplastic piece and mount it on the foam pad. Then connect the four straps in a manner as seen in the images above. Hooks are then inserted onto the forearm strap and those hooks are then connected to the hooks on the thermoplastic through a bungee cord. Basic understanding of cutting thermoplastic is necessary.

Cost

The bill of materials for the entire device is $21.79, including taxes.

Breakdown of materials and prices:

7 x 3.24" of thermoplastic:	$4.29
4 Velcro Straps:	$8.00
2 Cloth Straps:	$4.00
4 Bungee Cords:	$1.00
Knee Pad:	$2.50
Flexible Steel Wire:	$2.00
Total cost:	$21.79

All materials are readily and easily available at Dollarama.

User Acceptance and Compliance

Design was built to be used by the client for his daily activities. Hence, it was designed so that it could be worn on top of his clothes so that he could use the splint without his clothes restricting the motion of his arm.

The splint has only two easily removable pieces that can be attached using a single arm.

The device was designed to be comfortable by minimizing number of components and padding was used to maximize comfort. The user puts the device on by wrapping the Velcro straps around his arm and securing it, along with the torso strap and green bungee strap that are secured at the front of the pad. The user then secures the Velcro wrist strap onto the forearm and connects the shoulder component to this strap by attaching a bungee cord onto the desired hooks to bend his elbow to a certain angle and allow forearm rotation.

The bungee cords, cloth straps, and thermoplastic come in varying colours for personalization.

The design is very safe due to the simplistic nature of the device. There are no moving components or sharp edges, and the device is padded where it makes contact with skin or clothing.

The simplicity of the device helped meet objectives of comfort and cost effectiveness. The minimum number of components and inexpensive materials used helped reduce cost for the client and user.

Benefits

Our design is cheaper, lighter, and easier to use than existing designs.

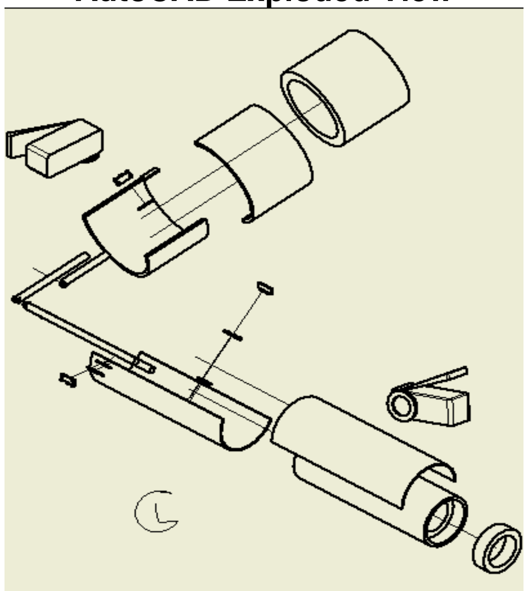
Our design weighs less than a kilogram and costs less than $25 to build, this is exponentially lighter and cheaper than existing, commercial products which can weigh significantly on the arm and cost up over eight hundred dollars.

The lock mechanism that our device uses is as simple as "hooking and unhooking". It can be put on and taken off with one functional arm, which doesn't hold true for most commercial products.

Acute Design Orthosis

Acute Design Orthosis
F01 – T01 - 5

AutoCAD Exploded View



Problem Description

The problem presented to our team involves Mr. F, a burn victim who has suffered second and third degree burns to his upper body, both arms, and upper back. Mr. F has extreme difficulty performing everyday functions due to several medical complications. Currently there are no elbow supports available to Mr. F that can assist with the motor function, cause minimal pain, and minimizes irritation. Mr. F cannot put on commercial splints with the serious injuries sustained to his hands and fingers. Our client, Tara Peckham, has charged Acute Design with manufacturing a device that will aid in Mr. F's everyday functions as well as cause minimal pain and irritation. Ultimately, the Device must permit the same range of motion necessary to perform simple tasks without help from family members, and (with slight modifications) be used to fit the needs of other prospective clients.

Design

The orthosis is designed to fit closely to the Mr. F's arm and weighs about three pounds. This close fit coupled with its light-weight allows Mr. F to maintain a full range of motion and perform simple tasks. It is broken into two parts, a forearm sleeve and a bicep sleeve. Each sleeve will enclose both parts of his arm giving the splint two main points of contact. The sleeves are also connected to one another at the inner and outer arm by a mechanism that 'locks' his elbow at certain angles. Both sleeves are fastened by two clasps to secure the orthosis to the arm. Both sleeves are approximately 3cm thick and span the circumference of his arm.

Functionality

The main purpose of the splint is to allow the arm to perform extension and flexion. These motions allow Mr. F to rehabilitate his arm and perform simple tasks. Several other functions that our design team thought were relevant include; easy to fasten, minimal contact to the skin, and apply constant force to the elbow. Although minimal contact to the skin is important, the final design changes the approach of this function. Instead of minimal contact to the skin, the design implements a line-soft material developed by the team. This material allows the arm to rest in place without being irritated by the material used in the design of the final splint. The final function is apply a constant force to the elbow. This is achieved by attaching a 'ratchet mechanism' to the forearm sleeve that allows the tightening or loosening of the sleeves. This causes the arm to go into flexion or extension respectively.

Materials, Components, and Assembly

All the material used in the prototype can be found at any local Home Hardware or dollar store. These materials range from foam padding to a cargo tie-downs. The tools used in the design process were; a saw, glue gun, and scissors. The length of time that was spent on the prototype was approximately five hours, which allowed the glue and other materials to set. To assemble the final design, it must be broken into parts. First, model the outer shell to the arm but allow space so the inner lining (approx. 2cm) fits inside the shell. The inner lining is made of four different materials and glued together using a glue gun. After the lining is fastened to the shell, then the cargo tie-down is attached to the forearm sleeve, to allow the movement at the elbow. Finally, we wrap the outer shell in foam to protect the user from any sharp edges from the assembly stage. When assembling the splint, we break it up into three parts attaching the inner lining the shell as well as the outer lining for protection. Lastly, you attach the two sleeves together using wire framing, by inserting each end into either sleeve. The design of the splint is basic but effective and covers all the caveats needed for a working splint.

Cost

The cost of the final design is approximately seventy-five dollars; this cost is directed towards the clinic. Since this cost was comprised of the material used for the final design, the only difference in the cost for the user will be the time required to assemble the final design for Mr. F.

User Acceptance and Compliance

Compliance was not a major concern. Although the exterior of the design was covered with a lining, it could be made more personable. Our design team was more worried with the functions that must be performed by the orthosis. The time to take the splint on and off, the size of the overall design must be reasonable. This splint can be put on and removed very easily using clasps to secure it to the arm of the user. The main purpose of the inner lining is to keep the splint comfortable and prevent irritation. It is comprised of four layers, the first a neoprene lining which keeps the splint lint-free. Beneath this lining are three other layers that allow for comfort as well as a moisture guard. This splint works with a ratchet mechanism that moves the arm into extension and flexion. Since the inception of the design safety a concern that has been considered. The final design is a very safe and user friendly. Our disregard to aesthetics might be the major pitfall of our design but we maintain that Mr. F would share the same opinion as the team in the sense that the functions are the primary concern of this project.

Benefits

The main benefit of Acute Design's elbow orthosis, is that it caters specifically to the needs of Mr. F. Splints on the market today help with the rehabilitation of the arm, but do not take into account the needs of burn victims. With burn victim's Velcro straps and other material used in mainstream splints aren't feasible because they can irritate the skin and cause infection. With Acute Design's splint, one of the main focal points was causing minimal irritation to the skin. Using the line-soft material (found in the lining of the splint) will help increase Mr. F's comfort.

Elbow Orthosis

Team Name
F 0 1 - T 0 2 - 1

Figure 1: Locked in forward position

Figure 2: Extended Position

Problem Description

Tara Packham, an occupational therapist from the Hamilton General Hospital approached us with Mr. B's problem. Mr. B who is on trial for drug charges has been victim to a motorcycle accident. In result he suffered a compound fracture, degloving of his right wrist and tendon and nerve damage. Mr. B also suffered a brachial plexus injury that left him without muscle control in his right shoulder and elbow. Mr. B now has difficulty performing everyday tasks relying on others as the injury occurred about his dominant arm. Mr. B further referred to as the user requires a device that can be locked into a position that allows him to make use of the functioning muscles in his wrist and fingers. The device must minimize pressure on the shoulder as well as be relatively inexpensive as commercial designs were seen to be impractical for said situation. This device must be built in a way that tasks the user must accomplish can be done with little or slight effort. The client (Tara Packham) has asked us at IEEE to build an orthotic device that satisfies these needs.

Design

The orthotic device is relatively lightweight and is adjustable to most arm sizes. It consists of two components which are connected via a backpack strap which wrap around the fore arm and upper arm respectively. Each component has Velcro straps which allow the user to attach it to his arm and adjust it to suit his needs. One strap goes around the back and other arm to hold the arm against the torso. The backpack strap between components uses a standard buckle to adjust the arm into various positions of flexion and extension by merely pulling on the strap or tab of the buckle. This design is easily adjustable to most arms. The upper component wraps around the side and front of the upper arm attached to the arm with Velcro straps that pass under the armpit. The bottom component consists of two pieces one longer piece which rests on the bottom part of the forearm and a shorter piece on the top so when the orthotic device is adjusted the components will not interfere with the elbow joint movement.

Functionality

The device created by IEEE satisfies most if not all of the requirements designated by the client. Our device is adjustable. The Velcro straps on each constituent part allow for adjustability at the upper and lower arm. As the arm size of the user was left to ambiguity our design had to be adjustable to multiple arm sizes. This was easily accomplished with the Velcro straps. Another adjustable component was our back pack strap. The strap through the use of tension allows the user to adjust his arm to various positions of flexion an extension.

Materials, Components, and Assembly

The device required very minimal materials which included: foam, cardboard, a backpack strap, Velcro and soft fabric. These materials are easily accessible and inexpensive. Construction was minimal and required the following tools: a glue gun, scissors and tape. Assembly is intuitive in the sense that the orthotic device can be easily built with little to no effort and should take 2 to 3 hours depending on skill level. No special instructions or experience are required to construct our orthotic device.

Cost

The cost of the orthotic device is relatively inexpensive. The materials had a total cost of $20 and can be easily found anywhere. The clinic should have no problem locating these materials and likely already have access to them.

User Acceptance and Compliance

The user's wants and needs are important to IEEE and we tried our best to meet these needs and increase user compliance. Firstly the device consists of two components with an intuitive design. These components are lightweight and easily attach to the arm via Velcro straps. They require little effort to be put on with one arm. It consists of foam padding and soft fabric for increased comfort about the arm, and can be worn over clothing to reduce skin chafing. The user must wear it above clothing as the adjustable strap would be difficult to utilize if it were below. Aesthetically the device is sufficient as it has no unusual devices or structures on it and will be relatively normal in the eyes of the public. The device is also safe to use as it has no pointed edges or areas of pinching. The cardboard and foam padding allow for a safe and comfortable design whereas the fabric can be used to increase its cosmetic appeal as the fabric acts as an outline around the orthotic device. Thus the device can be modified cosmetically to suit the users' preferences.

Benefits

Our elbow orthosis manages to satisfy all of the requirements of the client Tara Packham as well as other objectives and functions which can be useful to the user. Our device prevents unwanted motion with straps that wrap around the body easily and can be adjusted to suit the users every day requirements. Our device is easy to construct taking our group a mere 2 hours to build with no prior experience. Our device is also easily transportable and removable. The design allows the user to easily remove and store as the orthotic device as it is small and extremely lightweight. The device can be folded into a small package with its constituent parts. Tara Packham mentioned that the Mr. B wanted to do every day activities. A significant benefit of our design is that it manages to achieve functionality in a pronated position. A large variety of tasks require the arm to be in a pronated position and this factor can very useful if Mr. B wants to accomplish his daily tasks. Our greatest benefit is our cost. The device manages to satisfy functions typical of commercial orthotic devices while costing a mere $20. Most commercial ortheses can cost up to $1000 and sometimes only be rented out to a certain individual.

Tensile Elbow Orthosis

Ortho-Mechanics
F01–T02 -2

Figure 1

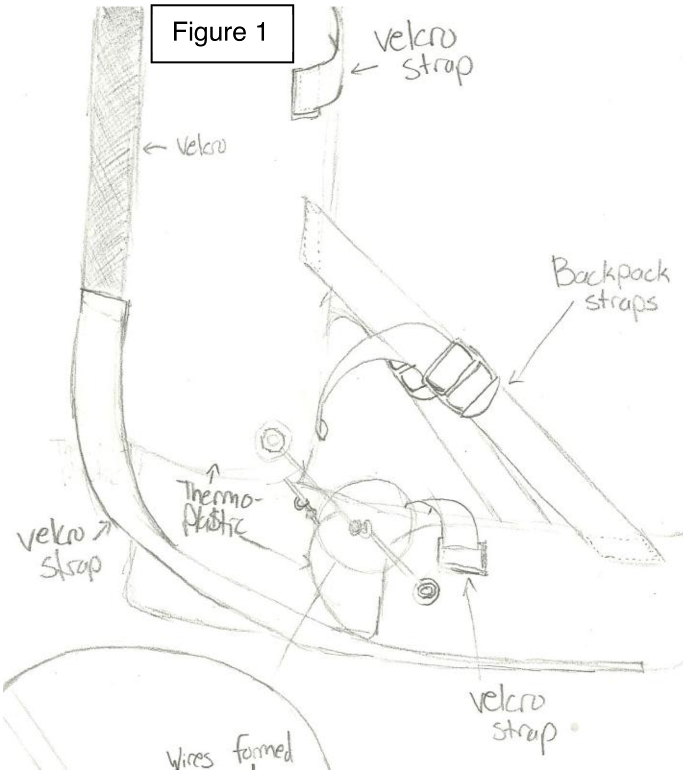


Figure 2

Figure 3

Problem Description

The client for this project is Mr. B. He is a 23 year-old motorcyclist who sustained major injuries when involved in an accident. He degloved his right hand and his humerus was also detached from the scapula in the process. Mr. B has motion in his wrist, hand and fingers but, as a result of this physical trauma, has minimal range of motion in the shoulder and none in the elbow.

Our client would like his right arm to be supported. It is important that as little pressure is placed on the shoulder and arm as possible. In addition, Mr. B wants the device to stabilize his arm when doing activities such as typing or walking while being inconspicuous when used. Increasing the range of motion in the arm is also invaluable in his full recovery. He requires a device that will offer extension, flexion, wrist supination and pronation, and ease of use by facilitating easy application and removal.

Design

The general design of the Tensile Elbow Orthosis (TEO) will be composed of two main arm cuffs (one for the forearm and the other of the upper arm). These two cuffs will be connected one to the other through the use of two straps similar to those found on a backpack in conjunction with one wire on each side of the arm. The wire is used to keep the TEO rigid, while the straps are used to support the arm in a particular position, based on the needs and activities of the user. On the underside of the TEO is a fairly thin Velcro strap. This strap is adjustable and fastened to both the forearm and the upper arm (Figure 2). Also, there is a belt-like system that keeps the arm anchored to the user's body to avoid any unwanted movement.

The design of this orthosis is quite light because the majority of it is composed of fabrics and thermoplastic, both of which weigh little. It weighs no more than four pounds. The structure of the TEO is simple enough to not require any kind of complicated mechanisms to function effectively which also aids in minimizing its size (Figure 3). It fits comfortably over the arm and is built to be as small as possible. When worn, it covers approximately ¾ of the forearm and upper arm.

Functionality

This orthosis has the ability to hold the arm in place through the use of the belt and support it. Support is given to the arm primarily by the straps which allow the arm to be held at many different angles due to their essentially complete adjustability. The cuffs are the secondary source of support. They are the mechanisms used to fasten the arm to the orthosis and to disperse the weight of the arm over a large surface area. The connecting wires are essential in this process because they prevent the unwanted movement and slipping of these cuffs.

The TEO can be used to increase range of motion as it has the ability to put the arm into forced flexion as well as extension. One disadvantage is that the extension therapy is not as effective as the flexion therapy because of the lack of extending torque that can be applied to the arm by the orthosis (Figure 1). It can perform all of the necessary functions specified by the client but it can be weaponized as the design involves metal wire. This trait is why that constraint could not be met.

Materials, Components, and Assembly

The main materials in the TEO are thermoplastic, Velcro, fabric, metal wire, nuts and bolts. The majority of these components can be found in the hand clinic (Figure 1). The only things that may need to be obtained elsewhere would be the fabric and the metal wire which can be found in any fabric store and hardware store respectively. The tools needed to construct this orthosis are as follows: plyers to bend the metal wire, scissors and glue to cut and attach the pieces of fabric that will be used to cover the orthosis and to fasten the straps, a thermal system that can be used to mould the thermoplastic, and a drill and wrench to fasten the nuts and bolts in place. With a high level of efficiency, it should take no more than 5 hours to make the TEO after the forearm and upper arm cuffs have been casted. Instructions necessary for this orthosis would include how to fasten various components together, and specifications as to what dimensions must be used for particular parts given the size of the user.

Cost

It will cost the clinic a maximum of $60.00 to fabricate this orthosis. A large portion of this is due to the high price of thermoplastic. It will cost the client quite a bit more than this because the client will be paying for materials as well as for the labour involved in fabrication. This price will fluctuate based on the exact number of hours required for manufacturing.

User Acceptance and Compliance

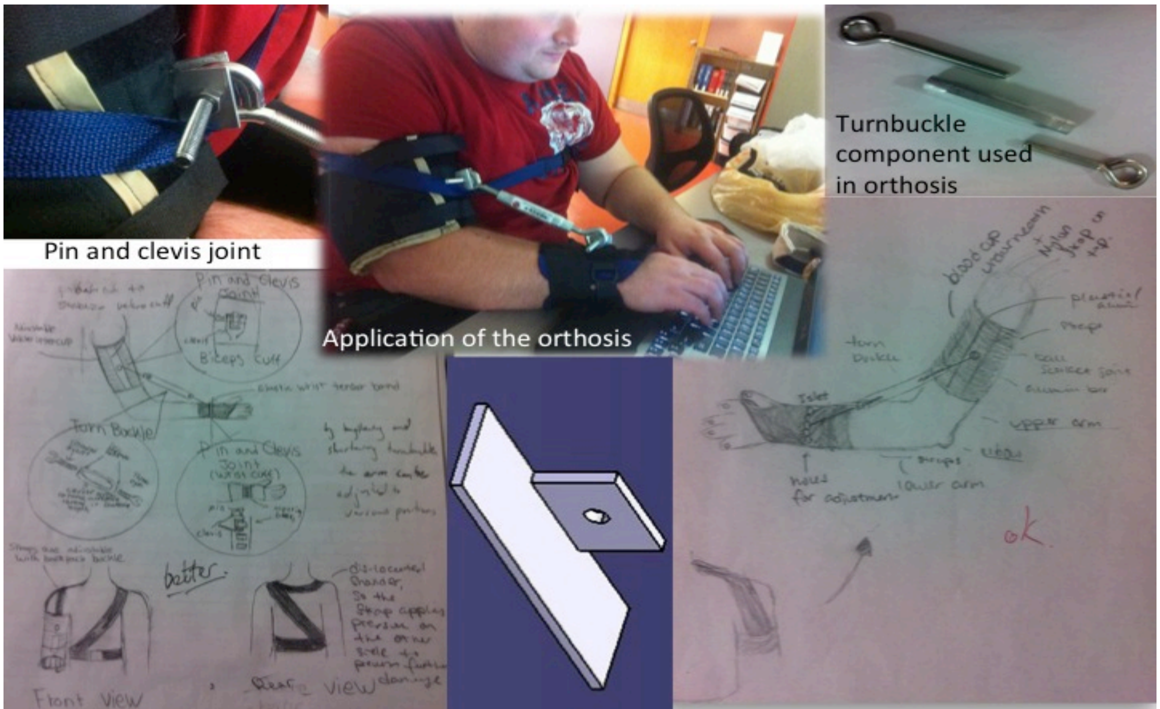
To optimize user compliance, the TEO was designed to fit inconspicuously over clothing. This will make it easier to be worn in public. Aesthetics are quite important to Mr. B which is why attention was paid to cosmetic details. For instance, the orthosis was covered in fabric as the final step to make it look as professional as possible. In this way, Mr. B would feel confident wearing it. In addition to confidence, this device was made for comfort. The cuffs were made large enough to distribute the weight of the arm over a large area so as not to cause irritation to the skin or restrict circulation. The user will be willing to wear it because it meets essentially every objective: provides flexion, extension, allows pronation and supination and will impede the user minimally during day to day activities. This design is safe because it is difficult to disassemble and there are no sharp edges that could potentially pierce clothing or skin.

Benefits

The TEO developed by Ortho-Mechanics is superior to others because it is extremely inexpensive while still meeting most of the initial objectives. Mr. B will be able to get full range of motion therapy, he will be allowed supination and pronation and all of the materials in the design are easily accessed by the hand clinic. The design is durable, easy to repair and certain parts can be reused effectively. Mr. B will be able to live normally and independently.

Ortho 5000

BACCH Dynamics
F01-T02-03



Final sketch for the orthosis, from multiple view.

Clevis joint L bracket (AutoCAD)

1st Alternative original sketch

Problem Description

The Hand Clinic requested a very specific design for the problems posed by Mr. B. In the case of Mr. B, he experienced an unfortunate motorcycle accident, in which he suffered severe injuries to his arm. His hand was degloved of the skin, his shoulder was completely luxated, and he suffered a loss of nerve function to his arm. The only part of his arm that has regained motor function is the wrist and hand. So, the device that has been requested by the hand clinic for him must support the arm, in multiple locking positions to allow him the ability to perform daily functions such as talking on the phone, writing or typing. The device should also allow for forearm rotation, and ideally, the device should be easy to put on by himself, with no help from others. The device should be able to be worn with clothes and be concealed for the most part.

Design

Our design is made of two cuffs, one for the lower forearm and wrist, and the other for the upper bicep. These two cuffs are attached by a turnbuckle, which controls the degree of flexion in the arm. By turning the turnbuckle, it lengthens or shortens, which either increases or decreases the angle between the upper and the lower arm. The turnbuckle is firmly attached to the cuffs through the use of a pin and clevis joints. As seen in the above diagram, the turnbuckle is firmly attached by a bolt, through the pieces of metal, and a washer and nut.

Functionality

This device offers a solution to almost all of Mr. B's problems. In the problem statement, it was requested that the device should support the arm in multiple locking position along the full range of motion. BACCH's design accomplishes that by use of the turnbuckle. The turnbuckle's ability to lengthen and shorten, thereby changing the angle of the arm demonstrates the ability for the user to put his arm through the full range of motion, and, since the turnbuckle holds firmly when not at rest, the arm "locks" in those locations. Other functions accomplished by this design are the ability for forearm rotation, and it is easy to assemble. By use of multiple turnbuckle attachments around the wrist cuff, the device allows for Mr. B to rotate his wrist into an either supinated or pronated position, and the device will hold the arm firmly there. Lastly, this design is very easy to put on, take off, and assembly, without any external assistance. Even with use of only one arm, Mr. B should be able to use this device with ease.

Materials, Components, and Assembly

Our device uses parts that can be either bought cheaply, or easily made. The components of the device include a turnbuckle, metal attachments, wrist and arm cuffs, and the support straps. The turnbuckle and the wrist cuff were bought from a hardware store and a drug store respectively. The upper cuff was made by sewing two pieces of fabric together. The fabric on the inside is softer than the outside, but still provides enough friction with the arm to reduce slipping. Both the inside and outside material can be bought from a hardware or craft store. The cuff was sewn with large holes in it, in which pieces of rigid foam were placed. These can be bought at most hardware stores and provide stiffness, as well as comfort to the arm. The pin and clevis joints present on both the cuffs were easy to acquire materials for, and easy to assemble. They are L-shaped and were sewn into the fabric of the cuff, which holds them, as well as the turnbuckle, firmly in place. They are held in place by a bolt, washer and nut. The last part of the design is the strap around the middle. This required no assembly, as it is only a large velcro strap, designed to wrap around the body and hold him arm tight to the torso. The strap, bolt, washer and the nut can be bought at most hardware stores cheaply. Overall, this device is easy to buy parts for, as well as being easy to assemble, with no required expert knowledge.

Cost

For a single-user device, the overall cost of our design is relatively low. The cost came to around seventy dollars, with the most expensive parts being the wrist cuff, and the upper cuff materials. This cost can be reduced by the hand clinic however, if they use thermoplastic instead of metal for some parts. For example, the metal L-pieces sewn into the cuffs can be replaced by similarly-shaped thermoplastic. This can significantly reduce the cost for both the user and the client.

User Acceptance and Compliance

This device represents a very useful and effective investment for Mr. B, since it meets all of the required objectives for him, as well as provides aesthetic appeal. This device will support his arm in any position he needs to perform daily tasks such as writing or typing. The device is also concealable and, if strategically placed, some clothes can be worn over top. The device is very comfortable, since, at any point in contact with the body, the device is made of soft, comfortable material. BACCH's design is also very simple to put on and take off, even when only using one arm, which would be appealing for Mr. B. Lastly, this design is very safe. It would be very difficult to injure yourself with this design. Overall, BACCH dynamics believes that this design is not only the best design for Mr. B, but is also the design that Mr. B will want to wear.

Benefits

BACCH's orthosis offers a unique and effective solution to the problem at hand, and would be an ideal brace for Mr. B. Our device not only incorporates all of the requirements and necessities for Mr. B, but also includes some extra benefits. BACCH has developed an orthosis that achieves all the requirements requested by Mr. B. Our device supports the arm at all times, relieves stress from the shoulder, and locks the arm in multiple positions. The device developed by BACCH dynamics is the smartest choice for both Mr. B and the Hand Clinic.

Elbow Orthosis 9000 SE Type S Version D3.R

infinity international inc.

Team Name
F01-T02-4

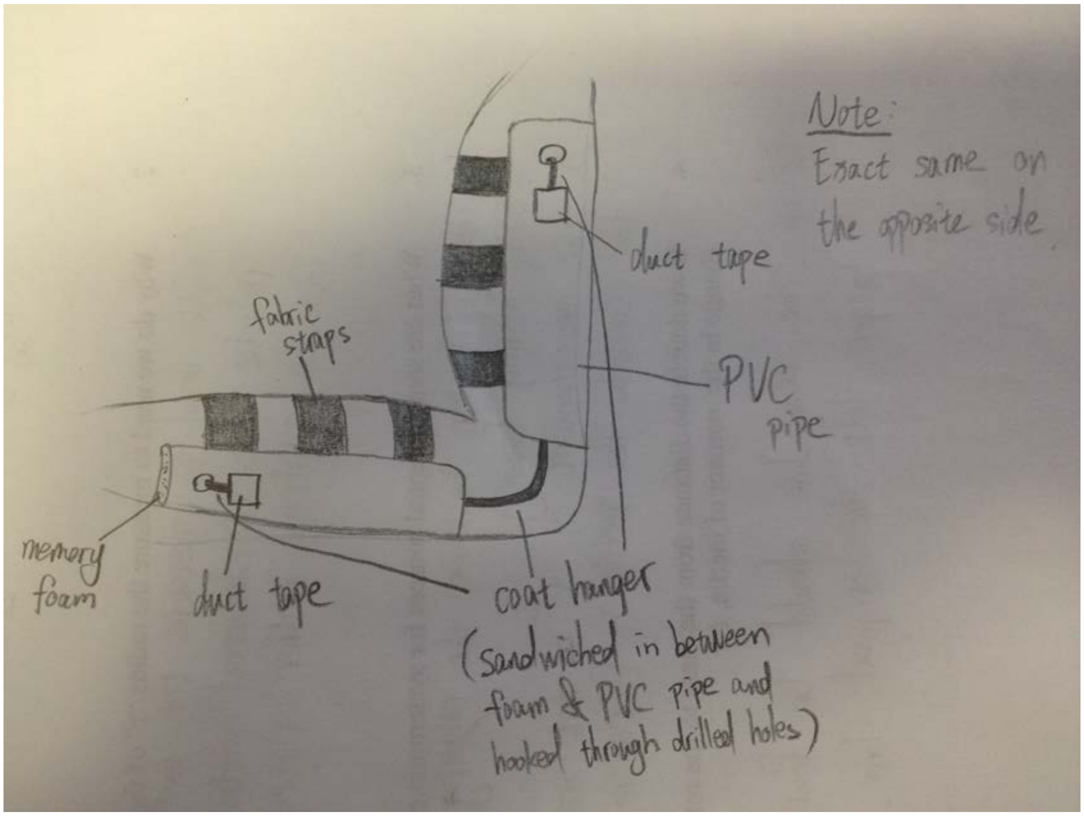


Figure 1

Problem Description

User involved in motorcycle accident, dislocating his shoulder and shattering his elbow in the process. He also severely damaged his brachial plexus, making him lose most of his coordination and movement in his arm. The user requested that he be able to independently equip the orthosis device and to be able to easily set a fixed angle for his elbow. He also expected to be able to easily rotate his forearm while comfortably wearing the device.

Design

The design would be quite comfortably light as we used light materials and straps that go around the torso and up the opposite shoulder. It will also be a medium sized device in order to fit around the arm of the user. Memory foam wraps around and take the shape of the arm when worn.

Functionality

The orthosis contains a very smooth layer of memory foam over the thermoplastic supports, which provides excellent comfort for the user when worn. The orthosis is also spacious to the extent that the user can effectively rotate his forearm while easily keeping it in a secure position. The coat hangers which serve to adjust the position at which the elbow is bent can easily be set to different angles due to its plasticity and strength.

Materials, Components, and Assembly

The materials required for assembly are as follows: thermoplastic, two coat hangers, double-sided tape/glue, and memory foam. Thermoplastic is on hand at the clinic and the other components can be obtained at any hardware/housing store. As seen in Figure 1, PVC is shown as the material for the shell. However, for the final product, thermoplastic will be used instead. Only a small drill is required in terms of tools. Assembling is a relatively simple process, and involves taking two pieces of thermoplastic sheets measured to length of a patient and then curving them upwards into a half-cylinder like object. Secondly drill two holes, each on the opposite ends of the thermoplastic on both sides. Thirdly, you want to cut your coat hanger down to the length of the orthosis (first piece on forearm, second piece on upper arm) and weave it through the holes on the thermoplastic (long side on the interior of the thermoplastic). Do the same for the other coat hanger on the other side. Then, cut the memory foam down to size of the thermoplastic and line the inside of the two pieces with it, using double sided tape to seal it.

Cost

- Velcro Straps: $5.00
- Thermoplastic material: $34.00
- Memory foam: $2.50
- 2 coat hangers: $0.20
- Tape + Glue: $1.00
- Total cost of materials: $42.70

User Acceptance and Compliance

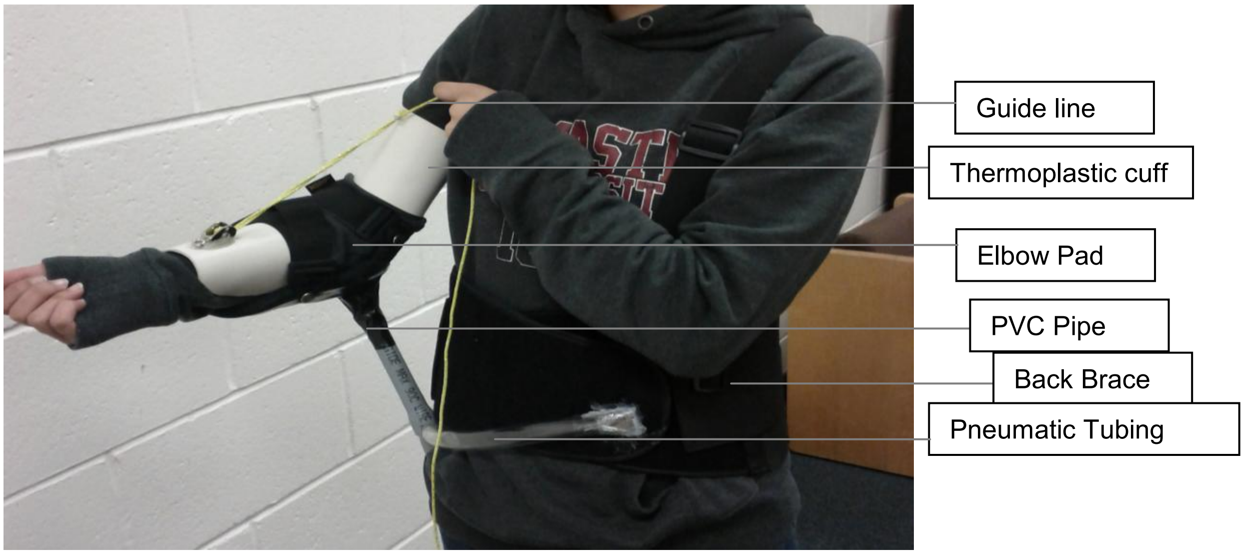
Memory foam provides excellent comfort when worn, molding to the shape of the arm. The device is easy to use independently (stretch straps for easy take off and easily adjustable). The orthosis also has a sleek solid look to it, making the user more than happy to wear it.

Benefits

The design is simple, cheap, light and extremely easy to build.

The Proficio Dynamic Elbow Orthosis

Joint Connection Engineering Firm
F01 – T03 – 1



Problem Description

The client, Tara Packham, from the Hamilton Hand Clinic has requested the assistance of Joint Connection Engineering Firm in the development of a dynamic elbow orthosis to assist in the recovery of her client; Mr. B. Mr. B has minimal elbow and shoulder control, but has fine motor control of his wrist and hand. His shoulder is subluxed and cannot handle any extra weight. The orthosis will address the problems of transverse motion of the arm and flexion of the elbow, as well as supporting the arm in such a manner that almost no weight is placed upon the subluxed shoulder. The orthosis should be user friendly and comfortable to in order to ensure user compliance.

Design

The orthosis consists of two main parts: the elbow – belt assembly and the double – cuff assembly which includes the pulley. Neither part of the orthosis should exceed 0.75 kilograms nor should the entire orthosis exceed a total of 1.25 kilograms**.** The two parts of the orthosis are to be put on at the same time. The upper cuff has a small screw hook located at the top. The lower cuff has a pulley attached to the end near to the hand. The upper cuff slides up the hand and the lower cuff is slid over the wrist and forearm. The two cuffs are attached by a guide line which allows for flexion of the arm. The belt – elbow assembly is secured through Velcro at the elbow and the rod is attached to the outer surfaces of the elbow pad and belt. The pneumatic piping is attached to the outer surface of the belt perpendicular to the PVC pipe. The entire orthosis will be custom designed to fit Mr.B's arm and the supporting pipe will be cut to size or replaced with a telescoping rod to suit his needs.

Functionality

The orthosis provides approximately 60 degrees of flexion and approximately 90 degrees of transverse movement. It also provides an excellent amount of support for the shoulder through the belt – elbow assembly. Furthermore, the elbow pad provides good support against outside threats that may injure his sensitive elbow. This is not all of the functionality required by the user however it does assist in his recovery by ensuring his shoulder does not shift. The orthosis also allows Mr.B to perform basic daily tasks such as open jars, brushing teeth and meal preparation.

Materials, Components, and Assembly

The materials used include: thermoplastic sheeting, a pulley, PVC piping, pneumatic piping, a knee pad, a back brace, Velcro, guide line, and a screw hook. The materials used to bond the components are: contact cement, hot glue and duct tape. All materials can be purchased from Home Depot, Home Hardware or the dollar store. The only tools required are a cutting tool such as a hack or miter saw to cut the PVC pipe to a usable length as well as a drill to create the hole in the PVC piping to allow it to run along the pneumatic pipe. The assembly will require approximately one and a half hours including measurements and fitting. The orthosis is made in two parts. The first part, the double cuff assembly is made of thermoplastic fitted to Mr. B. The middle of the forearm is measured as well as the top of the forearm and these measurements are used. The pulley is glued to the bottom cuff and the screw eye is inserted into the top cuff and glued in place so that it does not scrape Mr. B or come loose. The guide line is fed through the pulley twice and through the screw hook twice to create a friction lock. The belt component is assembled by drilling a hole with the same diameter as the pneumatic pipe in the end of the PVC pipe. The other end of the PVC is cut at an angle and glued to the elbow pad. The pneumatic piping is fed through the hole in the PVC and the pipe is glued to the belt. There will be additional special instructions pertaining to the assembly of the orthosis.

Cost

The cost of one orthosis is approximately $70 however not all of the materials, such as the extra elbow pad, are used. Price to the client should not exceed $150, including costs of materials and labour, assuming no external monetary assistance.

User Acceptance and Compliance

The user compliance has been addressed by attempting to provide as much comfort as possible through a smooth fit that does not cause friction. This can mainly be attributed to the fact that all skin contact is located at the two cuffs present or the cushion on the inside of the elbow pad. The cuffs may be put on in two different ways, depending on user preference, and are secured independently of one another in order to provide a higher degree of comfort in regards to the pressure on the different portions of the arm. The user will therefore be able to determine comfort according to his preferences. Mr.B can get the orthosis on and off without assistance however this is difficult. Mr.B can lie down to put the orthosis on easier and can slide the cuff on and off his arm with one hand. The Velcro can be put on with one hand but this is difficult on the lower cuff. Mr. B uses the orthosis by putting it on and adjusting the degree of flexion or extension by pulling the guideline to adjust the height of his forearm. He also uses the orthosis by pulling on the PVC pipe at its base to move his arm in the transverse plane to the position he needs. Cosmetically speaking, it consists of neutral shades and it has a sleek and futuristic feel.

Benefits

The Proficio Dynamic Elbow Orthosis is specifically tailored to the needs of Mr. B. He has sensitive skin due to nerve grafts after the accident therefore he requires protection for his arm. The rigidity of the elbow component protects his elbow from injury ensuring he is comfortable and safe and that no unnecessary trauma to his elbow occurs. The thermoplastic covering the major part of his arm also provides protection from scratching and injury but at the same time is light enough that it does not irritate his arm. The weight of the thermoplastic does not provide too much strain on Mr. B's elbow. The PVC pipe supports his elbow which is something that commercial orthoses do not perform. This support and light weight is designed for the subluxed arm or Mr. B. The motion provided by this orthosis in the transverse and sagittal planes allows Mr. B to perform daily living activities. Finally, the Proficio Dynamic Elbow Orthosis is cheaper than most commercial models making it the most suited to the user, Mr. B's needs.

Multi-Angle Elbow Orthosis

Engineers and Orthotics Co
F 01 - T 03 – 2

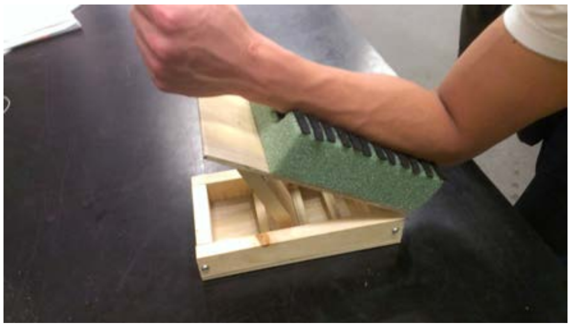


Figure A: The Multi-Angle Elbow Orthosis set to the second angle

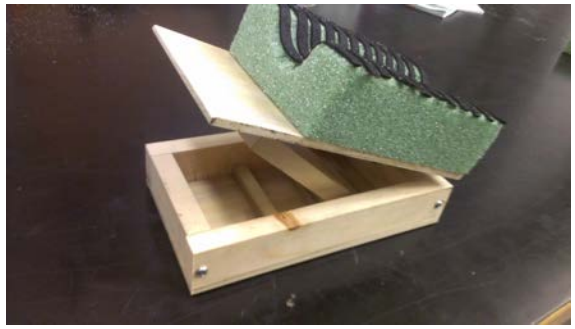


Figure B: The Multi-Angle Elbow Orthosis set to the first angle

Problem Description

The Hamilton Hand Clinic deals with patients who have suffered traumatic injuries to their upper limbs. The clinic is looking for a unique solution for a recent patient, Mr B. The 23 year old male was the victim of a traumatic motorcycle accident that left him with the degloving of the right wrist, nerve laceration, and a permanently subluxed right shoulder. Due to this, he has no movement in his shoulder, and cannot flex/extend his elbow hindering him in his daily routine. In order to help him with his routine, Mr B would like an elbow orthosis that allows him to vary forearm rotation, lock the forearm at various angles and must not cause any strain to his subluxed shoulder. We aim to provide an orthosis that will aid Mr B in performing tabletop functions while adhering to his aforementioned requests.

Design

The design consists of a non-skid wooden base with an adjustable arm support. The support platform consists of a styrofoam brick, glued to a wooden plank. The groove in the styrofoam is finished with soft foam tape. The support platform can be adjusted to several different angles by means of a double hinge mechanism. The mechanism consists of a flat wooden leg hinged to the underside of the support plank and square dowels attached at specific intervals along the inside of the base. The support can be locked at a certain angle by lifting the support platform just past the desired angle. The design is very portable, weighing under 2.5 kilograms and about the size of a vanity bag. The support runs the length of the forearm and can elevate the hand over 20cm from the table.

Functionality

Our orthosis performs the functions it was designed to do perfectly. It locks at various angles to assist in tabletop tasks or provide range of motion therapy if needed. It also stabilizes the forearm and elbow in a fixed position without causing strain on the shoulder. With the elbow in a locked position the user will be able to perform tabletop tasks that correspond to the set angle.

Materials, Components, and Assembly

The materials used within the construction of our orthosis are: wood screws, two door hinges, a square wooden dowel, foam tape, styrofoam square, rubber feet, super glue, and two separate wooden boards; ¼” thick by 5” wide, and ¾” thick by 2” wide. All of the aforementioned components can be found at any local hardware store. Tools used in the construction of the orthosis include: a table saw, a mitre saw, a band saw, a tape measure, an electric drill with a drilling bit and a cross head screw driver bit and a belt sander. The time needed to construct it was an hour. There are no special instructions within the assembly. Each step is straightforward and simple, no advanced woodcutting techniques are used.

Cost

The cost of this orthosis was kept to a minimum. We were able to construct it at the low cost of $25. Depending on which store each component is bought at, the price could range from $20-$30. A problem may arise when having to cut each of the wooden pieces. Access to the saws used during the construction process may not be available to everyone. However, a solution is offered at Rona. After purchasing the wood, Rona offers a service that will cut your wood to the desired lengths.

User Acceptance and Compliance

By sitting on a flat surface, such as a tabletop, the user simply has to rest his arm into our orthosis. There are no velcro straps or locking mechanisms to the body. Mr B is able to use our device without external help. The support has been made so that it is comfortable even after prolonged use; this should increase user compliance. With our design, the user would not have to constantly wear the orthosis. Instead, the user would set it on a table top and rest his arm in it when needed. The orthosis needs very little effort to use and is hassle free.

Benefits

First, our design is safe for Mr B's pre-existing conditions. The orthosis does not cause further strain to the shoulder and it is slip resistant, ensuring no recurrence of injuries. It is more than sturdy enough to support the weight of the forearm. Existing designs do not account for a subluxed shoulder, they will strain shoulder regardless of how it may distribute the weight.

The design is also simple and easy to use. Other designs can be confusing to put on, let alone operate. If the user is unsure of how to operate the device, they risk worsening their condition due to misuse. That’s why, with our double hinge system, Mr B will easily be able grasp how it operates.

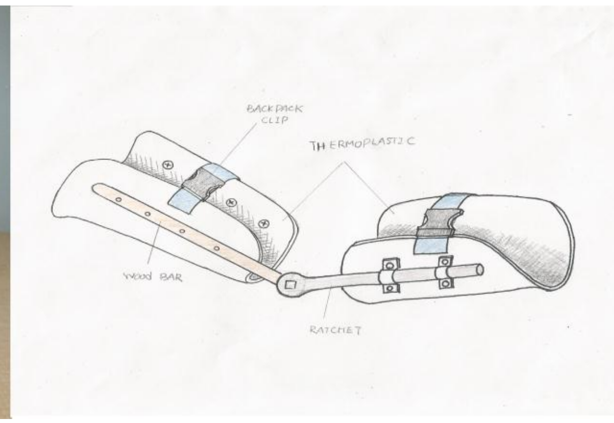
With our simplistic design we are able to minimize cost. The grand total was $25. Existing designs can cost hundreds of dollars, and even those of our peer’s must be fabricated into a final product, raising their costs. Our design requires few, if any, adjustments to be put into market, so costs will stay low.

With the simple design, user compliance will be promoted. Other designs may be a hassle to put on, use and then take off. Our orthosis is easily accessible and requires no hassles to handle it. Along with being convenient to use, it is comfortable. Users do not want to wear an orthosis if it is uncomfortable to have on; this is why we regard comfort so highly.

Lastly, our orthosis is unique. We have taked a different approach to the problem. As stated earlier, other designs will attach to the body, causing unwanted strain on the shoulder. Our design requires attaching to the body at all. We believe this is the best approach to serve his desires in an orthosis. It will both fulfill his needs and respect his condition.

Static-Progressive Elbow Orthosis

Biomedical Precision Dynamics
F 01 - T 03 - 3



Problem Description

The final problem statement is as follows: Mr. F is a 29-year-old male who was severely burned in a house fire. He suffered 2nd and 3rd degree burns covering a total of 20% of his body surface area. His burns affected his arms, face and upper back. He also suffered inhalation injuries. As a result of his burn wounds, he suffered from heterotrophic ossification, a build-up of calcium in his left elbow, which fused his joint together causing limited range of motion in his left arm. Due to his condition, he had no choice but to move back in with his parents whom he hates asking for help. The client, Tara Packham, has asked the team at Biomedical Precision Dynamics to design an elbow orthosis that will minimize skin irritation and provide tension in the arm to achieve various positions of flexion and extension. The orthosis should also be easy for Mr. F to put on and take off, and change the position of flexion or extension.

Design

The orthosis is comprised of three main parts, the bicep cuff, forearm cuff, and ratchet mechanism. As indicated in the visual, the cuffs are crafted out of thermoplastic and lined with a soft fabric liner. When fully assembled, the device weighs approximately 2 pounds. The size and weight of the orthosis are affected by the size of the user’s arm, as a larger arm will require larger cuffs and therefore increase the weight of the device. The cuffs fit over the arm and are tightened using the straps affixed to each cuff. The ratchet mechanism is attached to the bicep cuff using a thermoplastic bracket and epoxy, the ratchet head is placed in a block of pine wood, which is then affixed to the forearm cuff using screws.

Functionality
The design is able to do everything that the client requested. It is able to vary between angles of full extension and full flexion in the arm whilst being able to lock at any angle between these two extremes. It is also very comfortable to wear, there are only two components touching the arm, both of which are covered in a very soft fabric that can be easily removed and washed. The device can be easily put on and taken off due to the clips attached to the cuffs. Changing from flexion to extension was made simple by the design of the ratchet, which permits the direction of allowed rotation to be changed with a simple toggle.

Materials, Components, and Assembly
Materials used in the construction of our device include; a small piece of pine (1/4 inch thick, 1 inch wide), two ¼ inch long screws, a 18’’x12’’ sheet of thermoplastic, a ratchet, cotton fabric, quilt batting (a soft padding material), plastic epoxy glue, Velcro strips, and a plastic backpack buckle. Assembly consists of heating and forming the thermoplastic to the users arm to create a forearm cuff and bicep cuff, sewing two cotton rectangles with padding in between them, then screwing the piece of wood to the forearm thermoplastic cuff. The buckle is glued to the outside of the piece of wood. Afterwards, Velcro strips are glued to the inside of the cuffs. The ratchet is then fastened to the upper cuff with another piece of formed thermoplastic that is glued to the upper cuff. Finally, the ratchet is press fit into a drilled hole in the pine, the wood is relatively soft, meaning this step can be done by hand. Assembly took 2 hours for one person, not including time for glue to cure. The assembly time will vary with the fabricator’s skill in working with thermoplastic.

Cost
The orthosis costs $75.50 to construct including all materials and fasteners. This cost assumes that the client has free access to a screwdriver, scissors, an old backpack, a large pot, a stovetop, a drill, and a sewing machine.

User Acceptance and Compliance
In making our design, the benefit to the user was one of our top priorities. In order to facilitate user compliance, the orthosis was designed to be extremely easy to put on, take off, and operate, in addition to both lightweight and comfortable. The user is able to easily put on and take off the device by placing the orthosis on a flat surface, making sure the cuffs of the orthosis are lined up with each other. The user then simply slides their arm through the upper and lower cuffs, fastening the straps once the device is properly in place. The cuffs are lined with a cushioned, removable fabric liner that is slightly larger than the cuffs themselves. This ensures that the actual thermoplastic of the cuffs is never in contact with the skin of the user. In order to use the orthosis, the user simply toggles the ratchet in order to achieve flexion or extension. Due to the nature of the ratchet, only one direction of rotation is allowed, and as the user pushes their arm into flexion or pulls it into extension, the ratchet automatically prevents rotation in the opposite direction. The orthosis is a lightweight device, weighing approximately 2 pounds. With the majority of the weight held close to the body, the weight of the orthosis is negligible.

Benefits
The device is inexpensive and relatively easy to assemble using components that can either be bought from the hardware store or found in a household. Household items such as backpack straps and padding can be used to tighten the orthosis and provide a comfortable fit. The ratchet allows for the motion of the arm with a simple flick of a switch and locks in place stiffly. The switch built into the ratchet minimizes the number parts that make up the device, making it relatively easy to construct. The majority of the orthosis is reusable; the only part of the device that needs to be disposed of is the pine block the head of the ratchet is affixed to. The orthosis is relatively inexpensive, easy to construct, and an effective tool in patient therapy and rehabilitation.

Elbow Orthosis

Diamond in the Rough
F01 – T03 – 4

The picture demonstrates the brace being adjusted by pulling on the Velcro strap

Problem Description

The problem presented to the team by the client, Tara Packham, an occupational therapist at the Hand Clinic in Hamilton General Hospital. Tara Packham has 20 years of clinical experience in hand therapy as well as a MSc in rehabilitation sciences. The Hand Clinic deals with mainly arm and hand injuries that are too complex for general hospital care. She represents Mr. B, a 23 year old single male, who was involved in a motorcycle accident. Due to the accident, Mr. B suffered compound fractures and dislocations, degloving his right wrist with tendon and nerve lacerations. He also suffered a brachial plexus injury and received nerve grafting on his right arm. Due to these injuries, he has lost motion in his arm and is unable to perform everyday tasks. He still has mobility in his wrist, hand and fingers but is unable to move the rest of his arm due to loss of muscle and nerves in his shoulder through to the elbow. The device must support his arm while not limiting its mobility. It must provide a full range of motion and be easily adjustable in order to efficiently perform a variety of daily tasks. It must also be versatile in order to support all environments where two hands are needed such as sitting, standing and moving inside and outside. Mr. B is currently on trial for drug charges and may potentially end up in a medium security prison. As a result, the client would like to be able to wear the device in prison, therefore it must meet prison safety regulations. The orthosis must be made with simple materials that are easily accessible to Tara Packham at the Hand Clinic and it must be easy to assemble with the means available at the Hand Clinic.

Design

The design is visually attractive because of the cloth that used to cover all the parts of the orthosis. The orthosis is very light weight because there is no metal or heavy material used for the construction. All the parts are made from Thermoplastic and plastic. The orthosis is small in size as less material is used to make it light because there is very less strength in user's shoulder that permits him from holding heavy parts. No metal is used in the orthosis for two reasons, one that it will be very heavy on user's shoulder when compared to plastic. Secondly, the user may be jailed due to drug charges and metal parts are not permitted in jail. The harness needs some assistance while wearing, other than that the orthosis is very user friendly as it can be adjusted by one arm.

Functionality

The elbow orthosis supports the motion of flexion and extension by adjusting a Velcro strap attached to the upper arm and forearm to change the angle of the arm. It also supports the motion of pronation and supination by attaching a Velcro strap that is fastened to the wrist to either the right or left side of the forearm, causing the hand to flip face up or face down. The brace provides all of the functions that the user asked for.

Materials, Components, and Assembly

The materials used for making this orthosis are only D-rings, thermoplastic, Velcro and soft cloth. Thermoplastic was used to make three different parts of our orthosis. The parts were covered in cloth to provide comfort in and out. D-rings were attached to the parts using epoxy glue and Velcro was passed through them which was used to provided mechanical range of motion vertical and rotationally to the forearm. It take about couple of hour make this orthosis when instructions provided. There are no special instructions for the assembly. It depends on the comforts and needs of the specific user.

Cost

The total cost to build the device is roughly 60 dollars. The total price of material bought was around 100 dollars but only 60 percent of the material was used.

User Acceptance and Compliance

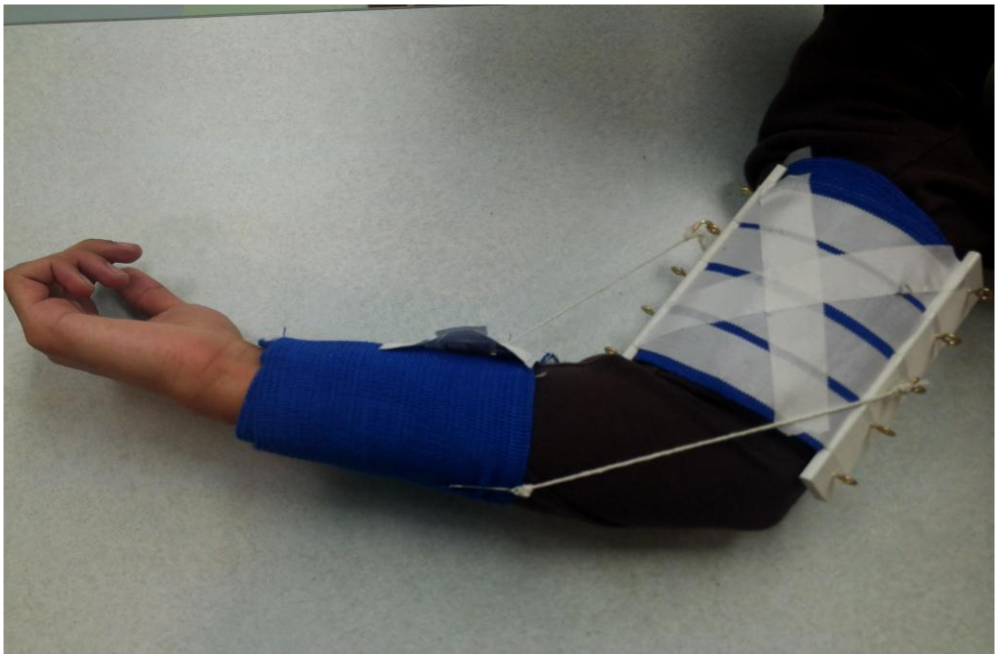
The user wanted the orthosis to be comfortable, light weight, user friendly and something that isn't very bulky looking. Our orthosis provided a solution to all these compliances. It is light weight, and uses less material than other orthosis. The user can easily put it on and off with his one arm. The harness goes through the neck, around the chest and can be tightened to support the shoulder while wearing the orthosis. Maximum comfort is provided by using very soft cloth inside and outside the orthosis. Most users would prefer this orthosis over others due to its comfort and its functionality.

Benefits

This design is better than those of commercial braces for several reasons. First of all, this brace is approved in jail, which is a feature that many other braces due to the metal used in their designs. Second of all, this design provides comfort that is specific to the client. It is more comfortable than other braces because it is easily adjustable with an adjustable shoulder, wrist, and elbow strap. It is also comfortable because it does not put a large load on the injured shoulder because it is lightweight. It spreads the load to other parts of the body such as the opposite shoulder, using the harness. Also, this design is much simpler than other designs on the market. It is simple to use because it does not have any hinges or rods and the Velcro straps are colour coded according to function. It is also simpler to make because it only involves low cost materials that are commonly found in the hand clinic and Canadian Tire. It does not require any complicated welding or large machines. Because of this, it is also very low cost compared to other braces. Finally, this design provides a larger range of motion than other braces. This brace allows flexion, extension, pronation, and supination. Most other braces only support 2 or 3 of those motions, not all four.

THE ORTHO-SLEEVE

Team Name
F 01 - T 04 - 1



Problem Description

The three main parts that are addressed in our design, regarding Mr. B. are the shoulder wound, the loss of flexion and extension movement of the arm, and the capability of forearm rotation and positioning. These problems are due to his little working muscle at shoulder and none at elbow; wants to lock elbow splints at various positions to use hand; would like to be able to vary forearm rotation.

Design

The design itself is a very light, adjustable and flexible apparatus. It basically consists of woven fabrics, few nails with rooks and two PVC laths. There is no heavy metallic or wooden structure involved. All the components of the design are very light. Another interesting feature is that since it is mostly made out of woven fabric, it is very flexible. It can be easily manipulated to wear and folded in order to put away.

It basically consists of a long sleeve that has attached to it, all the components. At the top it has the large Velcro strap for the shoulder. I the mid-section it has the two PVC laths and nails for the elbow wound. Finally, at the bottom it has the Velcro for the wrist with an elastic band for the forearm injury.

Functionality

The client wants to be able to move his hand and rotate his wrist. The design allows the client to vary forearm rotation by allowing the user to lock the elbow splint at various positions in order to support and hold up the arm. The design of the orthosis is light and allows him to wear it without fear of damaging arm. The splint allows the user to lift his forearm by locking the splint at various positions and allows him to move his wrist. The splint also satisfies user's requirements; he wants the design to be permitted if he is incarcerated (i.e. design needs to be safe). It can essentially do everything the client requested.

Materials, Components, and Assembly

The materials required by the elbow orthosis include: knitted cotton arm sleeve, a plastic fastener, hooks used to adjust the arm support and lastly, elbow pads that secure close to the arm. The materials can be obtained from a local thrift store, as the items are common. It does not take much time to construct the elbow splint, and there is not a heavy list of instructions needed to build the device. Assembly does not require special instructions.

Cost

In order to manufacture the product, the clinic will need some products that were already cited above. These materials are woven fabric, Velcro, PVC and nails. In order to put the product together, the client will need to use fabric glue and sewing machine. The materials used to make the product are quite common and not expensive. However, they will need fabric glue, sewing thread and some manual labour in order to get the final product. The costs can be divided into material, machine and labour. It will cost the client more or less $50 dollars.

User Acceptance and Compliance

For our design the user compliance has been met. The final product does solve all the problems posted by the user in simple but effective ways. Since the design is a sleeve, it is light and flexible. However the sleeve cannot be very tight because of the users wounded shoulder, so there must be some room for comfort in putting on. As soon as the sleeve is on, the user will grab at the end of the Velcro strap and wrap it around its own body, fixing it at the wounded shoulder. In this way, the sleeve will be secure and the shoulder locked up. Since the design is not too complex the user can put on the apparatus using one arm only. On the other hand, the design does have some materials that would oppose a threat since the user is incarcerated. This can be solved however, by substituting the metal nails and the strings for materials that are allowed in prison.

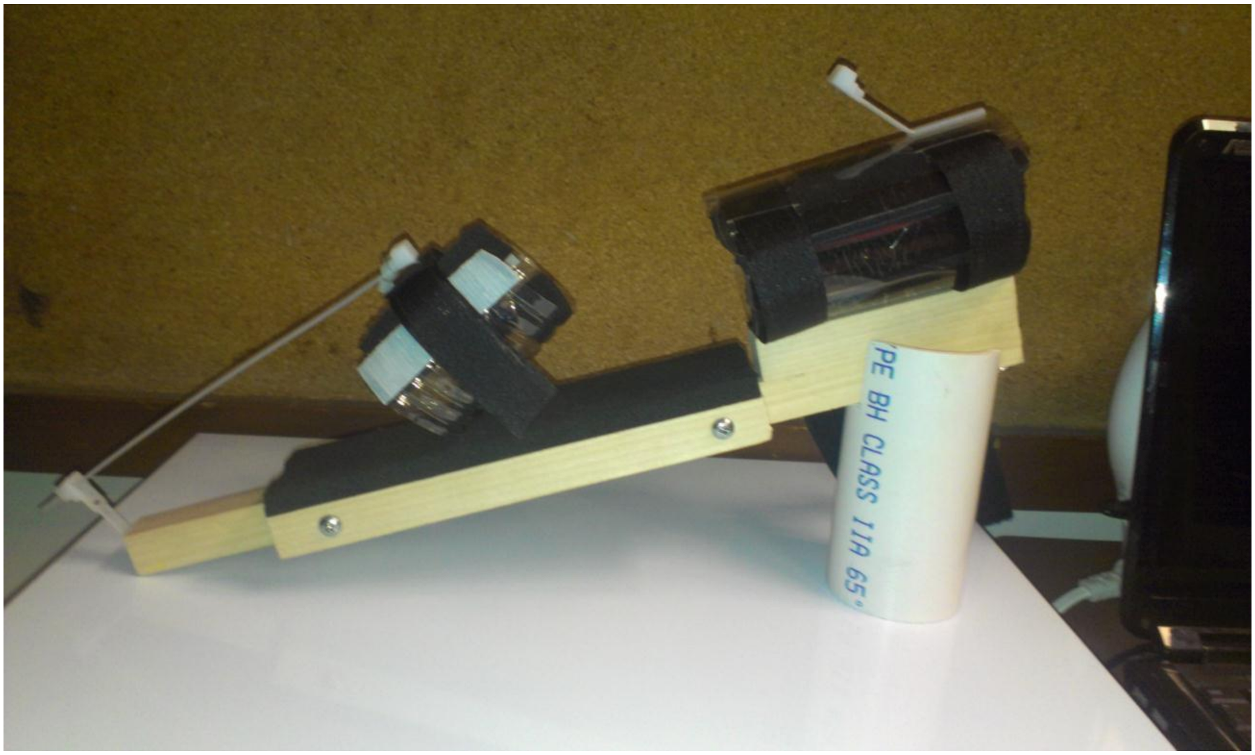
Benefits

Our design has some features that are critical to solve effectively the problems stated by the user. It is a very light design, so it will not put any stress of weight in the user's shoulder. It is flexible so it makes it easier to the user to manipulate and put it on. And finally it is simple since the user can put it on with using one hand only. For us, these were the most important functions that had to be met.

The Zip Splint: Elbow Orthosis

Generic company inc©

Generic Company inc.
F 01 - T 04 - 2



Problem Description

Our user, Mr. F, a 29-year old male, suffers from second and third degree burns on twenty percent of his body's surface area, inhalation injuries and severe burns on both of his arms. While in the hospital for treatment of his injuries, heterotrophic ossification occurred in his left elbow, which solidified it and required surgical attention.

Mr. F is a client of Tara Packham from the Hamilton General Hand Clinic. Tara came to our company on his behalf with a request for a biomedical device that can assist him with his recovery therapy.

The purpose of this device is to force Mr.F's arm in both flexion and extension, while also being easy to use by someone with weakened finger dexterity, lightweight, durable and non-irritating for Mr.F's damaged skin.

Design

Our design is composed of a wrist cuff, a bicep rest and a beam and support mount. The wrist cuff attaches to the body with a single Velcro strap and attached to this strap is a 7.5 inch long cable tie. The bicep rest and beam are connected, and the beam extends approximately 1 foot from the bicep cuff underneath the arm. The bicep rest and upper cuff attaches to the arm with 2 long Velcro straps. All components are padded in order to provide comfort for damaged skin and are spaced out to allow air circulation. Both the bicep cuff and the beam have a receiving end for the cable tie where it can be fed through to provide an extension or flexion force as needed. The final part of the device is the support mount which has a slot to rest the beam in to give it a natural angle while attaching it to the arm. This can be removed once the device is properly secured.

Functionality

The function of being easy to fasten and adjust is achieved by using excess lengths of Velcro straps to minimize the strength and precision needed to adjust the straps.
Abrasion to the skin is minimized by using soft foam to reduce the contact the burned skin has with rough surfaces.
The device is made easier to attach to the arm by adding a support block as a standalone component which serves to provide stability as well as a more comfortable angle for the user's arm when attaching the splint.
Applying flexion and extension forces are achieved by feeding a cable tie from the wrist cuff of the device into either the support bar beneath the elbow to provide extension or the bicep cuff to provide flexion. The cable ties have a built in release and can be adjusted to a variety of different positions.
All functions requested have been achieved to some degree with a strong focus on comfort and applying flexion and extension and a lower focus on ease of use.

Materials, Components, and Assembly

The final design component lists consists of: (1) 3 foot long ¾ inch poplar beam, (1) 2L pop bottle, (1) 1.5m x 19mm closed cell, self-adhesive weather stripping foam, (3) 7.5 inch releasable cable ties, (2) 1 foot Velcro straps loop side, (1) 5 inch Velcro strap loop side, (4) 3 inch self-adhesive Velcro pads hook side, (6) #8 x 1 ¼ inch self-tapping metal screws, (2) #8 x ¼ inch self-tapping metal screws.
To assemble the device, start by cutting the poplar beam in to 4 pieces with one piece being about a foot longer than the user's bicep, 2 of the pieces being half that length each and the 4th piece being the remaining material. Screw the 2 medium sized pieces onto one end of the longer piece using pilot holes to prevent the wood from splitting and use plastic from a 2L pop bottle to form the bicep cuff, which is then attached to the top of the beam. Form the wrist cuff in the same way using half the length of plastic. Attach 2 Velcro strips to the bicep cuff and 1 to the wrist cuff, and then attach a 7.5 inch cable tie to the wrist cuff and the receiving ends of the remaining 2 cable ties to the end of the support beam farthest away from the bicep cuff and to the bicep cuff itself. Lastly, line the wrist, bicep cuffs and beam with weather stripping.

Cost

Components cost approximately 30 dollars, plus the cost of a drill, drill bit, wood saw, epoxy, scissors, etc.

User Acceptance and Compliance

The user's problems with sensitive skin has been considered by introducing foam pads the wrist and bicep cuffs in order to reduce the irritation, and the pads are also spaced apart so as to allow for air circulation which will further reduce damage to the skin.
To allow the user to get the orthosis on and off independently, a support block made of PVC tubing is used to provide support just below the bicep. This gives the orthosis a more natural angle when mounting, making it easier to put the device on independently.
The lack of dexterity in the user's hands in accounted for by increasing the length of the Velcro straps that secure the wrist and elbow straps into place. This allows for Mr.F to grip the strap with his entire hand, reducing the need for fine motor control.
Visually the orthosis is not the most pleasing to wear but it is within reasonable limits for its ascetic appeal and it is comfortable when worn. Most likely Mr.F will wear this around his house where the visuals are not as important as the comfort of the device.

Benefits

The zip splint is better than anything else on the market because of its extremely low cost of $30 and its simplistic design, which allows the device to be exceptionally portable. The simplicity also makes manufacturing the design a simple task and can be completed by hand in under an hour with relatively little expertise. On top of that all these things are achieved without sacrificing the main function of the device, which can apply flexion or extension forces in a 150 degree range of motion.

Hook and Loop Elbow Orthosis

Pen to Draft
Engineering and Design Solutions

F01-T04 -3

[1]: The final prototype.

[2]: The initial prototype.

[3]: Improved Cuff design.

Problem Description

Mr. B is a 23 year old biker who has suffered massive injuries to his shoulder, nerves, and has had degloving on his wrist. He may also be incarcerated on drug charges. Pen to Draft's task was to design a cost effective, easy to make orthosis that could be fabricated by Tara Packham in the Hamilton General Hospital. This device should support the users shoulder, allow the user a full range of motion in the elbow, as well as allow him to lock it in place. The orthosis must also be allowed in the general prison population.

Design

Caption [1] shows the final product and what it should look like. The orthosis is essentially a two part device. The first part is a spandex band that is fitted around the body and tightened with a cloth belt. The second part is a custom fitted thermoplastic cuff attached to a hook (shown in caption [3]) that can hook onto the band through metal loops sewn onto the spandex band. These loops allow for the elbow to be set into various positions, according to the users preferences. The actual fabrication of the design would be done to the spec of the user. The design is mainly cloth so it is very light, coming in at about 1 kg. The size of the device is relatively large. The spandex are covers the upper are while the cuff covers about ¾ of the forearm. Though large, it is confined to the user's personal space so it is not intrusive to others.

Functionality

The Hook Loop Elbow Orthosis is able to support the shoulder, allow for a full range of motion in his arm, support the forearm, lock into place, and allow for his forearm to be rotated. The first function is achieved through the spandex band – cloth belt combination that immobilizes the upper arm and holds it to the body, taking load off the shoulder. It is able to have a full range of motion as the elbow is freely able to move and it is able to lock through the hook being attached to a different position loop. A secondary function of these last 2 specified functions is supporting the forearm, sincethe user doesn`t exert much force to their bicep. This prevents user straining their arm. Finally, the user can rotate their forearm because of the cuff being loose fitting. For Mr. B specifically, all of functions he requested have been delivered with this design.

Materials, Components, and Assembly

The materials required for this design are spandex cloth, a cloth belt, at least 4 metal loops, a blunt tipped hook, string, thermoplastic and thread. These materials can be found at Home Hardware and a dollar store. The bulk of assembly will involve sewing. First band must be sewn very loosely around the user's body, followed by the cloth belt being sewn onto the belt. The metal loops should be sewn in a vertical fashion, onto the side that the orthosis being applied. The number of hoops will depend on the user's specification. With this the first part of the orthosis is complete. The second part of the device, the cuff, is bases on a piece of thermal plastic fitted to the user's forearm. The string is attached to the cuff by folding over the front corners of the cuff onto the string. Next, spandex cloth is used to cover the cuff as an aesthetic feature, as well as to fasten the cuff to the arm and provide extra comfort. Finally the hook is tied to the string and the orthosis is complete. The time of assembly should be around 30 minutes to an hour.

Cost

The cost to the clinic to build the device is $32.87 according to our specs. However, using the cheaper thermoplastic that the clinic has at their disposal, the cost would drop significantly. The cost of time for the clinic as specified before should be relatively short.

User Acceptance and Compliance

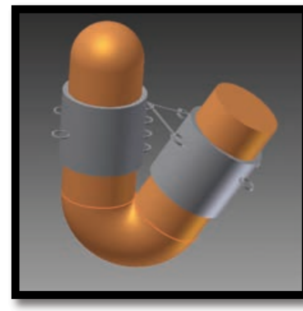
The Hook Loop Elbow Orthosis is design around user and therefore our team designed it to be user friendly. The both parts of the orthosis can be put on with one hand in a minimal time frame. The spandex band is put on like a shirt, and cuff is simply slipped on. To uses the device, the user needs to simply lit their arm with the string and hook it to one of the loop positions. For comfort, the materials used are very soft and light so they don't feel constraining. With these materials, the device is also very safe for the user and for others. Since the device has no real sharp edges, and hard pieces, other than the thermoplastic, the orthotic should be allowed in the general prison population. With this design, the objectives laid out for the design have been met.

Benefits

- Easy to make
- Cost effective
- Easy to use
- Lightweight
- Comfortable to wear
- Full range of motion
- Aesthetically pleasing

Elbow Orthosis

Macanics
F01- T04 - 4



Flexion: this picture demonstrates how the string attaches on to the hooks to let the arm flex. The angle can be adjusted by putting the string at a higher/ lower hook.

Extension: this picture demonstrates how the string attaches on to the hooks on the elbow (lower part) to let the arm extend.

CAD Model: the brown section represents an arm and the device shows a string attached to the upper and lower arm for flexion

Problem Description

An open-ended and ill structured problem presented by Tara Peckham, from The Hamilton General Hand Clinic regarding Mr. F, a 29-year-old man suffering 2nd and 3rd degree burns, heterotrophic ossification, and limited finger function and strength from a house fire accident. Currently, Mr. F cannot independently adjust the position his arm and splints in use cause him skin irritation and infection. These factors combined give Mr. F a difficult time completing normal everyday functions.

Our team's main goal was to design a device that would allow Mr. F to independently and easily, put on and off, and lock his arms in different position, with minimal skin irritation.

Design

It is a three part system that performs the main functions of an orthosis, and it fits on as a single product. It weighs less than a pound and fits snugly with respect to the arm, to cause minimal movement along the arm. It uses a Velcro system to hold on to the arm. It also uses a flexion and extension support system to achieve range of motion by letting the user adjust the angle between arms.

Functionality

Our orthosis concluded in performing all the functions that Mr. F situation required.

The functions include locking and supporting the arm by connecting the upper and lower arm gauze components by a string and hook.

Hooking the forearm piece to various positioned rings on the upper are the function of range of motion up and down is created.

The use of soft, stable, and non-moving cloth allowed for comfort. When the arm is flexed or extended only the gauze layer is pulled up therefore Mr. F experiences no skin irritation.

The orthosis distributed the force or weight by using light gauze and cloth material that wraps around and covers Mr. F's arm.

The orthosis' final function is being easily accessible. It takes about thirty seconds to put on and take off the device by laying out the device flat on its front, place arm, then using the Velcro straps to hold the device on the arm. Also, the device consists mainly of cloth and fits the given arm therefore it is mobile.

Materials, Components, and Assembly

The final design consists of three components, one on the upper arm, the lower arm, and elbow piece concluding in one orthosis. There are only a few parts required to re-build our device. The three components are made of soft cloth and gauze, to provide comfort to the skin. Velcro straps are attached to the parts to provide ease when putting it on. There are hooks attached to the parts, made of steel and they provide a sturdy base to hold the strings in place. The strings are doubled up to provide extra strength so it does not break under pressure. All the components are sowed together so it does not fall apart.

Most of the materials required can be found around the house or in a tool shed. However, if the builder had no products at hand, they would require a roll of gauze, 3 pieces of soft cloth, 14 rings, 2 hooks, Velcro straps and a roll of string to build the device.

The tools used to build the orthosis consist of a sowing kit, pin and thread, scissors, pliers, and paper clips.

It takes about an hour to assemble and thirty seconds to put on. Some instructions that might be needed would be to measure the upper arm and forearm of the client then cut out pieces of gauze and soft cloth that fit the circumference of their arm. Then lay out the gauze layer on top of the soft cloth layer then sow them together through a vertical line down between them. Then sow on the rings to the upper and lower arm gauze pieces. Finally tie the two strings connected between the upper and lower arms.

Cost

These items will cost less than $20 combined, as none of these are very expensive parts and they can be bought at a local Home Depot or a dollar store. In order to make a profit the price for the user would range between $15 and $18.

User Acceptance and Compliance

User compliance has been considered by making the elbow orthosis mobile by making the device light and fitted to the user's arm, comfortable by using light, soft cloth and gauze material, and easily accessible by only using Velcro straps to put on and take off the device.

The user uses the device by adjusting the string hooked onto various leveled rings on the upper arm to extend and flex the arm.

Mr. F will want to wear the orthosis because it performs the functions required for Mr. F's arm to heal while fitting the shape of Mr. F's arm therefore Mr. F can wear day-to-day attire on top of the device.

With respect to cosmetics, the look fits the arm of the user.

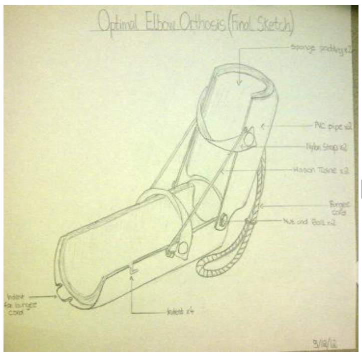
Finally, considering safety, the device has no hazardous materials!

Benefits

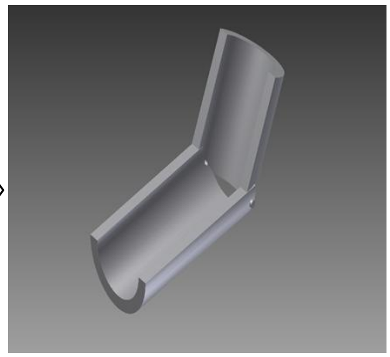
Our design is better than existing devices because it performs all the functions required presented in the problem statement stated by Tara about Mr. F. Existing devices are overpriced, consist of performing one particular function, and may be heavy or not distribute the force of the orthosis, and may irritate the user's skin unless soft materials are used.

Optimal Elbow Orthosis

Optimal Engineering
F 01 - T 05 - 1



The final sketch we based our design off of.



A simple CAD representation of what our final prototype will look like

The final prototype that our team built

Problem Description

Tara Packham, an Occupational Therapist at the Hamilton General Hand Clinic, has a patient who is suffering from severe burns to most of his body. These burns have cause Heterotrophic Ossification, the development of extra bone due to a build up of calcium, at his elbow. His injuries limit his hand function bilaterally, causing difficulty when adjusting angle mechanisms, knobs, and straps on traditional elbow orthosis. Traditional elbow orthosis also cause heavy irritation and blisters to the patient's injuries. The patient requires independent use and adjustability of the orthosis, as he does not wish to rely upon others for help. Due to these reasons, Tara Packham requires a dynamic elbow orthosis that can minimize the patient's pain, be comfortably adjusted and worn, and can be independently used. This type of orthosis would be applicable to other patients with severe injuries to the arm.

Design

The orthosis will take up about two thirds of his forearm and half of his triceps. The exact lengths of the pieces will depend on the size of the user's arm and are easily changeable. The orthosis mass is approximately 750g, though it depends on the size of the user's arm. The length and strength of the bungee cord is easily changeable to match the user’s requirements. The prototype we built used only two straps to hold the arm in place, though the user's arm is most likely larger, which may require more straps.

Functionality

The brace allows the user to adjust the angle to the which the elbow is bent, providing both a flexion and extension force when needed to ensure that the elbow will stay at the required angle. This allows the user's elbow to gain flexibility and strength as it is placed at different angles. Pieces of string and bungee cord allow for the angle adjustment to be made with ease, even with the user's injuries taken into consideration. Padding helps keep the user comfortable and ensures that his injuries do not become irritated. All of the user's requests are fulfilled in the device.

Materials, Components, and Assembly

To build the orthosis, you would need to have PVC pipe, bungee cord, nuts and bolts, Sponge padding, nylon straps , snaps, and mason twine. All of these materials would be easily available at a local hardware store. The device could be built using only a drill and some type of saw, though a cutting tool like a grinder would be helpful. Building the device may take 3-4 hours at first, but with experience that time would go down substantially. Some basic instructions of where to drill, where to cut, and where to put in nuts may be needed. The only special instructions which would be required would be where to cut the indents in the upper portion of the brace for the twine to slide into.

Cost

The nuts and bolts used cost approximately $0.80. The PVC pipe costs around $15.00, depending on where you purchase it. The bungee cord used cost $2.00. More cords may be needed depending on the strength and size of the user's arm. The mason twine costs $3.00 for an entire spool. The cost of the padding may change depending on the type needed for the user's injuries, the type we used cost $2.00. The nylon straps cost $2.00. The snaps we used cost $6.50. In grand total, our entire prototype cost $31.50 to build. This amount may change in the final product if materials are changed.

User Acceptance and Compliance

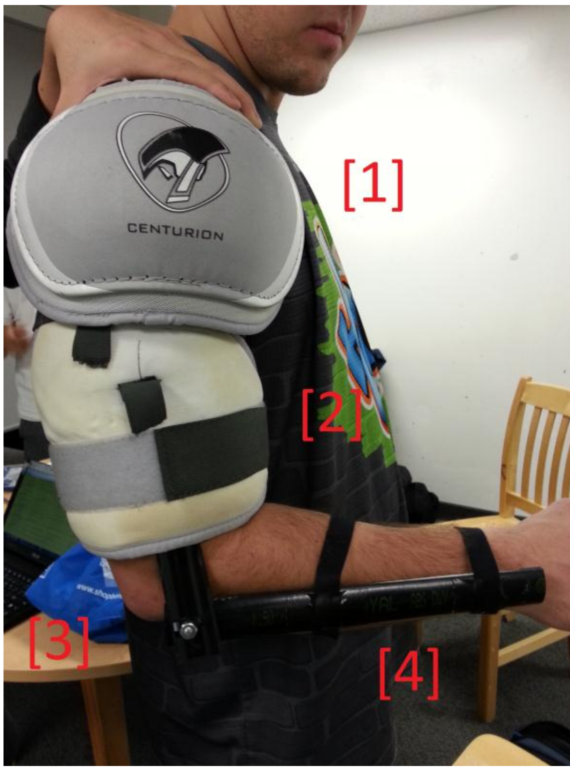
The user’s comfort and ability were a large concern of our group, which was taken into consideration for our design. We have added soft foam padding to ensure that the irritation of the user’s injuries is limited, and we have done as much as possible to make the orthosis easy for the user to adjust. Our design uses strings and a bungee cord to apply the flexion and extension forces respectively. These components are easy to slip a finger into and pull out, ensuring that the user will be able to adjust the device with relative ease. The colour of the device is easily changed with paint. Nylon straps with convenient flaps on the end allow the user’s arm to be kept within the device, and be removed from it with ease. Sharp edges on the device have been kept to a minimum, to ensure the safety of the user. In cases where sharp edges were necessary, they have been rounded down to help limit any potential injuries. We met almost all of the objectives for our design, such as keeping the cost to a minimum, allowing the user to use the device alone, and using materials readily available to the Clinic.

Benefits

There are several key benefits which prove that our design is better than those of our peers. The first being how easily obtained all of our components are. Almost all of the materials we used in our design are already available to the Clinic, and any that they do not already have are available at most local hardware stores. Another benefit is the fact that our instructions are easy to follow and they are relatively simplistic. The ease with which Mr. F can adjust our orthosis is another clear benefit. The use of strings and slots ensure that Mr. F can easily change the angle of the orthosis without injuring his fingers, and without required him to apply much force. The bungee cord on the bottom of the device is also easy for the user to slip on and off as required. Another benefit is the use of padding. The padding helps to increase User compliance as well as comfort and safety. The nature of all of the materials we used in our design helps to ensure that the user's injuries are as safe as possible. All of these benefits prove that our design is superior to the various designs created by our peers.

Splinter's Inc. Arm Splint

Team Name
F01 - T06 - 1



[1] is the location of the strap around the torso, demonstrating self support.
[2] is the upper arm strap, which holds up the upper arm, demonstrating self support.
[3] is the bolt and pin rotation system, which allows the user to perform flexion and extension of the elbow, demonstrating the active range of motion and the ability to lock the elbow in place.
[4] is the forearm straps, which support the forearm and demonstrate the ability for forearm rotation.

Problem Description

Mr. B, a 23 year old single male, is a patient at Hamilton General Hospital who had a motorcycle accident. After the accident, Mr. B had a compound fracture in his right hand, dislocation of the right shoulder, and degloving of the right wrist with tendon and nerve lacerations. The brachial plexus was also destroyed, restricting any motion of the shoulder, and he has no working muscles in or around his elbow. Mr. B's occupational therapist and our client, Tara Packham, would like a device to be made for Mr. B due to the cost and lack of availability of commercial splints. Tara would like a device that is able to vary forearm motion, lock the elbow into position, and allow Mr. B to work on active assisted range of motion exercises.

The device also needs to add very little or no weight or stress on Mr. B's shoulder.

Design

The design is light and self-supporting for the user. As seen in the visuals above, the shoulder component is strapped to the forearm to reduce subluxing of the shoulder. The shoulder component also is strapped around the torso of the user to keep it in place. This all adds to the size of the design, but the design was refined to the smallest it could possibly be. The weight is kept down by using perforated thermoplastic and lightweight foam as main materials.

Functionality

The design was made to provide specific functions that the client relayed. The design allows for forearm rotation by the user, is self-supporting, locks at the elbow, allows for active assisted range of motion exercises, and prevents pain for the user.

Materials, Components, and Assembly

The design is made of these materials: perforated thermoplastic for the shoulder cover, polystyrene plastic for the arm rods, velcro straps for the arm, an elastic strap to go around the user's torso, and minor components such as the pin to lock the elbow's position the bolt for the rods to rotate on, and foam. The only tools needed to construct the design are glue, a sewing machine, a drill and the thermoplastic water bath. Time to construct is estimated between 10 and 15 minutes. To construct, the client will need to cut the thermoplastic into 1 piece for the shoulder. The piece will be heated and molded to the user. The rods will be connected putting a hole in them with a drill and filling it with the bolt. The rods will be connected to a strap around the upper arm, which will be have string sewed to it and then sewed to the shoulder thermoplastic. The rods will be covered in foam for comfort.

Cost

The cost of the design is estimated to be around $94.00. This includes approximately $60.00 for one 18" by 24" piece of perforated thermoplastic, $6.00 for three straps of velcro, $4.00 for two 8" by 10" sheets of polystyrene, $14.00 for one elastic nylon strap, and $10.00 for the minor components such as nuts, bolts, a pin, and foam.

User Acceptance and Compliance

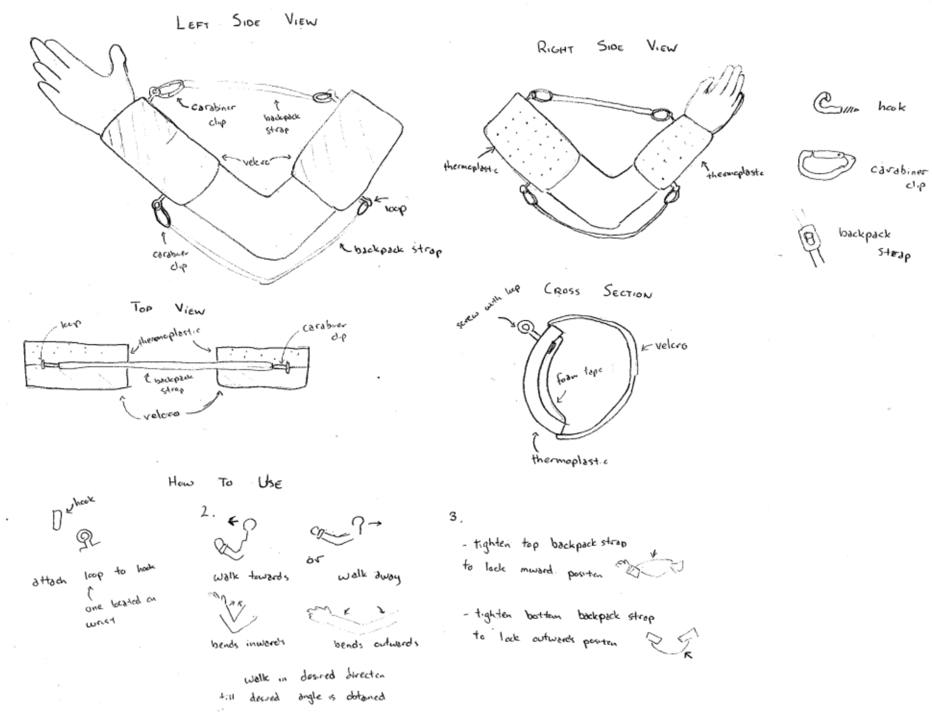
Splinter's Inc.'s conversation with the client's representative gave off a strong sense of compliance for the user, in his own opinion. The representative said that the user would like to wear a design just like ours. The design is lightweight, and has foam covering the arm rods to increase the comfort. The thermoplastic shoulder cover is made of perforated thermoplastic which allows for the skin underneath to breathe. The design's functional prototype showed that the design will be easy for the client to get on and take off. This is because of the adjustable strap around the body and the velcro straps that can be opened for the arm to easily get in.

Benefits

The design we made has multiple benefits over other designs for the user and client. The manufacturing of the design is quick and easy, with few components needed. The cost to manufacture the design is cheap. All materials and components needed to manufacture are easy to get because they are available at any hardware store. The design solves almost all of the problems presented by the client. It allows for range of motion, supports its own weight, locks at the elbow, and allows for forearm rotation.

MPSA Orthosis

MPSA
F 01 - T 06 - 2



Problem Description

The problem involves Mr. F, a 29 year old man who has developed complications after being burned in a fire. Mr. F suffered second and third degree burns covering 20% of his body surface area. He recently underwent surgery to return motion to his elbow after it developed heterotrophic ossification following the fire incident and the subsequent weeks of critical care treatment. There are severe burns on both arms and both hands, and recent skin grafting on the forearm. Tara Packham from the Hamilton Hand Clinic has asked the team to design and prototype a dynamic elbow orthosis that can increase the range of motion of the elbow through extended rehabilitation. The damaged skin is sensitive to pressure, and neither hand has a high level of dexterity in the fingers. Mr. F would like to be able to remove and adjust the device independently with little discomfort.

Design

The design is relatively simple, and involves two major components connected with tension (backpack) straps. There are two arm braces which can easily be identified on the sketch above which will be constructed from thermoplastic lined with foam tape for padding. The straps connecting them will be backpack straps, each with a carabiner clip on each end. Also attached to the arm braces are eyebolts, one on the top, and bottom of each brace. The brace will cover around 40% of the forearm, and 50% of the bicep. Overall the combined weight of the device will be roughly one pound.

Functionality

From a functional standpoint, the device is very effective. The orthosis helps the user independently adjust and secure his elbow through a full range of motion. This will help the user to regain full motion of his elbow after recovering from the burns and bone ossification. Based on the information provided regarding the user the design meets the needs put forth, regarding independent use and adjustment, comfort and low cost.

Materials, Components, and Assembly

The device consists of two relatively large pieces of thermoplastic, two backpack straps, four eyebolts, foam tape and four carabiner clips. If not readily available at the clinic the rest of the supplies can be found at any local hardware store. The overall construction would likely take no tools to create and would take less than two hours total. To create it the thermoplastic must be molded to the shape of the arm, and then foam tape placed inside the arm braces in all locations where the victim is not burnt. When molding the thermoplastic, the eyebolts can be molded directly into the plastic. The backpack straps and carabiners can be clipped onto these eyebolts.

Cost

The clinic has access to thermoplastic, and additional costs include $5.00 for backpack straps, $1.00 for each carabiner, $2.00 for foam tape, $10.00 for Velcro and less than $1.00 for the eyebolts.

User Acceptance and Compliance

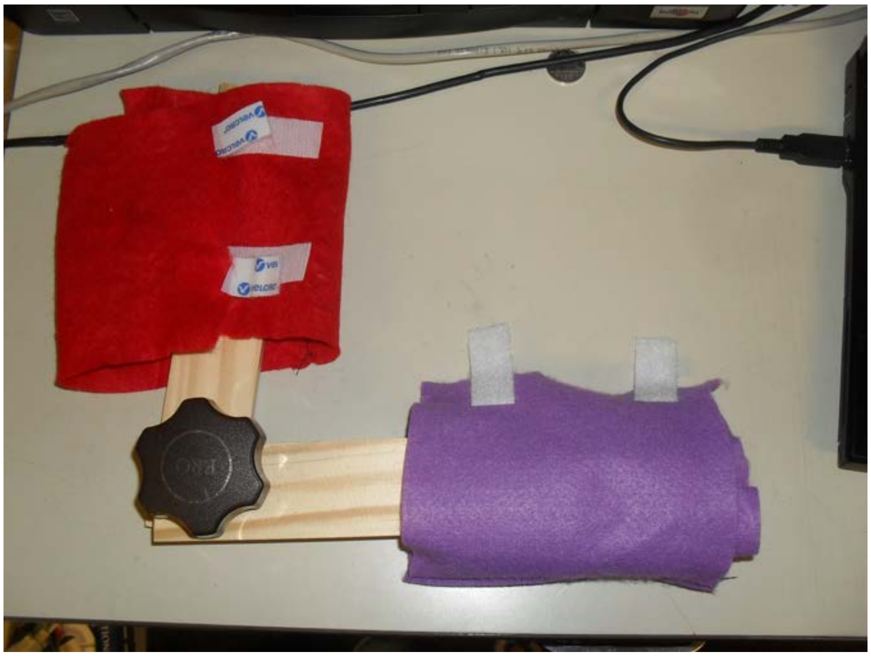
The user, Mr. F, has greatly been considered in various parts of the final design. As identified by the original problem statement, two objectives were laid out by the user. Firstly Mr. F wanted the design to be comfortable and reduce pressure on his burns and grafted skin, which are still healing. This was addressed by ensuring that as little pressure as possible was placed on the arm, and what pressure is placed on the arm is spread out along the undamaged skin. This was achieved by having the arm brace lined on the interior with foam tape, customized to Mr. F's burns. If the foam tape is placed on locations where the arm is not burnt, then the brace is elevated off the arm in all places where the arm is burnt, ensuring that no burns are in contact with any part of the arm brace. The second objective addressed was that Mr. F wanted the ability to put on, utilize and remove the orthosis all independently, and within the scope of the limitations due to the injuries he is recovering from. This was addressed by reducing the amount of adjustment and involvement required by the opposite hand, as this hand is damaged and painful to use. The brace is attached to the arm by securing Velcro straps, which are within Mr. F's ability to secure; furthermore, the adjustment of the elbow itself does not require very much involvement from the opposing hand. To move the elbow to various positions requires a substantial amount of force, which Mr. F is not able to apply with his hands in their current condition, so instead the arm is adjusted by mounting the wrist to a hook on the wall and using body weight to walk forwards or backwards until the arm is at the desired location, and then adjusting a backpack strap to hold the arm in that position. Once this strap is secured, Mr. F can remove his arm from the hook on the wall and his arm is now locked into the desired position or angle.

Benefits

One of the benefits of this design is that the design is easy to take off and on independently. The main reason behind this is since the orthosis is constructed with thermoplastic that is molded to the shape of half of the fore-arm and bicep it is easier to stay on when tightening or loosening the Velcro straps. Another reason why it is easier to put on and take is the Velcro straps have tabs on the end which provides the user with a simple way of putting on and removing the device. When wearing the device, the adjustment and locking of the angle of the brace is completely independent. Not only is it independent, but it minimizes required interaction form the opposite hand. Minimizing this directly relates to Mr. F's condition as his opposite hand is still damaged and cannot carry out the force required to move his elbow in a conventional way. The overall use of common and readily available materials paired with the overall low cost and ease of construction of the device all act as benefits to the client.

Joint Elbow Splint

Firm Thirty-Two
F 0 1 - T 0 6 - 3



Problem Description

The problem presented to the team involves Mr. F, a twenty-nine year old male, who has suffered from second and third degree burns on his face, arms, and upper back. Mr. F also suffered from heterotrophic ossification, which has now made his elbow immobile. Tara Packham asked the team to design a device that will help Mr. F rehabilitate his elbow. This device should facilitate bilateral movement of the elbow, should be comfortable on the already irritated skin, and should be made with low cost materials available to the clinic. Mr. F also desires a device that he will be able to use independently. Optimally the device should allow Mr. F to gain use of his elbow for daily activity, and must be made of materials available to the clinic.

Design

Our design is made out of two main parts, the two cuffs, and the joint. The cuffs are both made out of cloth with gauze sewed on the inside. The gauze is used to keep Mr. F`s skin comfortable. The cuffs also have Velcro tabs on them for easy getting on and off. The other main factor of our design is the joint. The joint is used to change the amount of extension and inflection of the elbow. This is done by using a loaded spring and a large knob. The spring is attached to the knob so that when the knob is pulled upward the arm is free to move. When the knob is released a peg locks the arm in place by using the spring. The joint is connected by two pieces of thermoplastic to support the arm. Finally the outside of the arm has another two pieces of thermoplastic that are able to move freely, providing more support for the arm. The device is light weight because of the small amount of lightweight materials that were used. The device also goes from the forearm to the client`s bicep.

Functionality

The device our group made satisfies the functions requested by the client as a result of a number of the features. First, the device has a loading spring mechanism which allows the user's arm to be fixed in various positions that can be easily adjusted without another person's help; this part of the design makes the device capable of rehabilitating the user's elbow by slowing increasing the user's ROM throughout the use of this device. Additionally, the client requested the device be comfortable on already irritated skin, to achieve this we made it so that gauze would be the only thing to touch the user's skin. We believe this will be comfortable to weaker skin such as the skin on Mr. F's burned arms. The device is also notably light so it should not burden the arm, making the user uncomfortable. Another feature is the elongated Velcro straps which can be used like tabs to make the device easy to put on and take off without help. From these features the user should be more independent. Overall our device satisfies all of the functions that the user should need.

Materials, Components, and Assembly & Cost

Joint Elbow Splint is cheap and simple to make. The simplicity of the design and its components allow the orthosis to be made within roughly three to four hours. The plastic components of the orthosis are made out of thermoplastic. The main reason for the choice of thermoplastic was its availability, affordability and because it is easy to mold into a variety of shapes. One 18" by 24" sheet of thermoplastic costs $67.25 and can be bought from Kyle Lee, who has provided our class with thermoplastic. This is more than enough material to build our design and the excess can be used for subsequent elbow splints. The spring loaded mechanism in our design can be made from a metal rod (preferably aluminum due to its weight), springs, and a cheap knob. These materials can be easily obtained at Canadian Tire, if not already present at the clinic. The gauze, lotion and aloe that are directly applied to the arm are easily obtained at the clinic. It does not matter what type of cloth material is actually used to warp around the forearm and upper arm, since it will be resting on top of the gauze. However it would be best to choose a material that is cheap and soft, such as wool. The total cost of creating this orthotic elbow will be within the 80 to 100 dollar range.

User Acceptance and Compliance

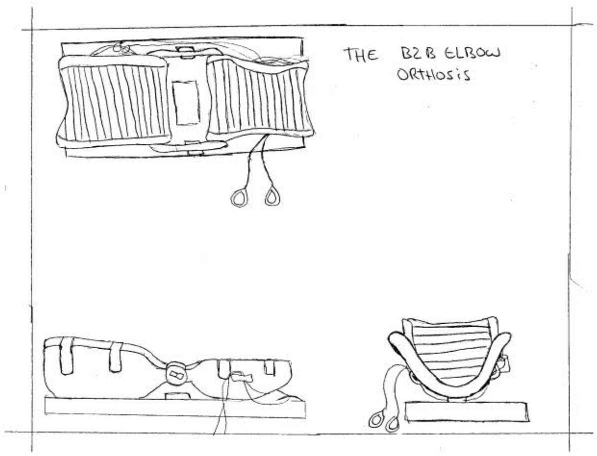
The product has been constructed in a way that makes user compliance a pre-requisite. In the absence of any mechanism that the user can override or detach, the device functions as a single unit that simplifies user compliance considerably. The user slides his arm into the mechanism and secures it in place using the Velcro straps. The design minimizes effort required in putting it on and off. The mechanism is comfortable. The body of the apparatus is lined with gauze and aelo vera lotion to minimize friction and provide a cushion for hard impacts. The gauze also absorbs any seepage that might result from burned skin. Given the simplicity and usefulness of the mechanism, the user will gladly use this product. The apparatus can be painted for aesthetic appeal.

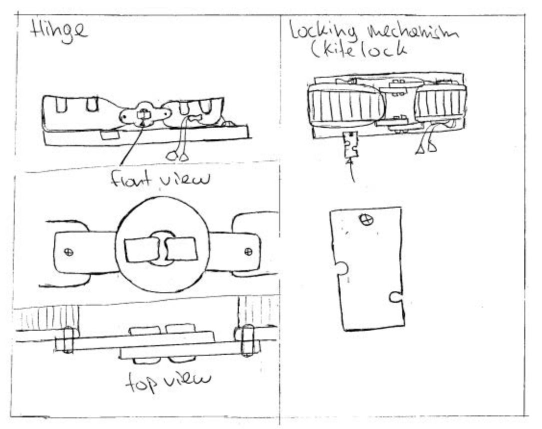
Benefits

The team was careful in meeting all the client's needs while designing the device. Firstly, the client will be able to make adjustments easily, because of the loaded spring that was used in the device. Secondly, our team used low cost materials that could be found in the clinic or any local hardware store, making out device inexpensive. Moreover, the client will be able to feel to put on and take off the device independently because of the Velcro tabs on the device. Furthermore, the use of thermoplastic in our device resulted in making our device light, so the client's burned skin should not be affected when wearing the device. Lastly, our team decided to use gauze to make contact with his burned skin, because it will soothe his irritated skin, and eliminate seepage from the burns. Since the device meets all the client's needs, the team's device should be reliable and efficient to use.

The B2B Elbow Orthosis

Back to Being Engineering Firm
F01-T07-1





Problem Description

The problem presented to the team by Tara Packham, an Occupational Therapist at the Hand Clinic of Hamilton General Hospital. Her patient, Mr. F, is a victim of an accidental fire. Mr. F sustained second- and third-degree burn injuries to twenty percent of his body surface area, specifically to the upper half of his body, as well as inhalation injuries. Due to the fire, his left elbow developed heterotrophic ossification which fused the two long forearm bones connected to his elbow, causing complete arm immobility below the shoulder. An orthopaedic surgeon implanted a hinged elbow splint after removing some of the bone structure build-up fusing his bones, which gave Mr. F a very limited range of motion. Mr. F seeks a therapeutic device to increase range of motion in both extension and flexion. The device should be able to be set up and used independently by the user. Such a device would ideally allow more independence to the user during recovery, and minimize pain during therapy.

Design

The elbow splint is comprised of two thermoplastic moulds of the bicep and forearm, attached via a thermoplastic hinge in between (left visual),; adjusted via a set of strings that when pulled cause flexion or extension; locked by a kite lock (right visual) that keeps this angle between the thermoplastic moulds by holding the string taught; and supported by a lightweight plank of wood attached to the bicep portion of the device. The thermoplastic moulds and string handles are covered with a foam material. The device is worn from a few inches below the shoulder, around the elbow, to just above the wrist. It is relatively lightweight, as it comprised mostly of thermoplastic, and the plank of wood is placed on the lap or another surface so that the device does not weigh the shoulder down.

Functionality
Our design uses a simple hinge to allow an angle between the bicep and forearm pieces of the orthosis. The locking mechanism for our device is a kite lock located at the bottom of the device. The string used for extension or flexion is looped through the lock so that the forearm piece cannot move. This provides the force necessary to increase the user's range of motion. This device can also be independently set up and used due to its easy handles and straps. Our orthosis also considers comfort with its foam padding. The entire arm of the user is supported with the plank base at the bottom of the device. Our device meets all the requirements of the client who originally desired an increase in range of motion in extension and flexion and minimal pain during therapy.

Materials, Components, and Assembly
The materials needed to for this elbow orthosis include: a sheet of thermoplastic (12in by 18in), a plank of wood (60in), screws, foam padding, string, and household tools such as a screwdriver and knife. All of these materials other than the thermoplastic could be purchased from a nearby hardware store, while the thermoplastic needs to be obtained through a clinical retailer. Only simple tools, such as a screwdriver, knife, cutting board, a pan, and stove are needed to make this elbow orthosis. This elbow orthosis only takes 6 hours to build and assemble, and less than 1 day to collect the necessary materials. Instructions on how to make the hinge, cut the thermoplastic, attach the plank, and make the string bridges might be needed. The assembly part of the design was designed such that it could be assembled and used without instructions. The elbow orthosis will secure the arm from any bacteria, hold the bone straight and increase the range of motion of the arm, while the burned skin is allowed to recover and the user himself will be able to take this orthosis anywhere for convenient use.

Cost
The materials used for the “B2B elbow orthosis” are quite inexpensive and could be found in any local hardware store. The prices for each material range from between $1 to $10 with the exception of the thermoplastic sheet which is the most expensive material that costs about $30 per sheet. Overall manufacturing cost for the product is an estimate of $45

User Acceptance and Compliance
The user’s comfort and compliance has been considered in this project. To put the device on, the user must unfasten the Velcro straps, place his arm into the thermoplastic moulds and replace the Velcro straps to fasten himself in. He then can use the flexion or extension strings to pull the device up to his angle of arm. From this rest position, the strings can be further pulled to push the elbow past its physical limits in order to increase range of motion, and then he simply places the string into the kite lock. To remove the device, he must take the string out of the notch, unstrap the Velcro and take his arm out of the thermoplastic moulds. The device has been designed to be comfortable by using breathable foam material on the inside of the thermoplastic moulds and as a handle around the string. It can be worn seated or lying down. It has a smooth, clean surface that can be decorated with friends signatures or other aesthetically pleasing things. It is relatively small and lightweight, so wearing the device in public is no problem as long as it is used when seated or lying down. The device is also affordable, as it costs less than $60 in materials to manufacture, and safety has been taken into account by the fact that the user can easily force and not force his elbow into extended range of motion.

Benefits
The user will be able to set up and operate the device by himself. Also, since the device is adjustable, Mr. F can use the device anywhere as long as he remains stationary.

The orthosis is made of thermoplastic which means that the device can be moulded perfectly to fit Mr. F’s arm at any stage in his therapy. For comfort, the lightweight moulds are fitted with a foam mat, as well as the strings that operate the flexion and extension angle adjustment. The thermoplastic is lightweight and is used as a stationary device and the user can be seated or lying down.

Also, because the device is stationary when being used, the weight of the device does not affect the user. The foam mat is also beneficial because the mesh material breathes.

Every aspect of the design has incorporated the clients’ ability to recover 100%. For example, the firm thermoplastic normally has sharp edges, but in the device’s edges have been flared out and wrapped in foam to prevent injury. While the client is using the device, a foam cushion is placed between the hinges so that they may rest their elbow comfortably.

The Glide

Thod Engineering
F01 - T07 - 2

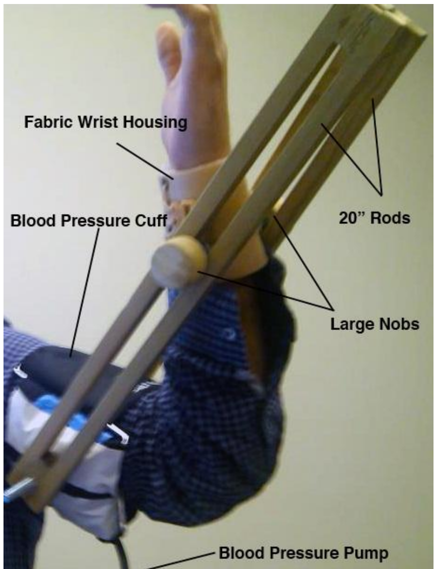


Figure One

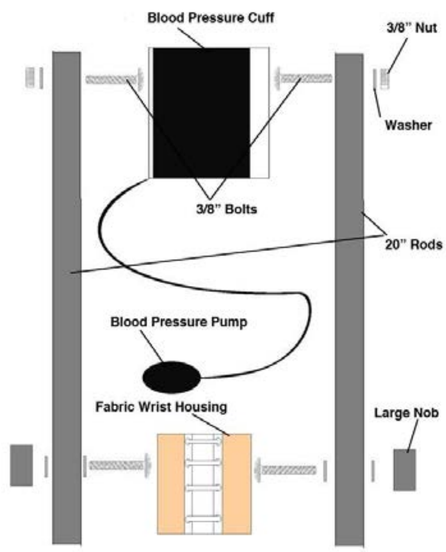


Figure Two

Problem Description

Mr. F has sustained injuries in a house fire. The extent of his injuries is mainly to his left arm. They include varying degrees of burns as well as heterotrophic ossification to his elbow. These burns and ossification have left Mr. F with limited bilateral movement and limited fine motor skills. Additionally, Mr. F's elbow is locked in place and cannot express a full range of motion to maximum abduction and extension. The elbow splint being designed for Mr. F (the "Glide") will force his elbow to bend. The splint will be dynamic thereby allowing Mr. F to select the degree that his elbow is bent at and will vary according to Mr. F's pain and comfort thresholds. The splint will be used as therapy for hours at a time until he regains the full range of motion of his elbow. Due to Mr. F's injuries, a normal dynamic elbow splint will not work since: (a) he has trouble changing the mechanism's angle because the nobs are too small; (b) he has a hard time fastening Velcro straps; and (c) his burned skin quality puts him at risk for infection and discomfort if the straps cause blisters. Also, Mr. F would like to be able to use the splint without the assistance of his parents and thereby allow him to remain independent in his rehabilitation.

Design

The Glide's design is relatively simple compared to other designs on the market. It is compact, lightweight and very easy to use. The total weight of the Glide is less than one kilogram; therefore it places little pressure on the arm. The design for the Glide consists of three main components: (a) the blood pressure cuff; (b) the fabric wrist housing; and (c) two rods. Once in the correct position on the arm, the blood pressure cuff sits four inches above the elbow and the fabric wrist housing sits right at the wrist. The two rods are connected from the blood pressure cuff to the fabric wrist housing on both sides of the arm. The fabric wrist housing component is not locked to a set distance along the rods. Therefore, it is free to slide to any distance thereby changing the angle that the elbow is bent. Figure one demonstrates one of the many positions that the Glide can be locked in.

Functionality

The purpose of the Glide is to act as a dynamic elbow orthosis for Mr. F. The Glide will provide therapy for Mr. F's elbow joint. By gradually forcing the elbow to bend at larger and larger angles, the arm will slowly regain its full range of motion. Our prototype of the Glide achieves this by wedging the wrist away from the shoulder with two rods. As the rods wedge between the wrist and shoulder, the elbow bends at a greater angle. Our design allows Mr. F to lock the splint at any angle for the required duration based on his comfort and pain thresholds. The Glide enhances instead of restricts Mr. F's already limited motion and can be used in conjunction with his daily activities.

Materials, Components, and Assembly

The Glide consists of two 20 inch rods, one blood pressure cuff, one fabric wrist housing, four 3/8" in diameter bolts, four washers, four 3/8" in diameter nuts and two large nobs. Figure two illustrates an exploded view of how the Glide is assembled. It is very simple to construct and requires no special instructions. Excluding time for glue to dry, the Glide can take as little as one hour to build. The blood pressure cuff can be found at any local medical supply store and the other materials can be found at any local hardware store.

Cost

The cost to the client is simply the cost of materials and time to assemble. Material costs are approximately $56 including taxes. The cost to the user is relatively inexpensive considering the Glide will last for the full duration of therapy which can be a couple of years.

User Acceptance and Compliance

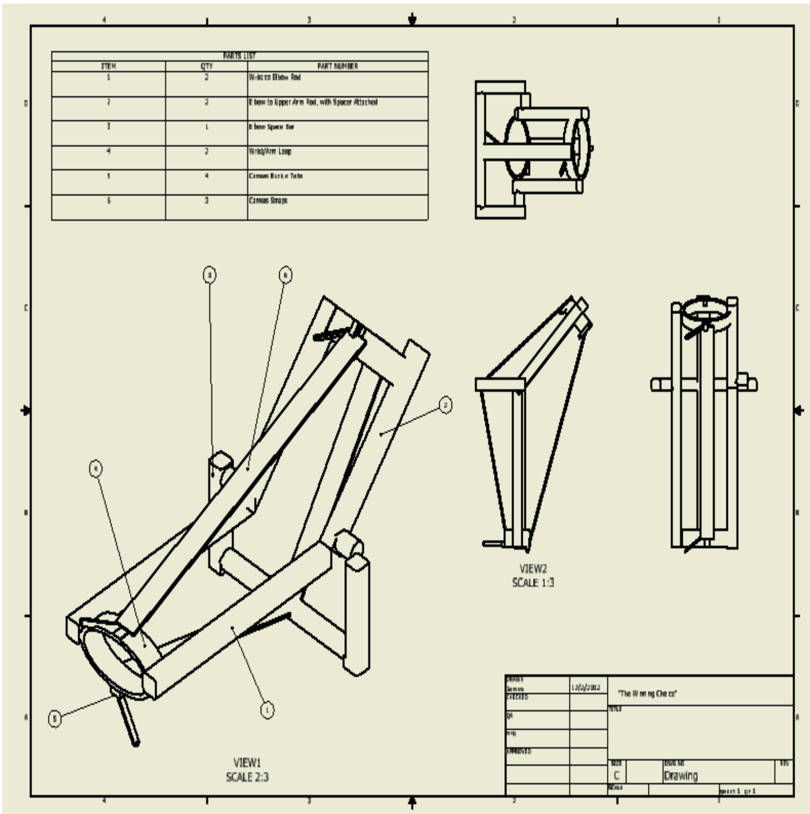
When designing the Glide, we took into consideration the needs of the client as expressed to us. The Glide must be comfortable, easy to use, require no extra assistance from the user's parents and be able to perform the function of a dynamic elbow orthosis. Putting on the Glide is very simple and will not cause Mr. F any pain or discomfort. Due to the large inner radius of the blood pressure cuff, Mr. F is able to easily move the Glide up his arm. The two rods are attached to the blood pressure cuff which Mr. F can also use to help move the Glide up his arm. Mr. F then slips his wrist into its respective holder and simply pumps up the blood pressure cuff to the desired pressure. Large nobs attached to the wrist component are tightened when the elbow is at the correct angle which locks the Glide into place. The pressure around Mr. F's arm created by the blood pressure cuff holds the Glide in place. The blood pressure cuff allows Mr. F to adjust the pressure based on his comfort while also providing a quick release if he needs to remove the Glide in an emergency. To remove the Glide, you simply remove the pump attached to the blood pressure cuff. This deflates the cuff thereby allowing the Glide to move down Mr. F's arm the same way it came on. In terms of comfort, the Glide is designed to evenly distribute its weight and have minimum contact with Mr. F's arm therefore it will cause him little discomfort. The blood pressure cuff and the wrist housing will all be padded with soft materials to add to the Glide's comfort. In terms of the ascetics, the Glide is relatively small and compact and should not draw much attention if Mr. F were to wear it in public. Also, the rods on the splint can be painted whatever color Mr. F chooses. Finally, in terms of safety, the rods have been sanded down, the split has been removed of all jagged edges, the bolts have been cut to the smallest length possible and all metal pieces will be covered in soft fabric.

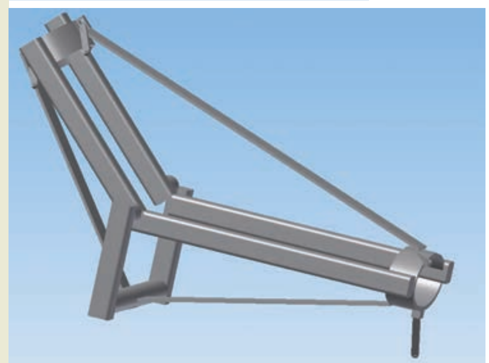
Benefits

The Glide is a much better solution to the problem than those of our peers because we overcame the three main problems with all other splints. Mr. F does not have the fine motor skills or range of bilateral movement to affix Velcro straps. The Glide is unique since we have designed a way of attaching it to Mr. F's arm without the use of Velcro straps. Also, most splints have small nobs which are hard to adjust. With the Glide, we made large user-friendly knobs that Mr. F will easily be able to turn. These nobs can be customized to Mr. F's hand to allow for even easier use. Finally, most splints are heavy and place a lot of pressure on the user's arm. The Glide is very lightweight so that it does not cause discomfort to Mr. F while also allowing his burns to heal.

The Winning Choice

Phoenix Innovations
F 0 1 - T 0 7 - 3





Problem Description

Our patient requires a device that allows him to further extend and flex his arm to his improve range of motion. He needs the device to be comfortable since his skin is very sensitive and allows him to use it with poor dexterity.

Design

The weight of the design is approximately – pounds. As the picture suggests the design is going to be closely fitted to the arm.

Functionality

It provides tension for extension and flexion. The device allows the user to adjust at which the arm is held. The device applies pressure on the arm to hold the arm in place and to improve his range of motion. Also our device constrains the range of motion of the user's arm so that it is only flexing and extending in the sagittal plane.

Materials, Components, and Assembly

The device requires PVC piping, PVC cement, canvas straps, loops, adjusting buckles, hinges, screws, fleece and duct tape. An alternative to the PVC could have been thermoplastic or aluminum piping. Using the aluminum piping would allow the device to be more compact and more portable and also the use of PVC cement would not be needed, which would reduce the overall cost of the device. Thermoplastic could be used as the piping and since the clinic already has thermoplastic it would be more convenient and also there would be no need for PVC cement. These materials can be obtained through Home Hardware and Dollarama. The tools required for constructing it are hacksaw, sewing kit, brush, milling machine, and file. The instructions for building the device:

- Measure and Cut PVC into pieces
- Glue pipe sections onto joints
- Cut slits into piping to insert straps
- Cut straps to desired lengths
- Sew the straps to a buckle
- Attached hinges to the two joints
- Repeat process for all straps and joints

Cost

It will cost the clinic $20.40 and it will cost the user depending upon what the clinic might want to charge the client. We would recommend $25.

User Acceptance and Compliance

Yes all the requirements that the user requested have been meet. The user can take the device on and off by loosening the canvas straps around the wrist and bicep to easily slide arm out and into the device. The device has been designed so that there is soft material wherever there is contact to Mr. F's skin. Also the design has a stand so the user can rest his arm when using the device for long periods of time. The user pulls the loops attached at the bicep to flex his arm and uses the strap at the bottom of his arm to provide tension to allow for flexion. Yes the user will want to wear our device since it will satisfy all the requirements that were suggested by the user. The device looks manly as it contains PVC piping and also it is gray. The Winning Choice is safe since the only major safety issues regarding it is that if Mr. F tightens the straps too much it could reduce blood flow to his arm, which could lead to him damaging vital part of his arm. Also if the straps are a little bit loose which could lead to friction and irritation over time. We met all our objectives since the device is cheap, safe, comfortable, and finally easy to use.

Benefits

The benefits of our design is that it is light weight, cost-effective, easy to build, portable, works for extension and flexion, adjustable tension, and easy to take on and off. The weight of the design is a plus point since it only weighs 2 pounds. The total cost of the final device is $20.40, which makes our design affordable to our client and affordable to the patient. This makes our final device competitive with all the other devices presented by our acquaintances. The device is relatively easy to build and only take 1 and a half hour to build, which means that Tara Packham could have the patient in and out of the clinic in one appointment, which is really convenient for the clinic. The device is portable since it can fold up and fit inside of a small bag. The device can be used for both flexion and extension which is a bonus for our device since our user Mr. F does not have to change devices for flexion and extension which would cost the clinic as well as the user a lot more money. Since the device allows for adjustable tension Mr. F can set the exact amount of tension that is required and make sure it does not cause discomfort. Lastly the device is easy to take on and off which means that with little effort Mr. F can operate then device.

InnovaSplintX™

MetaMorthoses Ltd.
F01 - T07 - 04

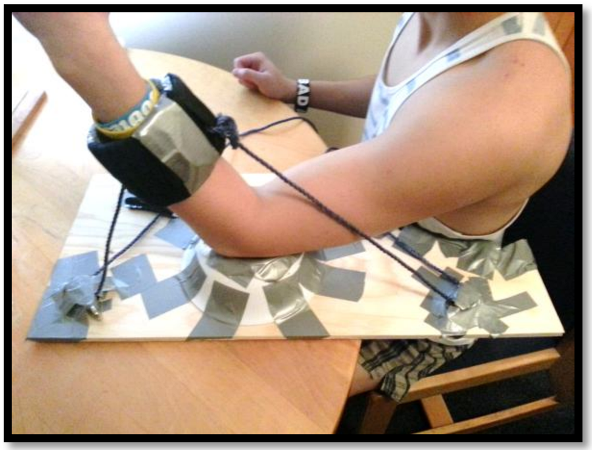


Fig. 1: This is the first prototype of the InnovaSplintX™.

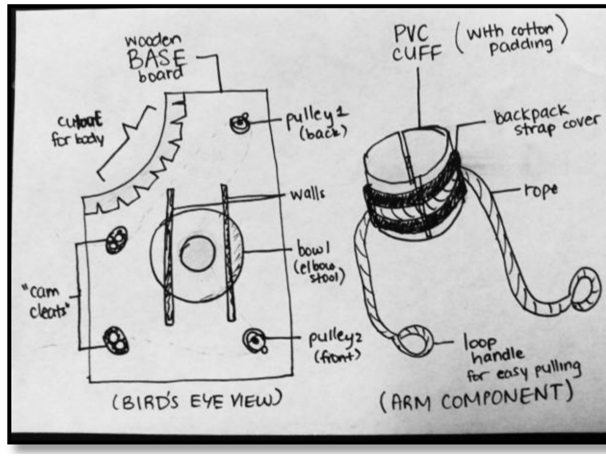


Fig. 2: This is a sketch of the two separate components of InnovaSplintX™.

Problem Description

The problem presented involves Mr. F, a 29 year old male who lives at home with his parents. He is a patient of Tara Packham from the Hamilton Health Science Centre Hand Clinic.

Mr. F had been under the influence of alcohol which led him to start a fire in his house as he fell asleep while smoking and lit cigarette. After laying in a hospital at Hamilton General Hospital for four months, heterotopic ossification occurred in his left elbow. After extensive surgeries, a generous amount of the calcium had been removed. However, he still did not have full range of motion in his arm. In terms of forearm rotation, his right forearm has full forearm rotation whereas his left forearm has no rotational capacities. Twenty percent of Mr. F's body surface area is still covered in 2nd and 3rd degree burns.

Though Mr. F's surgeon prescribed a hinged elbow splint, the swelling and stiffness in his fingers, hands and arms make it difficult to use this device. Currently Mr. F struggles with Velcro straps and putting the device on. He often needs the aid of his parents. He wishes to be more independent and does not wish to continuously ask for assistance.

Design

Our team has imagined a unique and innovative design that suits the needs of Mr. F and people alike. InnovaSplintX™ is designed to be a relatively light, stationary device used as a therapeutic elbow orthosis. When laid flat, the base takes up approximately two squared feet.

InnovaSplintX™ consists of two major components: a static wooden board that mounts two cam cleats, two pulleys, an elbow stool and support, and the wearable component, made up of two ropes attached on either side of a forearm cuff.

The user would sit up against the wooden base in the cut-out for their body. Next, they would wear the cuff on the forearm, and place their elbow on the elbow stool, which provides stability, elevation and comfort. These three parts of the splint are covered in excess cloth and cotton padding to provide user comfort.

Once in place, the user can either extend or flex their arm by choosing the specified, labeled rope. There are two walls built alongside the elbow stool which support and guide the arm during the extension and flexion motions. During this exercise, the board will want to slip, however that issue is easily solved with the presence of rubber stoppers on the bottom of the base.

For extension, the user would pull the rope that is stringed through the farther pulley and cam cleat. For flexion, they would pull the rope that is stringed through the closer pulley and cam cleat. The pulleys here are used to redirect the pulling motion, making it possible for the user to operate it independently (refer to Figure 1 above for direction of active motion).

Functionality

The functions outlined by the client were for the splint to support the arm, being able to adjust the angle of flexion and extension, and to lock the arm at specified angles.

As described above, InnovaSplintX™ is able to support the arm because it is stationary. It lays flat on a level surface with minimum slippage. For further support, the “valley-wall” built around the stool prevents the arm from falling or slipping sideways, restraining it to a vertical plane only, ultimately reducing unwanted pain and stress on the shoulder.

In addition, elbow angle variation is achieved with the pulley-rope system. As the user pulls the specified rope, the arm is pulled into extension or flexion.

Finally, the orthosis is successful in locking the arm at various angles via the cam cleats. Once the desired angle is maintained, the nature of the cam cleats allows the ropes to maintain tension at various distances.

Materials, Components, and Assembly

The InnovaSplintX™ requires very basic materials that can be found at any hardware store, such as plywood, pulleys, nylon ropes, cotton padding, tape and PVC pipes. However, there is an exception with the cam cleats as they are only found in marine equipment stores.

The tools required to construct this design can also be found in most people’s garages, such as a saw, drill, glue gun and scissors. Overall, with the appropriate tools and knowledge and some simple assembly instructions, this device can be built within two to three hours.

Cost

The cost applies to the client and user and it totals to approximately $60.

User Acceptance and Compliance

Our user-friendly splint design fulfils the important required therapeutic functions. It is also, as requested by the client, easy to use by oneself and without help from others.

There are two ways to put on this device: either slide the padded cuff onto the arm or open the cuff via its hinge and secure once it is in the desired position on the forearm. The latter option combined with the padded elbow stool allows for a comfortable experience without causing excess friction to burned and swollen skin.

InnovaSplintX™ is a simple mechanism that has a quick and easy setup, which means it can be used at home while watching television or during other leisure activities.

Moreover, it is designed with safety in mind. In other words, it is not a hazard to the user and their surroundings. The generous amount padding provides comfort while reducing the chance of minor injuries like cuts or scratches.

In terms of desirability, this is a well-rounded orthosis design that combines functionality with ease-of-use and safety. However in achieving this, the design may not be as aesthetically-pleasing in terms of its size and immobile nature.

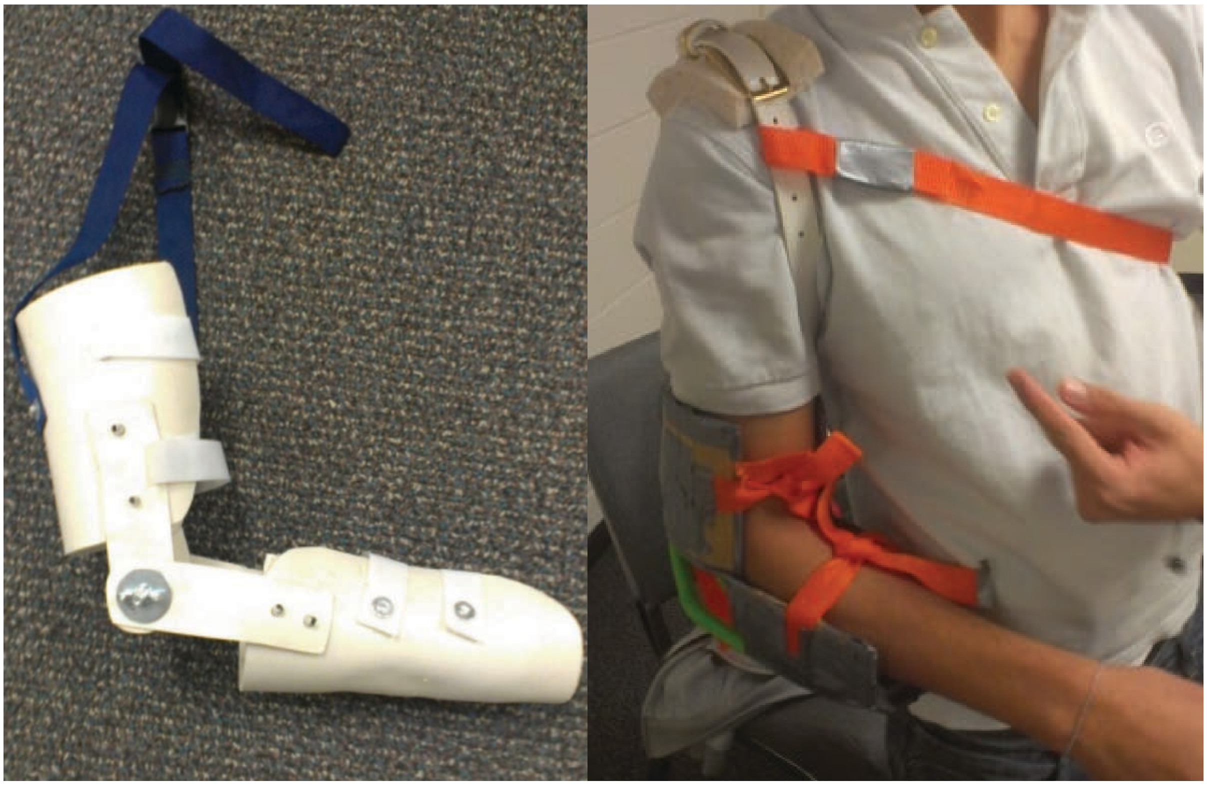
Benefits

The benefits of InnovaSplintX™ are that it is a simple and easy-to-use device, it is cheaper than commercial brand-name products and it is (built to last/durable) easily replaceable and repairable. Our splint is designed using easily accessible materials with Mr. F and patients alike in mind.

All in all, our relatively inexpensive dynamic elbow orthosis is a well-rounded product as it is composed of significantly cheaper components that are able to perform the same key functions as the higher-end provisions.

Humelift

Apex Solutions
F 0 1 - T 0 8 - 1



Left: Final Orthotic, Right: Prototype Design

Problem Description

Ms.Tara Packham requested an elbow orthosis with shoulder support for patient, Mr. B at Hamilton General Hand Clinic. The patient, may be incarcerated so the orthosis should be designed to be safe within a prison community. The user, Mr. B, wanted an orthosis that allows him to perform tasks, by placing his arm in various fixed positions. Another request from Mr. B was that the orthosis allows rotation around the elbow joint and must not add stress to his shoulder.

Design

The Humelift was intended to be lightweight and streamline, so as to reduce the pressure on the arm of our user. The shoulder and cross supports reduce stress on his arm, and spreads it across the chest. The thermoplastic is a major portion of the design due to its uncompromising mould-ability and strength, because of this the orthosis allows movement where intended, (shoulder and elbow joint), but can be locked and provide absolute support to the arm.

Functionality

The orthosis designed can stabilize the elbow in a static position and raise the head of the humerus back into the glenohumeral joint. The friction lock at the elbow is adjusted by the user in order to obtain to flexion or extension in his arm. Straps connecting to the bicep cuff and wrapping around the shoulder can be adjusted by pulling the straps at the cuff and wrapping around the shoulder. This will lift the humerus, which in turn, places, the humeral head back in its original position. On the distal end of the forearm there is also extra space, this space is to allow wrist motion in any direction. Extra space is necessary so that thermoplastic and any other material on the orthotic does not irritate the skin. Foam inlay is simply used to provide comfort to the arm of the user, and to reduce irritation between the skin and the orthosis.

Materials, Components, and Assembly

The upper arm cuff: The upper arm cuff is made out of thermoplastic and moulded to the upper arm of the user. The cuff is approximately 4”, but will be remodelled to adjust to the arm of the user.
Forearm cuff: The forearm cuff is made of thermoplastic, moulded to the user’s forearm. The cuff is approximately 6” long and will vary depending on the size of the arm of the patient. The cuff wraps around wraps around the arm ¾ of the way to allow for tightening.
Locking pivot: The locking pivot is made of two pieces of metal. The two faces in contact are grooved, causing friction, to fix the position of the arm.
Shoulder strap: The shoulder strap is made of nylon strapping and is riveted to the upper arm cuff. The strap has a clip to allow the user to quickly release the strap.

Refer to design on Page 1.
The upper cuff (1) and forearm cuff (2) are connected by a locking pivot and the bicep cuff is connected to the shoulder strap (3).

Cost

The average cost, of all the items came to approximately $90. This includes he cost of the thermoplastic used for the upper and fore arm($45), shoulder straps($10), pivots ($15), Velcro straps for cuffs ($10), rivets ($6), foam ($4).

User Acceptance and Compliance

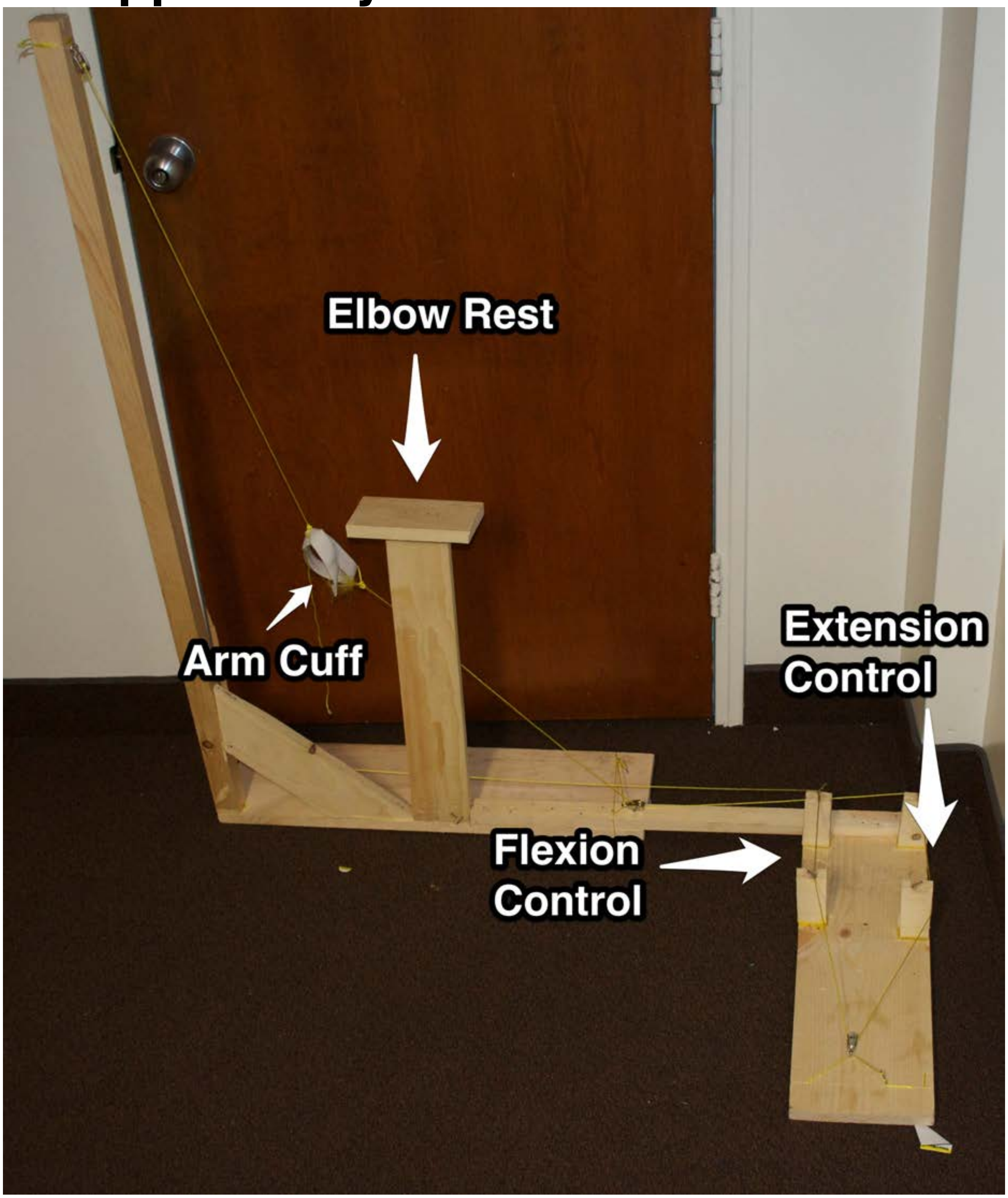
It is important that the orthosis be easy to take on and off, otherwise the user would have likely not used the orthotic as prescribed, and the development of his healing would be at a loss. The orthotic makes use of velcro straps around the forearm cuff and bicep cuff for their ease of use with a single hand. It uses a clip strap around the shoulder which can also simply be adjusted and clipped. The hinge is a simply system that uses a wing-nut as means of locking it in place.
The user has no sense of feel in his arm because of the accident, which is why special attention has been paid to the safety of the design. Perforated thermoplastic and padding were materials used to increase the user comfort. On top of this the total surface area of the skin being covered by the orthotic was minimized, without sacrificing design functionality.
The bulk of the orthosis had to be considered so it was not uncomfortable and awkward for it to be worn. The design was made without to eliminate any protrusions, and moulded to the client to be well fitted. The design was meant to be as inconspicuous as possible. The design can be worn under loose clothing, which although is not the optimal situation, design functionality was of a higher priority than this. The design on its own isn’t unappealing so if it must be worn over clothes it will not bring to much attention from its aesthetics. Without these considerations the orthotic would be less desirable for the client to wear, and again the progress of rehabilitation would be delayed.

Benefits

The benefit of the design is the stress-relieving shoulder strap, which when combined with the chest strap reduces the burden that the user has to bare. It will allows the user to heal faster. This unique shoulder support combined with the chest support separates us from other conventional designs. Finally, and most importantly, the design achieves almost all the objectives presented within the constraints given.

A Dynamic Elbow Orthosis Requiring Minimal Manipulation of the Upper Body

Cootes Assistive Devices
F01-T08-2



Problem Description

The problem presented by the client involves Mr. F, a 29-year-old male. He was burned in a house fire, resulting in 2nd and 3rd degree burns on most of hiss upper body. The burns caused heterotrophic ossification in his left elbow, which has recently been operated upon and removed, however, leaving him with a very limited range of motion. Mr. F wished to increase the range of motion in his elbow, but burns on his arms cause irritation between existing apparatuses and his skin. He wishes to have an individually operated system that can be adjusted without having to reach across his body. He also wants to be able to put on the device without help from others. The burns cause stiffness and swelling which makes it difficult to perform fine movements with his hands and fingers. The requested apparatus needs to be able to provide both flexion and extension therapy, while avoiding skin irritation.

Design

The design is a wooden structure, intended to support the arm and provide an easily accessible mechanism for the adjustment of the level of extension or flexion delivered by the device. It is not designed to be mobile, but is relatively light considering its girth. The main characteristic of the design is the closed wire loop that can be shortened to create flexion or extension.

Functionality

The device can provide both extension and flexion therapy. The device is adjustable with minimal exertion of the client's burned extremities. It satisfies the client's most unique needs, however, it is not portable. In order to create tension for flexion therapy, the user uses his foot to depress the closest wire. The closed loop shortens and pulls the wrist forwards. For extension, the user simply depresses the other wire.

Materials, Components, and Assembly

The device is constructed primarily out of wood. It also uses thin string or wire, along with small pulleys. These materials can be obtained at any hardware store. The device can be constructed using a saw, hammer, and carpenter's glue. It can be constructed in 90 minutes. A diagram is the most helpful direction for building, and no difficult steps are required.

Cost

The device is very affordable. The cost of raw materials is approximately $40, not including labour.

User Acceptance and Compliance

The device requires the user to be seated during operation, and, as such, is best used during periods of relaxation i.e. watching television etc. Ideally, the final product will have extensive padding around the elbow rest and the arm cuff, and the height of the elbow rest will be fully adjustable. The wooden surface leaves plenty of room for customization. The device has no sharp edges. Because of the small amount of movement created by the device, accidental overextension is unlikely.

Benefits

This design requires virtually no manipulation of the client's upper body. Adjustment is facility solely by foot controls. The arm cuff is designed to put on easily by the user. Ideally, the arm cuff will be inflatable, further minimizing upper body manipulation. This design is unique because the main structure does not have to be supported by the arm.

Elbow Orthosis for Mr. B

ARM & SPLINT
F 0 1 - T 0 8 - 3



Problem Description

The problem presented to the team involves a 23 year old motorcyclist, Mr. B, who obtained a brachial plexus injury with a compound fracture/dislocation and degloving of the wrist. Due to these injuries, he is unable to use his dominant right hand to perform simple tasks, like writing. Our team was faced with several problems to tackle, which include creating a splint that is inexpensive, supports the subluxed shoulder, elbow, hand, arm and neck, and allow for range of motion. These conditions must all be met, while at the same time looking aesthetically appealing and providing a great user experience.

Design

This design is very simple. It consists of a white thermoplastic piece covered in foam. There are two Velcro straps attached to the sides of the thermoplastic. There is a pink strap that attaches from one end of the thermoplastic to a buckle. Another strap is attached from the opposite side of the thermoplastic to the buckle. There is a strap stopper at the end of this piece of strap to prevent the strap from falling through the buckle. There is foam that lines the first piece of strap to allow comfort on the shoulder. There is Velcro along the second piece of strap to allow the orthosis to be locked into place. This orthosis is approximately 500 grams so it will be easy for the user to hold and wear. The approximate size of it in respect to the arm is it is 3/4th the length of the forearm.

Functionality

This orthosis can do a variety of functions. It is able to relieve stress from the shoulder, the arm and the elbow. Along with the sling, the placement of the support strap allows for the shoulder to rise when the range of motion is adjusted, therefore supporting the subluxed shoulder. It also allows for range of motion of the elbow - the arm can be set at almost any angle so that it can help to exercise the arm. The only function that it cannot accomplish, unfortunately, is allow for forearm rotation and forearm range of motion. Apart from this, it is able to accomplish all the other tasks that the client has asked for.

Materials, Components, and Assembly

This design is very simple. It does not require many complex materials or components. The materials that this orthosis require are thermoplastic, Velcro, plastic, nylon and foam. The components that are part of the orthosis include a strap, thermoplastic, buckle and Velcro straps. These materials and components can be easily obtained from a dollar store, except for the thermoplastic. The tools required to construct this design are duct tape, glue gun, scissors, a knife and a towel. This entire design can be built in approximately two hours making it an easy orthosis to build for a user. The instructions that would be needed to build this orthosis are:

1) Mold the thermoplastic to the user's forearm
2) Attach Velcro straps to thermoplastic
3) Attach one end of the support strap to the bottom of the thermoplastic and the other to the buckle.
4) Attach one end of another support strap to the opposite side of the thermoplastic, and the other around the buckle.
5) Insert foam into the thermoplastic and add foam onto the shoulder strap.

This assembly does not require any special instructions due to its simplicity.

Cost

This design is very inexpensive. The final cost to construct this design is approximately $40.00. The most expensive material is, of course, the thermoplastic.

User Acceptance and Compliance

Through this design, user compliance was almost completely achieved. Most of the user's needs were taken care of and considered in the design of the orthosis. The only task that could not be accomplished was to allow range of motion for the forearm. This orthosis is extremely easy for the user to take on and off. The user will simply strap the thermoplastic onto their arm, wrap the strap around their shoulder and then tighten the strap that has come around the chest. To make the design more comfortable, foam has been added to the thermoplastic forearm mold and also to the shoulder strap so that the user can comfortably wear the orthosis. The user uses this orthosis to help with range of motion of the elbow by pulling the strap tighter or loser depending on what range is wanted. The user will want to wear it because it is comfortable; it helps relieve stress on the shoulder, elbow and arm, and it is also aesthetically appealing without attracting attention. The orthosis is kept very simple, with simple colours as this helps to attract less attention, but at the same time the simplicity makes it attractive. This design is also very safe to use because there are no sharp edges on it and no materials that may cause harm to the human body.

Benefits

The benefits of this design include:

- Inexpensive
- Easy to put on
- Allows for a functional arm
- Light
- Portable
- Simple

The Arm Support

Engineering Enterprises
F 0 1 - T 0 8 - 4

Problem Description

Develop a device to help user perform day to day tasks. User is Mr. B, an adult male who underwent serious motorcycle injury. Primary goal was to provide comfort to his arm. Accomplish this by reducing subluxation and having a comfortable prototype. Secondary goal was to provide as much movement as possible for his arm. Have to do all this while not placing a lot of load on the shoulder

Design

The elbow orthosis depicted above uses simple Velcro strapping to hold both a cuff around the upper portion of the bicep and a long rigid support around the forearm. It utilizes the clients working elbow joint as the hinge between the two pieces which are connected by a strap similar to those found on backpacks that can easily be adjusted in length, which runs from the cuff on the bicep to the clients wrist and is attached around the support. The device itself is relatively light because it is made mostly of straps and fabric apart from the support on the forearm which would be made of thermoplastic. However because support and weight on the clients should is such an issue the brace is also supported from a belt that wraps around the clients opposite shoulder to the brace. It is connected to the cuff on the backside and to the forearm support on the front and is used to pull the entire are back into the proper shoulder position and away from the subluxed position.

Functionality

The arm support provides many functions. It reduces subluxation in his shoulder and provides a way to adjust and lock his arm at different angles doing this without placing a lot of load on his shoulder.

Materials, Components, and Assembly

For the orthosis adjustment mechanism, many complex industrial components were considered such as turnbuckles, springed hinges, ratchet straps and buckles. It was reasoned, however, that a simple-but-secure strap and buckle based mechanism would be ideal. The final design assembly many materials. A straps used to hold thermoplastic to forearm, to connect wrist to shoulder andto pull up humerus. A plastic ladder lock used to fasten one strap, thermoplastic (rigid semi-cylinder) to support the forearm, and velcro used to fasten thermoplastic to forearm. All of the components above (save the thermoplastic) can be obtained at any combination of hardware and even craft stores. The thermoplastic, however, must be purchased direct from the manufacturer.

Any given individual constructing the brace would absolutely need to understand that the (opposite) shoulder strap is supposed to pull the humerus up along the vertical axis *only*. The two contact points of this strap are on the bicep and the back of the elbow. This is to ensure there is no tension pulling the forearm on any horizontal axis, allowing for uninhibited, immobile stability of the elbow and forearm. It is also important for the builder to understand that the further the contact points of the ladder-locked strap are from the pivotal point (the elbow), the less strain there is on the entire arm. This means that the strap should run from the wrist to high on the bicep. Lastly, the builder needs to ensure that the bicep cuff fits snugly, as it is being used to both pull up the humerus and hold up the forearm via the ladder-locked strap. This elastic cuff is the integral component of the orthosis.

Cost

The costs included; thermoplastic which is $ 30, a small and large ladderlock and backpack strap (including hook) for $ 7 and $15 respectfully, velcro strip which are $5 and a hot glue gun and glue which costs $4. This is a total of $61.

User Acceptance and Compliance

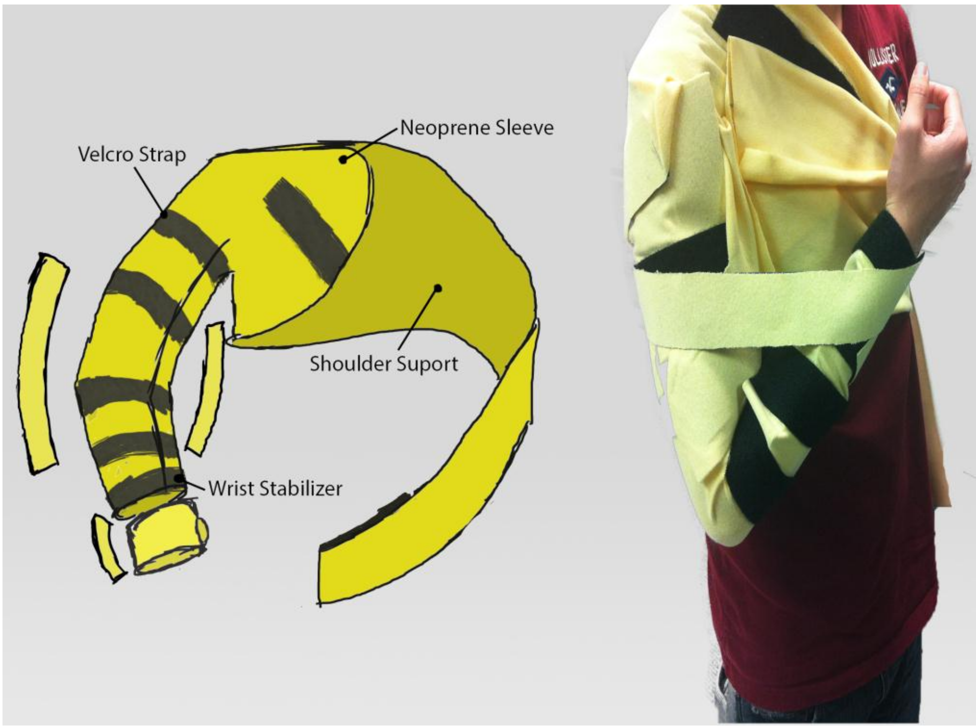
He has the ability to move his arm up and down thanks to the strap adjuster located from his humerus to his forearm. Has the ability to adjust the direction of his arm thanks to the strap adjuster that wraps around his shoulder. The there is a strap that goes around the opposite shoulder of the orthosis that help support the arm. The orthosis has been designed to be comfortable by having padding located in the inside of the thermoplastic therefore having less discomfort. Also the material used in the orthosis is very light and easy to move around with, therefore having the ability to move around and not have to worry about it being a burden. The objective we set for this project was to be light weight, very durable and non weaponizable. Our objectives were met throughout this project, the orthosis is very lightweight because it is made from thermoplastic and the straps are made from fabric. The final objective that was met was that it should not be weaponizable. Safety has been taken into consideration because there is nothing dangerous on the thermoplastic .

Benefits

While designing the prototype there were several other benefits that were formed during the creation. There is a large strap that supports the design from each thermoplastic support around the opposite shoulder. This strap reduces a great deal of strain on the right shoulder. It also provides another benefit of pulling the back of the design so the users arm stays perpendicular to the user and not pressed to their stomach like a sling.

Orthostrap

Engineering Design Limited
F01 – T08 - 5



Problem Description

The problem presented to the team involves a man, “Mr. B”. Recently, Mr. B experienced a motorcycle accident. He sustained various injuries including de-gloving and severe nerve damage. As a result Mr. B was left with very little working muscle in his right arm. He can, however, use his left arm perfectly. Mr. B also suffered a Brachial Plexus injury. Essentially, his shoulder is held in place by skin tissue and rerouted chest muscles. Due to the lack of working muscle at the elbow, Mr. B cannot turn his hand. He would like this rotation about the forearm to be re-introduced. The team has been asked to design a device that can be constructed in Tara Pedrhen’s clinic and allows the use of Mr. B’s right arm. The device should be able to lock his arm into a selected position while inflicting minimal stress on the shoulder. He would like to keep his muscles active. Finally, Mr. B is awaiting trial for drug charges and wishes to be kept in the general population, should he be incarcerated. The device should not contain parts that can easily be weaponized.

Design

The selected design for the elbow orthotic resembles a sleeve. Velcro straps are used to secure the arm at any desired position. A shoulder brace prevents the orthotic from sliding off the arm as well as decreasing the stress on the shoulder. The design is very light, weighing less than a kilogram. This means that stress on the shoulder is minimized, which means comfort is increased.

Functionality

The orthotic is capable of locking the user's arm in virtually any position. It all depends on the positioning of the Velcro straps. The straps make is quick and convenient to wear and adjust the position of the hand as well as allows the full range of motion. The straps and sleeve on the arm is held up by a neoprene shoulder support which is light weight and prevents the user's arm from getting hot and sweaty. This flexible material also allows the arm to bend easily and eliminates the inconvenience of aligning the hinge of the orthotic with the elbow. This orthotic is built with a shoulder support to help reduce the amount of stress exerted on Mr. B's shoulder and allowing it to heal faster while reducing discomfort. It also prevents the Velcro sleeve from sliding down the hand and becoming and inconvenience. The orthotic comes with a wrist stabilizer that allows Mr. B to do range of motion exercises with his wrist as well as lock his wrist in position when needed. This complete orthotic is constructed almost completely out of soft, flexible materials and will be permissible amongst the general population. No part of the orthotic can be weaponized in case Mr. B is incarcerated.

Materials, Components, and Assembly

This item would be made of neoprene and covered with the loop (fuzzy part) of Velcro the fuzzy part will be used to ensure the orthotic is comparable to wear. The orthotic would be worn like a tight filling sleeve of a shirt with a strap that hangs from the back. The strap can be pulled under the shoulder of the functioning arm across the front and Velcro to the front of the shoulder. The elbow will be supporting by using the hook end and strap to any of the fuzzy surfaces on the sleeve. The wrist will be supported in a similar way with a thermoplastic "glove" that has more Velcro on it. The majority of the materials such as thermoplastic, neoprene and Velcro can be purchased from general material stores such as the Canadian Tire, Wal-Mart, and Home Depot.

Cost

All materials used are relatively inexpensive and readily available to the clinic. The small amount of thermoplastic required costs an estimated $5.00. The selection of Industrial strength Velcro used costs an estimated $12.00 at most hardware stores. The neoprene used for the sleeve costs an estimated $30.00. The third-party shoulder brace, to which the sleeve is sewn, costs $25.00. The final expense for all materials is a predicted $72.00.

User Acceptance and Compliance

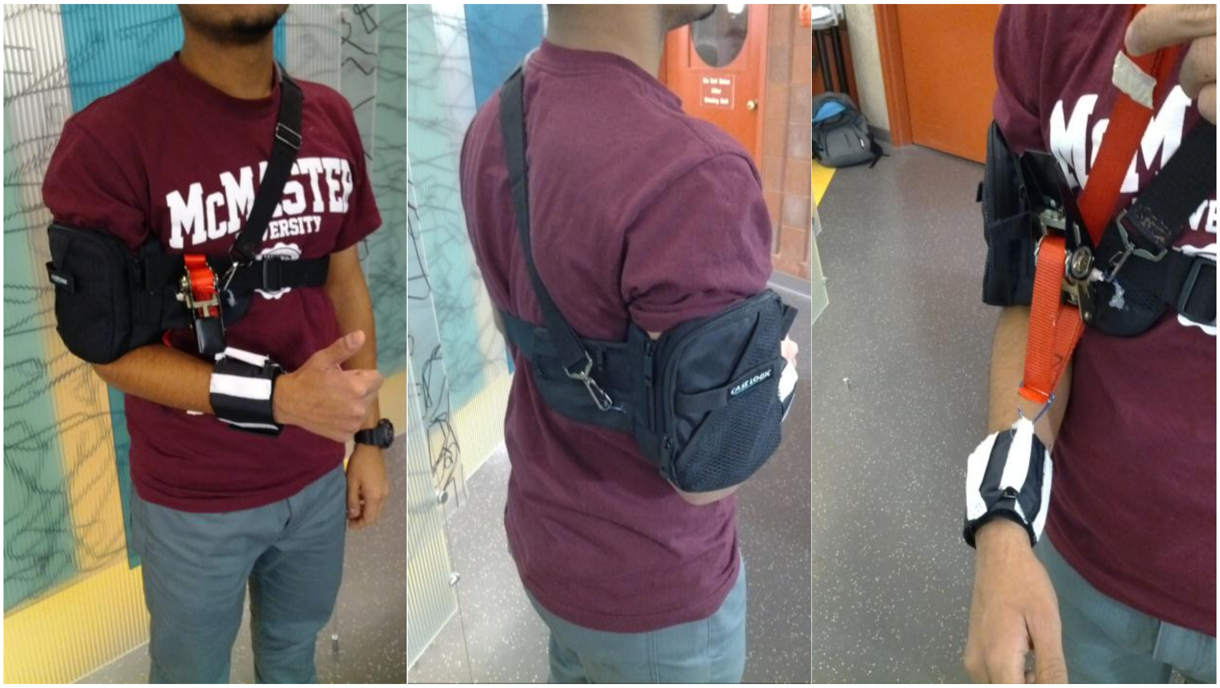
This design was made with Mr. B in mind and is specifically designed to satisfy his needs. To do so the orthotic is made to increase his compliance to wear it. The comfort of neoprene and fabric will ensure the orthotic does not irritate any part of the user's body. The design is made to be convenient to put on and take off by just Mr. B to allow him to be more independent in his therapy. Furthermore Mr. B can choose the colour of neoprene he would like. The easy to use Velcro also allows adjusting the straps fast and convenient which will increase Mr. B's willingness to use the device.

Benefits

This specific design has many benefits that put it ahead of the leading competition. The orthotic is made of materials that are very lightweight, allowing for little to no stress on the shoulder. As the client requested, full range of motion, the ability to have the arm locked in any position and easiness to adjust/remove/put on are all provided with simple Velcro straps. A neoprene sleeve and shoulder support makes this orthotic very comfortable as well as flexible. Instead of bulky commercial orthotics, this orthotic can easily fit under clothing. It also is relatively inexpensive due to how common the parts are (Velcro, neoprene and thermoplastic). Finally, user compliance is emphasized with the ability to customize the orthotic by changing the colour of the neoprene sleeve.

The Lock-On Orthosis

Lock-On
F 0 2 - T 0 1 - 1



Problem Description

The Lock-On elbow orthosis enables users with similar problems to Mr. B to utilize their hand for daily activities in multiple locations. It locks the arm at finely adjustable angles and enables pronation and supination of the hand. The mechanism is easily operated with a single hand and includes straps that divert weight from the injured shoulder.

Design

The design features a ratchet strap secured to a thick padded chest strap, worn high beside the injured arm. A shoulder strap is attached to this which wraps around on top of the opposite shoulder. From the ratchet mechanism, a third strap connects to a wrist cuff with three locations on the wrist cuff for a carabineer to hook on. Overall, the entire device weights approximately two to three pounds, the largest contribution being from the ratchet mechanism. While worn, the shoulder cuff, with a size comparable to a pencil case, protrudes away from the arm by an inch all the way around.

Functionality

The design created aids the user with many desirable functions the user would want to accomplish. These include everyday activities such as writing, typing on a keyboard and carrying objects that require both arms. Functionally, the design allows the user to place and lock their arm in multiple angles of flexion and extension.

Materials, Components, and Assembly

The materials the design requires are as follows: Velcro strips, ratchet strap, cloth strips, fanny pack, carabineers, and hanger wire. The tools needed to assemble the design are pliers, scissors, tape, glue gun, and needles and thread (replaceable with a sewing machine). These supplies and tools can be obtained at Canadian Tire, a hardware store and/or value village. Constructing the design can be done in roughly thirty to forty-five minutes, depending on the skill of the sewer. Instructions for the design are fairly straight forward; the only special considerations that may be required are specific placements of straps for different users and attaching the ratchet to the shoulder cuff. It is to be noted that the ratchet mechanism should be attached to the chest and not the arm.

Cost

The total cost to produce one orthosis is estimated to be fifteen to twenty dollars, with the majority of the expenses dedicated to the ratchet strap.

User Acceptance and Compliance

The user's compliance was considered with the up most priority when designing the Lock-On Orthosis. To begin, the user does not need anybody's assistance to put the device on, and taking it off is very simple as well. The device is designed to be worn for long periods of time so many steps have been taken to make it as comfortable as possible. The wrist strap is wide so the pressure from the carabineer is distributed over a greater area to reduce constriction of the wrist. The shoulder cuff is padded to try and minimize irritation and to provide optimal comfort. This device is very easy to operate; the user simply cranks the lever on the ratchet to raise the forearm up. To lower the forearm the crank is simply put in the unlock position and the free end of the strap is pulled which unwinds the ratchet strap, lowering the arm. The simplicity, along with comfort, and the fact that the device is not bulky or flashy, is a big factor when it comes to user's usability. The device does not cause harm to the user or the people around them. Many aspects of this design demonstrate the objectives that Lock-On strived to achieve.

Benefits

There are several benefits of using this device rather than some existing solutions. One of the main benefits is that it allows for the arm to be placed at a variety of different angles, compared to most products where the arm can only be set at a few predetermined angles. Another benefit of the device is that the majority of its weight is not on the injured shoulder. The device utilizes support straps to avoid putting extra stress on the injured area. Thirdly, the device can be easily put on and taken off by the user, allowing for them to have independence in their everyday lives.

The Holey Orthosis

P.I.E

Professional Inventors and Engineers
F02 – T01 - 2

Problem Description

Our product addresses several issues that Mr.B faces. Mr. B was involved in a motorcycle collision, which caused severe damage to his right side of his body, particularly his right upper body/shoulder. His shoulder is dislocated, and severe nerve damage is present. His muscles in his wrist and fingers are functional, but has no feeling in his forearm and upperarm, as well as his elbow and shoulder being unable to move. This effectively has rendered Mr. B's right arm unusable without the use of an aid.

With the Holey Orthosis, Mr. B can use his arm again, to perform daily tasks. The Holey Orthosis helps Mr.B lock his arm into various degrees of flexion and extension, as well as up to approximately 180 degrees of supination and pronation of the wrist. Furthermore, the design incorporates a shoulder strap, which takes the weight of the orthosis and distributes it across the left side of the upper body. This means that the orthosis is comfortable and light on the weak shoulder, causing little to no stress. The Holey Orthosis gets the job done!

Design

The design can vary in size, depending on how large the user's arm is. Generally speaking, the design is tailored to the user's arm size and the strength of their body. It is custom fit, and uses the least thermoplastic necessary, making it as lightweight as possible.

There are 4 main components to the orthosis. The wrist glove with Velcro straps is the first component; it is just a simple glove with soft Velcro attached to the wrist area of the glove.

The next component is the forearm cuff. This is put on and off by doing/undoing Velcro straps that are on the inside of the right arm. There are two soft strips of Velcro on the sides, which can be attached to two Velcro straps, which connect the wrist to the forearm. Rotating the wrist and attaching the Velcro effectively locks the wrist in that position. In addition to this, there is a hook on top for an insert of the user's choice.

The third component is the strap, which is simply attached to the upper arm cuff. It functions very similarly to a guitar strap, where it can be tightened and loosened.

The last component is the upper arm cuff. Again, it is put on/off by doing/undoing Velcro straps on the inside of the cuff. There is a hook on the front of the cuff (where the bicep is) and an insert can be hooked onto that hook.

Functionality

The Holey Orthosis is not only comfortable, but also custom fit for the user. In addition to these wonderful assets, the Holey Orthosis is also breathable, lightweight**,** does not reduce mobility, and does not take away from the ability to perform day to day tasks like writing.

Materials, Components, and Assembly

The Holey Orthosis was constructed with thermoplastics, polyester, fabric, metal alloy inserts, guitar straps, Velcro straps as well as duct tape. Other than the thermoplastics, these materials can be found at hardware stores like Home Depot and Lowe's. The thermoplastics were purchased at a thermoplastic distributor.

The tools that were used to assemble the orthosis include an exact-o-knife, drill with drill bits, (all of which can be purchased at hardware stores); as well as a kettle to heat water, a large bowl and water, which can be found in the common home.

Cost

The cost of producing is roughly the same as the cost of producing the prototype - $80. Furthermore, approximately 1.5 hours of labour was put into the construction of the prototype.

User Acceptance and Compliance

Taking into consideration that the user has trouble with his right side in terms of mobility, the process of putting the orthosis on and off is very simple and this is where our design excels: the velcro straps are on the inside of his right arm, meaning his left arm can easily reach over and undo the straps to take the device on and off. Furthermore, the padding is constructed with the most cost efficient material: non-allergenic polyester. Not only is this material amazingly comfortable for its price, it is also non-allergenic, preventing any allergic reactions that may happen if Mr.B were allergic to any materials inside polyester.

There is also some colour added to the orthosis, particularly to the straps that lock the wrist in any desired position. The colour gives the orthosis an aesthetically pleasing look to it.

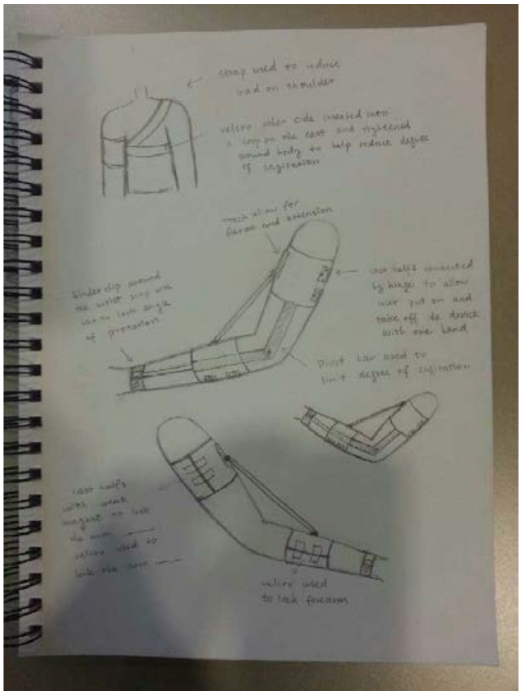
In addition to these very important characteristics, our idea for a solution is also able to go into incarceration. There are no sharp points or edges that protrude from the orthosis which can cause bodily harm.

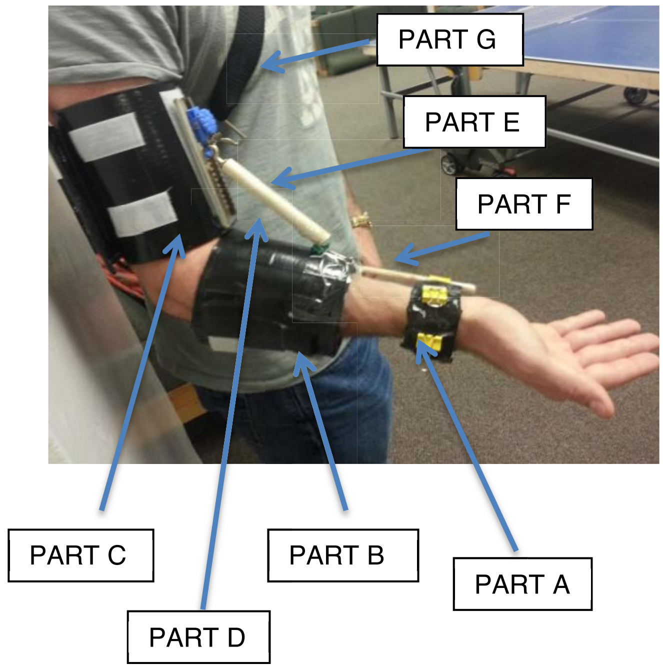
Benefits

Benefits to our design are within our functionality and user acceptance. The comfort of the orthosis is unparalleled by any orthosis in the market, as most use hinges and locking braces to lock the hand in uncomfortable positions. The wrist locking straps that are incorporated into our design allows the user to rotate their wrist to the specific position they want, instead of pre-set angles. Furthermore, the padding prevents any skin irritation, and lets the user not have any uncomfortable feeling in their upper arm, forearm and wrist while wearing it.

Dynamic Elbow Orthosis Proposal

Team AZAS
F02- T01- 3





Problem Description

On behalf of General Hamilton Hospital, Tara Packham has asked team AZAS to develop a prototype of a dynamic arm orthosis that will assist Mr. B with daily quintessential activities. These activities require the arm to accommodate important flexion and extension positions in consolidation to pronation and supination of the forearm. Currently, Mr.B suffers from compound fracture/dislocation of the right shoulder, degloving of the right wrist with tendon nerve lacerations, brachial plexus injury and has received nerve grafting and therefore has no use of his upper right arm and limited movement in his hand. Mr B has asked for a method or device to increase his range of motion. The dynamic orthosis will provide resistive and/or supportive forces that will allow Mr.B to adjust his right arm into these essential positions for an extended period of time. The dynamic elbow orthosis will also be required to introduce counteractive supportive and resistive forces for Mr.B's right shoulder.

Design

Compared to other traditional arm orthosis on the market this device will be slightly heavier. However team AZAS believe this is an acceptable compromise as the load onto the shoulder has been accommodated for. The net weight of the device will weigh 4 lbs. However, the final design's weight could be minimized by selecting a thinner grade of thermoplastic and drilling large holes in areas where structural integrity is not important. The final design will consist of 3 sections. Each section will be a cast formed to shape different parts of the right arm with thermoplastic. The design will consist of a cast that forms around the wrist [part A], ¾ the length of the forearm [part B] and about ¾ the length of the upper arm [part C].

Functionality

From interpolating the problem description, the user has essentially requested a device to adjust the orthosis angle into set positions to allow for Mr.B to execute basic tasks and to reduce the load onto his shoulder while in his debilitated condition. The upper arm rod [part D] is used to alter the angle of the orthosis and change the angle of extension/flexion by adjusting the position of the slide [part E]. The forearm rod [part F] is designed to allow pronation and supination of the wrist by fastening it to the binder clips shown in the diagram. When fastened, radial movement of the wrist will be fixed. In combination of these two functions. Mr.B will be able to perform simple daily activities such as eating, carrying light objects, reading and typing on a keyboard. The strap support [part G], provides enough necessary tension to slightly lift the injured shoulder and reduce the amount of weight caused by the arm. As shown above, the orthosis has been designed to satisfy the conditions stated by the client.

Materials, Components, and Assembly

The final dynamic orthosis is designed for simple assembly and construction. The orthosis will be composed of hinges, 2 plastic rods, thermoplastic, binder clips, Velcro, adhesive sided magnets and the sliding mechanism of an exacto knife. All of these components should be available at any local hardware store and in Tara Peckham's shop. The assembly will require a screw driver to fasten the hinges to the cast, an exacto knife to cut the casts in half and a small hand drill for the hinge pilot holes. The hinges for the initial locking mechanism should be placed on the medial sides of the casts. The general assembly is expected to take 90 minutes after the molding of the cast.

Cost

Team AZAS spent $81 to build this prototype. However the final product is expected to cost the client $45 to make. The majority of the additional cost of the prototype is due to a significant portion of materials not being utilized when bought in bulk. We believe this cost should not be included as the excess materials can be used for prototypes designed for other users.

User Acceptance and Compliance

User compliance is the primary objective of this design. For this device to be user compliant, it must be easy to adjust and easy to put on and take off. To simplify the adjustment process, all degrees of rotation have been disjointed into separate functions. Basic locking mechanisms have been implemented into the design to reduce the complexity of the product. This is especially demonstrated with the exacto knife slide mechanism. Mr.B's orthosis was designed with a hinge as illustrated in the provided visuals. This hinge mechanism will allow each cast to be put on individually with the left hand by simply clasping over the corresponding position on the arm. Since the cast is thermoplastic, it has the capability of being formed to the shape of the arm. This will provide comfort without sacrificing structural integrity. Generally danger is associated with complexity. By breaking down the functions to individual levels, Mr.B is able to focus more on an individual task and is less likely to injure himself. Since the orthosis is extremely easy to use and provides a wide range of possible set positions, Mr.B will not feel it is necessary to take off the orthosis due to it hindering his daily routine .

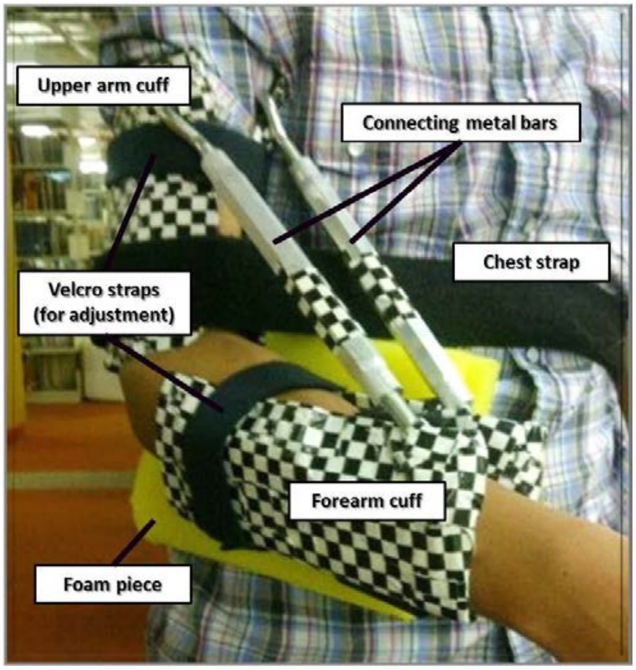
Benefits

The product designed by team AZAS is both economical and easy to use. Typically competing arm orthosis designs will start at $300. The orthosis designed for Mr.B is expected to have a base cost of $45, which is 7.5 times cheaper. This is dramatic reduction in price. Since the orthosis is designed to have a wide range of motion, it should assist with the rejuvenation of muscles and nerve damage. The product has also been designed to be significantly easier for Mr.B to take on and off compared to alternative methods.

Dynamic Elbow Orthosis

FOUR ELBOWS

Four Elbows
F02 – T01 – 4



Problem Description

The problem presented to the team by Tara Packham, an Occupational Therapist at the Hand Clinic of the Hamilton General Hospital, involves Mr. B, a twenty three-year-old male who was injured in a motorcycle accident. He has sustained various injuries that have caused his right arm to be unstable and have no control, thus making everyday tasks difficult for him to accomplish.

Four Elbows has designed a dynamic elbow orthosis that supports and stabilizes the elbow and allows patients with a weak and injured elbow to have a greater range of motion in the forearm (larger forearm rotation). Most importantly, the device created will enable Mr. B, as well as patients suffering from a similar condition, to perform daily activities easily and independently. By using our device, called the "*Positioner*", Mr. B will no longer require additional aid when doing daily activities such as brushing his teeth or writing and typing.

Since our team understands that Tara will not have the tools to constantly make adjustments to it, the orthosis has been specifically made to be low-maintenance; it requires very little effort from the patient to position it on his or her arm. It has also been made to be budget-friendly, utilizing materials that can easily be found at any general hardware store.

Design

The dynamic elbow orthosis designed by our team, *Four Elbows*, features a padded upper arm cuff and lower arm cuff, connected by a metal bar with a hook that allows for device to support the elbow at various angles. The cuffs of the *Positioner* cover most of the back of the upper arm and forearm, while the fronts of the arms are slightly exposed; the device does not cover the wrist, as this would hinder movement and make it more difficult for the patient to complete daily activities. The device also includes a chest strap. The entire unit is approximately 2.5 pounds in weight.

Functionality

Functionally speaking, the device created is able to support and stabilize the upper arm and forearm, increase mobility of the entire of arm as well as secure, or “lock”, the arm in various positions (at angles of 45°, 90°, etc.) to allow Mr. B to perform daily activities easily without applying pressure on his already dislocated shoulder, thus satisfying all his requests.

Materials, Components, and Assembly

The following materials are required to produce the device include a cylindrical metal bar, Velcro, cardboard, duct tape, jersey fabric, foam, and plastic hooks. These can easily be purchased at general hardware stores (such as Home Depot); some materials may even be found in one’s own home. The only tool required during the construction process is a cutting instrument. The total construction and assembly process will take approximately two hours.

Cost

Materials required for production will cost the clinic approximately $40 CDN, while the amount of labour required about 2 hours. The user will be charged according to what the clinic feels appropriate.

User Acceptance and Compliance

While constructing the *Positioner*, the ability of the patient to put on and remove the orthosis easily and efficiently was specially taken into consideration, especially since the client presented to the team, Mr. B, has an extremely weak right shoulder and any additional strain would simply cause more him more pain and discomfort.

The team ensures the design to be comfortable: the cuffs are padded with a soft jersey fabric and the elbow is further supported at a comfortable angle using a large piece of foam. The position of the foam piece is also adjustable, so that the client can move it to his or her desired position for use in different situations.

The user is able to utilize the orthosis by securing the cuffs onto his upper arm and forearm and adjusting it to his preferred tightness using the Velcro straps. As mentioned previously, he will also be able to adjust the angle that his elbow lies at his side using the foam piece.

Safety was also an important factor that we took into consideration. The pads and hooks are padded not only for comfort, but also to prevent accidental scraping of the epidermis. The team has also thoroughly tested the design to confirm that the metal bar will stay hooked onto the cuffs, eliminating any possible dangers to the user.

The *Positioner* has been specifically designed to combine practicality and appearance - it will not only help support and stabilize his elbow, it is also comfortable and aesthetically pleasing. The team chose to stick to a monochromatic palette; patterned duct tape was used for a more *avant-garde* approach, and a silver metal bar was used to highlight the edginess of the checkerboard-patterned tape. These artistic qualities make the device a sophisticated choice for both genders.

Benefits

Among the existing elbow orthosis designs currently on the market, many are able to stabilize the elbow or increase mobility or adjust the angle at which the arm can be secured at, however, they are unable to combine all of these properties, thus failing to fulfill Mr. B’s requirements. The design our team created is more preferred as it is able to comfortably support and stabilize the elbow without adding strain to already injured body parts on a cost-efficient budget.

Mr. B will be able to wear the dynamic elbow orthosis over jersey tops and thin sweaters and underneath any article of clothing ranging from light zip-up hoodies to winter jackets.

The Cast-Away

Alpha Q
F02- T01-5

Problem Description

We were asked to create an orthosis that allowed users to have a fully supported shoulder, carry out flexion and extension of the arm, carry out supination and pronation in addition to being safe, low cost, comfortable, discrete, with as simple a design as possible.

Design

Our design has two main components, the shoulder support and the arm sleeve, and we take pride in its simplicity. The shoulder support takes form in a suspender type design responsible for taking the orthosis' small pressure off the shoulder and distributing it to the torso. It also has three belt loops in place to make sure it remains in its desired location and ensuring all pressure is taken off the shoulder. This component is made of an extremely light cotton- based fabric and one Velcro strap as a means of holding the orthosis on. The arm sleeve, which is responsible for the flexion and extension of the arm, is carried out by pulling a string on the user's "good side" which either pulls the arm up for flexion or releases it for extension. Once in the desired position, the user can wrap the string around their belt loop to secure in place. The arm sleeve also aids in the pronation/supination of the hand. This is achieved by looping a string through either the user's middle finger (for pronation) or thumb (for supination) then attaching it through one of the rings on the sleeve of the orthosis. To increase the comfort of the user, a glove will be worn during the pronation/supination function. This component is made of the same cotton fabric as the shoulder support, two Velcro straps (to ensure easy application and removal), curtain loops (to serve as a guide for the flexion/extension string), and string. As the photos illustrate, our orthosis is low profile and extremely light, ensuring that the orthosis acts as the arm's second skin.

Functionality

In order to ensure complete client satisfaction, we considered the daily functions of the user in our design process. We concluded that most daily functions would require the arm to be either: flexed to a 90° angle, with some slight variations depending on the activity; fully extended to a 180° angle, when arm needs to be in a relaxed position (ex. when walking); allow the hand to be held slightly pronated while arm is held at a 90° angle when the user is, for example, keyboarding; allow the hand to be held slightly supinated, for example, when the user is writing.. Our orthosis meets all the stated needs of the client and the user.

Materials, Components, and Assembly

Everything used for our orthosis can be found at any local sewing supply store. We required .5 metres of a strong, breathable, and washable cotton based fabric; .25 metres of an elastic based cotton; .75 metres of curtain rings (small plastic rings pre-sewn onto a strip of plastic mesh); string; .2 metres of Velcro;1 thin "magic" glove; and thread. The only tools we required were a sewing machine and scissors. With practise and knowledge of a sewing machine, this orthosis takes no longer than 45 minutes to an hour of construction time. As our design is very simple, there are no special assembly instructions required.

Cost

Our orthosis is extremely inexpensive. All of the materials cost no more than $20.00 and, since the orthosis takes so little time to make, the labour cost will be low. The end cost to the user should be in the $30 - $35 range.

User Acceptance and Compliance

Several things were considered in our design in order to ensure full user compliance. Our orthosis is extremely low profile, allowing the user to wear it under their clothes. The simplicity of the fabric and the colours offered allows the user to request a colour they feel most comfortable with for the skeleton of the orthosis. Ease of application was a primary consideration in the design of our orthosis. Step 1: put belt through 3 loops, acting as additional belt loops, to ensure the orthosis stays in place. Step 2: The orthosis is then put on like a backpack by the user. The user puts their arms through the two straps which are then secured in the front using a Velcro strap. Step 3: The arm orthosis is pulled on like a sleeve and secured using two easily accessible Velcro straps (see "Design" for usage instructions). By equipping the orthosis with wider straps to allow for even weight distribution over a larger surface area and extra padding for pressure points, we have incorporated user comfort into our design. Safety of the user was considered by constructing the orthosis with soft, thin, light, materials, to ensure no harm comes to the user.

Benefits

No other orthosis on the market today offers a means to accomplish all of the functions required by the client and the user. Our research showed that although there were many variations of functions and objectives, none suited the needs of our client. For example, there are orthosis on the market that offer all the functionality, such as flexion extension etc., but are extremely heavy, bulky, and unsafe. There is also one that offers the basic flexion and extension but has no shoulder support and is very bulky. The bottom line is that the commercial orthosis currently on the market do not satisfy our client's needs. *Cast Away* is different! We offer an orthosis that not only allows for flexion, extension, pronation, supination, and shoulder support but also one that is safe for the user and others; washable; easy to use; easy to make; inexpensive; comfortable; completely portable; low profile; and will aid in the user's recovery. Our orthosis is one of a kind. Reach for *Cast Away* the next time you have a subluxed shoulder or brachial plexus injury.

VIC. Torious Elbow Orthosis

VIC. Torious Engineering
Your Vision. Your Reality.

Team Name
F02 - T02 - 1

Problem Description

The hand clinic at Hamilton General Hospital has a patient known as Mr. B, who was recently involved in a motorcycle collision. The accident caused several lacerations, fractures, a dislocation, and degloving in his wrist. This caused tendon / nerve damage which impairs basic day to day activity. The accident left him with very little working muscle in his shoulder, and none in his elbow, although he can still move his fingers and wrists. Mr. B is under the care of Tara Packham, who has asked VIC. Torious Engineering to design a device which assists him in the ability to use his right hand in basic day to day activities. It is evident that Mr. B requires support in his forearm / elbow as well as his shoulder. Because he will be wearing this device for long periods of time, the device is expected to be in the environment which Mr.B exposes himself to. This device can potentially be of use to others with similar injuries.

Design

The design has two small platforms which cover a portion of the user's wrist and bicep. These platforms are made of Styrofoam and chicken wire duct taped together, and are attached to the arm using Velcro straps. There is also a wire with a safety clip and a hook connecting the platforms by hooking on to the chicken wire found on the face of each component. There are also two thin straps going around the user's torso and shoulder to provide support for the shoulder, and a gel pad used for cushioning. The orthosis can be placed over any form of clothing including sweaters and shirts with long sleeves. In addition, the orthosis is very light weight due to the materials and there is a lot of breathing room for the arm because only the wrist and bicep is covered. In addition, the two straps are very thin and are a tight fit around the patient's body, preventing any safety hazards which may be imposed by loose, hanging material.

Functionality

The orthosis allows for the arm to be locked in several positions in the horizontal plane at various angles. It also allows for supination and pronation while providing support to the injured shoulder. There are straps around the patient's torso and opposite shoulder to aid in reducing stress on the injured shoulder. The design also provides a high level of comfort due to the gel pads placed between the inner shoulder and the torso.

Materials, Components, and Assembly

The materials include: foam, gel pads, two belts / straps, staples, chicken wire, duct tape, a safety clip, a hook, and a piece of wire/string. All of these materials can be obtained with relative ease in any local hardware store. The tools required for construction are scissors, pliers / wire cutters, and a stapler. Assembly for the manufacturer is fairly simple, and can be modified to suit patients with different arm sizes. Assembly for the user is only two steps, rendering it to be very simple. The design must be strapped on at the wrist and bicep, and then connected with a wire with a hook and clip.

Cost

The cost to both the clinic and the user will be very low due to the basic materials. If the product is mass produced, it will be inexpensive because the materials required come in bulk. Gel pads are approximately 10 dollars each, which are the most expensive components and are optional. Other materials such as duct tape and chicken wire come in high quantities and are only partially used. Approximately 10 - 15 orthoses can be made from 20 dollars worth of chicken wire. Duct tape, spray paint, hooks & clips all turn out to approximately 8 dollars. In total a single orthosis can be made for approximately 18 dollars. The orthosis requires upwards of 40 minutes to create, which should be taken into account for labour costs.

User Acceptance and Compliance

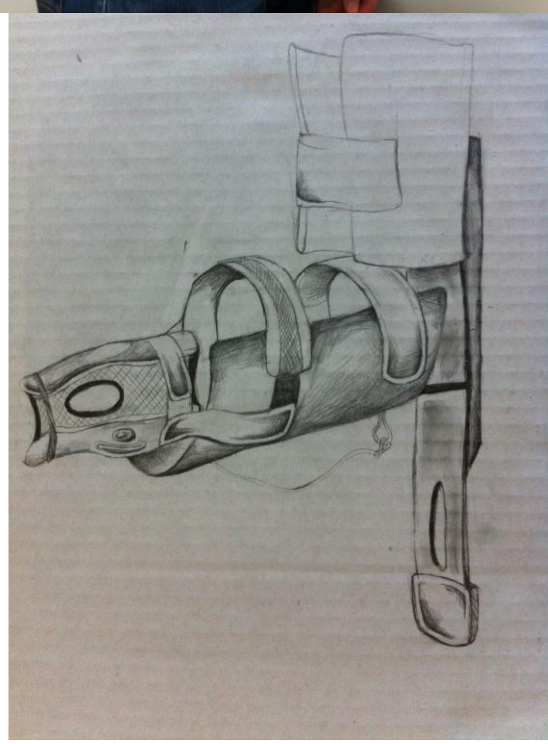
User compliance is a high priority which is why drastic measures have been taken to provide an optimal level of comfort. There are gel pads to ensure that the user's arm is not pressed up against his/her torso and the orthosis is designed to be very lightweight. Contact between the entire arm and orthosis is minimized so that it does not get in the way or feel bulky. It is also aesthetically pleasing due to the glossy black paint finish. Taking the mechanism off is a simple process, only requiring the removal of two straps and the unclipping of a belt. It is also portable because the device has many small components, which can be individually removed and stacked on top of each other to fit in a small bag.

Benefits

There are many benefits to consider with this particular design. It is highly inexpensive and lightweight compared to other orthoses on the market. The design can also be adjusted to fit a wide variety of individuals and can also be custom made. There is a large variety of modifications which can be made to the design, such as the size of platforms, number of angles available (more or less chicken wire), and number of gel pads. In general, the design offers more flexibility than other orthoses and covers a wide variety of functions.

Direct Shoulder Immobilizer

Team Name
F 0 2 - T 0 2 - 2



The problem presented to the team involved Mr. B, a 23 year old man who is recovering from a motorcycle accident. In order for Mr.B to have a successful recovery he requires an elbow orthosis, but because of the nature of his injury Mr.B required a more specific orthosis. The details of Mr.B's injuries include a compound fracture/dislocation, degloving wrist with nerve lacerations, and a severed brachial plexus affecting the right arm. However his finger and wrist muscles function optimally. The severed brachial plexus affects Mr.B's ability to move and control his muscles in his right arm, as his body has no method to send signals to the muscles in his right arm. Currently when Mr.B wants to use his right hand he has to support his right arm with his left or a sling. Tara Packham an occupational therapist at the hamilton general hospital has asked the team to try to design a device that would allow assist Mr.B in daily tasks. The device should reduce strain on Mr.B's shoulder and allow for wrist rotation. Optimally, the device could be used by others with the same or similar injuries as Mr.B.

The design is comprised of shelf bracket, with a U-shaped support fastened horizontally on the shelf bracket to support the forearm. A thin wooden rectangular rod; with another U-shaped support for the bicep, is attached to the shelf bracket to form a T-shape. Velcro straps are used to fasten the device to the user. The Velcro strap closest to the hand has a Velcro lining for the wrist rotation mechanism. A belt is looped through a notch cut into the base of the shelf bracket. The device with all pieces assembled will weigh approximately 1-2 lbs. Dimensions of the device.

The device performs two functions, first being the device reduces weight of the shoulder by placing the load of the arm on the waist, second the device allows for the rotation of the users wrist (This allows the user to lock his wrist in multiple positions) and thirdly the wrist guard attachment prevents the users' wrist from lying in a limp position. The client requested that the device should aid the user with daily tasks. The functions that the device performs allow the user to complete tasks such as writing, typing carrying objects and lifting small objects.

The device requires the following materials and components; a shelf bracket, approximately 2 metres of Velcro, a thin rectangular wooden block, plastic from a juice or milk carton, padding, light metal clips, string and fasteners such as tape or glue. The great thing about the materials used in the design, is that most of the materials can be bought at a hardware store or found in one's own home. The tools required to construct the device include scissors, drill and a saw. Construction of components and assembly of the device can easily be attained within a time frame of 2 hours. Instructions that might be needed include explanations of how to achieve rest position, and how to operate the wrist locking mechanism. The only special assembly required involves creating a notch in the shelf bracket in order for the belt buckle to loop through.

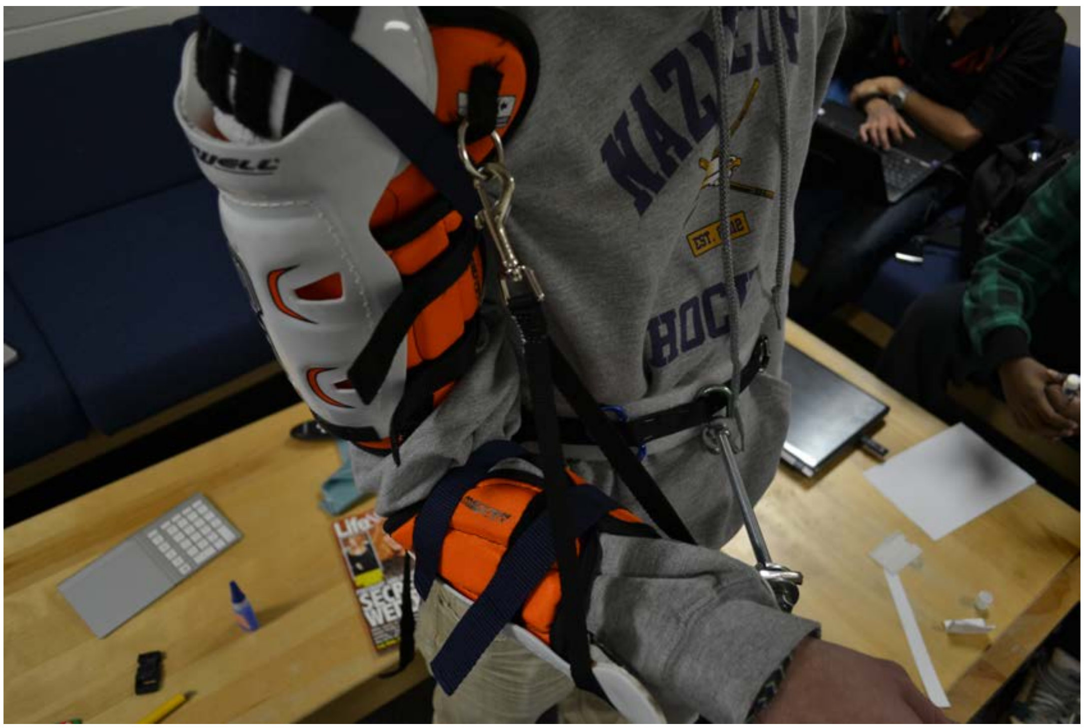
A rough approximation of the cost of materials results in a price of around a total of thirty dollars, depending where the components are purchased. Other cost includes labour time for the client, as indicated above the device can be manufactured in under 2 hours.

User compliance has been considered in many ways, from the comfortable padding that lines the device, to the devices placement on the waist that doesn't restrict walking motion. The user will be able to get the device on and off using Velcro straps to fasten the device to his arm, and then looping his belt through the notch in the base of the shelf bracket. The comfort of the design revolves around the layer of padding that lines the arm supports, the adjustable Velcro straps and the addition of rest position when the user is walking. In terms of cosmetic appeal the device is simplistic and the device can be worn over clothing allowing the device to be somewhat inconspicuous. The major consideration with safety in the design was solved through rounding off sharp edges or covering edges with duct tape.

The two major benefits of the device design are that this device is light and cheap to manufacture. The device is also very portable as a result of the multiple pieces that make up the device. Even though the device requires a belt to loop through the shelf bracket, no motion is impeded as a result of the waist being used as a weight support. Excelling in these key areas this device proves to be more beneficial for both the client and the user.

Terminator Orthosis

Terminator Engineering
Karl Zimmermann 1221411
Emily Tse 1209984
Mahmoud Mohamed 1217088
Darcy Schnarr 1210714
F02 - T02 - 3



Problem Description

Design an elbow orthosis that locks the arm into different positions. The adjustment process should be simple enough to allow the user to adjust the device with one hand. The device should not further strain the shoulder. The orthosis should assist the user in completing daily tasks. The design should also be easily modified to fit a variety of users.

Design

The design consists of two separate cuffs, one on the upper arm with a cup encasing the shoulder and one on the lower arm. Both cuffs are attached to the arm via Velcro straps that wrap over the arm and connect back to the other side of the cuff. A strap running from the lower cuff to the upper cuff can be attached at various positions to the upper cuff using a boat snap and harness rings. This mechanism allows for flexion as well as extension of the arm. Attached to the lower cuff is a hinge connected to a bolt. The head of the bolt points inwards towards the users stomach when being worn. This bolt can be hooked onto a belt the user wears at different positions to allow for horizontal abduction and adduction of the lower arm. A strap attached to the shoulder cup on the upper cuff runs under the armpit and re-connects to the other side of the shoulder cup. This strap uses the armpit to keep the upper cuff in place as well as shifting the weight of the orthosis off the shoulder.

Functionality

The design allows the user to lock the arm into multiple positions. The device can move the arm in both flexing and extending motions as well as horizontal adduction and abduction of the lower arm. The design is comfortable for the user to wear over extended periods of time and has a large variety of positions into which it can be locked allowing the user to go about many daily tasks. Due to materials such as thermoplastic, one person in a clinic setting can build the design quickly and efficiently. A user who only has the use of one hand can easily adjust the device.

Materials, Components, and Assembly

The materials used in the design can all be obtained at a hardware store or, in our case, Canadian Tire. In a clinic setting, many of the components in our prototype can be switched out for different materials that will reduce the weight and cost of the design. The hockey shin pads used for the upper and lower cuffs can be swapped out for thermoplastic, which is lighter and provides a more formed fit then the current material. The large metal bolt can also be switched out for a lighter material in the same shape making the device lighter. In a clinic with the substituted materials, the device could be built in approximately 25-30 minutes. Depending on the chosen materials, the device may require a needle and thread to sew straps to the cuffs. Some of the other major components of the design are Velcro, nylon straps, harness rings, a boat snap and D-clips.

Cost

The total cost of the materials used in the device is approximately $60. The device also requires approximately 25-30 minutes to build and assemble the various pieces.

User Acceptance and Compliance

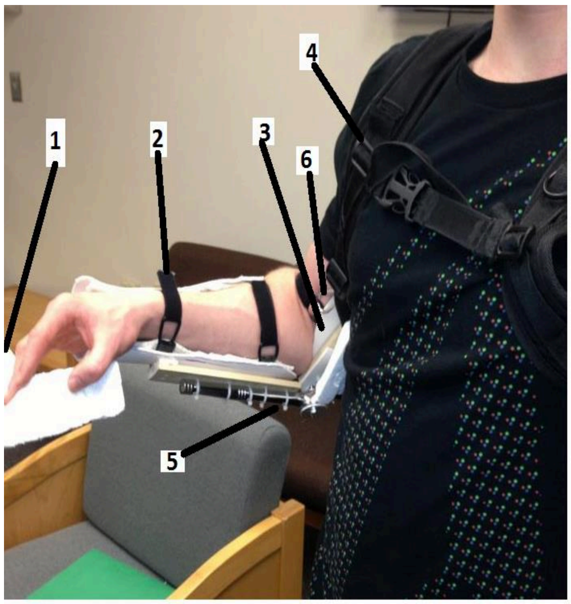
The design takes into account the fact that the user only has the use of one arm with respect to adjusting the device. All the adjustments required to use the device can be completed using only one hand. The strap adjusting flexing and extending motions uses a boat snap to attach to the harness rings. The nylon straps on the device connect using either buckles or Velcro, which are both one handed mechanisms. To adjust the bolt, the user simply loosens a wing nut and slides the bolt out of the D-clip. The bolt is then slid into the new position and the wing nut is tightened. The process is easily completed using one hand. To put the device on, the user will need to have a wall or vertical post to lean on as well as a horizontal surface on which they can rest their elbow when strapping on the lower cuff. The prototype uses the padding inside the hockey pads to provide comfort to the user. The belt around the waist is also padded to spread the force of the bolt out over the abdomen.

Benefits

The main benefit of our design compared to existing designs is the ability to move the arm not only in flexing and extending motions but also provides motion in the horizontal abduction and adduction ranges of motion. This is achieved through the use of the bolt and belt on the waist. This mechanism is unique to our design and provides a unique benefit. Another major benefit of our design is the user specific adjusting functions. All the adjustments required to fully use the device can be made using only one hand. This is a large difference from the vast majority of existing designs. Many existing designs that achieve similar functions have adjusting mechanisms that are difficult to adjust with one hand.

The Fulcio

Crossfire Industries
F 02- T 02 - 4



1. Desk Attachment

2.Velcro Straps

3. Arm Pit Wedge

4. Back Support

5. Ratchet

6. Carbineer

Problem Description

The problem presented to our firm involved Mr.B- a twenty three year old single male involved in a tragic motorcycle accident. As a result of this accident, Mr.B is unable to preform his daily tasks. He suffers from a multitude of injuries, which include a compound fracture dislocation, as well as the de-gloving of his right wrist with tendon and nerve lacerations. In addition, he is also a victim of a brachial plexus injury and nerve gratings that became transparent roughly six months after the accident. Mr.B would like to vary his forearm rotation, as currently his fingers and wrist muscles work, but he has no movement at his shoulder as well as his elbow. He would also like to work on active assisted range of motion. Tara Packham has requested Crossfire Industries to design a device that addresses Mr.B's problems, which would ultimately assist him in his day-to-day activities while aiding him during his rehabilitation process. Optimally, the device design will be able to help other clients with problems/injures similar to Mr.B.

Design

The design consists of four main components; , a main brace, a back strap, a ratchet system that acts as a dynamic adjustable joint, a wrist attachment and buckles. The size of the design will be as minimal as possible to reduce disruption in the user's daily activity. The main brace is customized for every individual as arm length varies between users. However, all the other parts are general in terms of size and are suitable for everyone. The wrist brace only covers the bottom part of the user's arm while the ratchet is on the inner part of the arm. The average client should expect the ratchet to cover between the middle of the forearm to the middle of the humorous.

Functionality

The dynamic elbow orthosis designed will help the client perform daily activities such as writing, typing and carrying light objects. In addition, the orthosis provides support for the client's dislocated shoulder and prevents unwanted horizontal abduction for his arm. The wrist brace add on supports the user's wrist while writing and typing.

Materials, Components, and Assembly

In our design we kept the complexity of the design to a minimum thus allowing easy access the materials needed. The mechanism of the arm is also quite simple allowing for easy installation. We used thermoplastic, a ratchet, zip ties, Velcro straps, backpack straps, maple wood, Styrofoam and padding. All of these can be easily found at a hardware store such as home depot. The tools needed to build our design are quite readily available. They include a saw, hot glue, a drill, a heat source (hot water), which can all also be bought at a hardware store. The estimated time needed to build our design at an average skill level is around one-one and a half hours. The instructions to build the device are quite simple such as drilling holes, gluing pieces together etc. The only difficult instruction would be the forming and tailoring of the thermoplastic to the client's arm which is something that is unique to every client.

Cost

Due to the wide availability of our materials, the cost for our device is fairly low. The materials that are the most costly are the ratchet and the thermoplastic. Due to the fact that most hand clinics buy their materials in bulk orders, we can confidently estimate that our production cost would be around $80 with one to one and a half hours of labour.

User Acceptance and Compliance

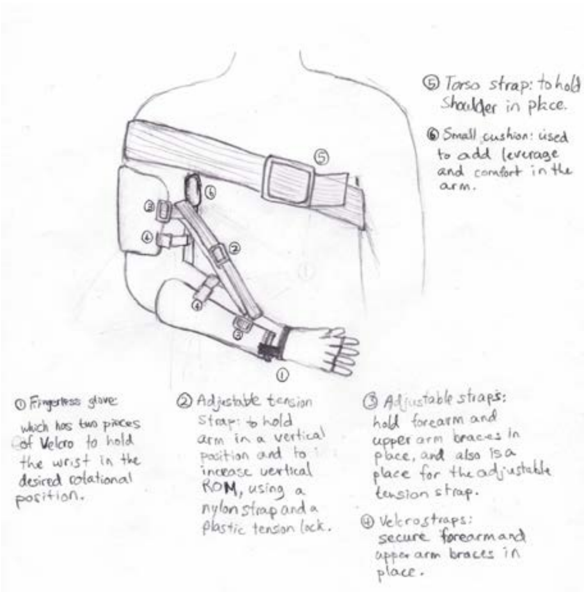
Our design has been made with the client's disability in mind. Our main triumph is that our product is very easy to put on and take off due to the fact that it can be done with one arm. The main adjustable component (the ratchet) is on the inside of the right arm, which makes it easily accessible to the working left arm. When an adjustment to the flexion or extension of the arm is desired the user can simply twist the ratchet switch, and move his arm to the desired position. The padding and the contoured shape of the plastic allows for great comfort. The colour scheme looks urban and simplistic which allows for integration into any outfit. There are no protruding edges or other hazards which can further worsen a condition. Not only is our device functional but it also addresses aspects that can promote its use with the client.

Benefits

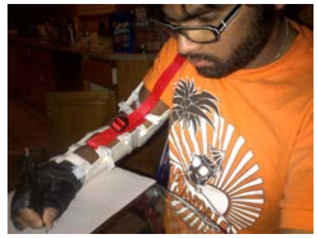
There are many factors that contribute in making out design better than current models out there today. Firstly, the cost to manufacture the orthosis is relatively inexpensive when compared to current models which can cost upwards of one thousand dollars. In addition, several design aspects which are tailored specifically for one use, such as typing, allow the device to excel in several areas. This allows the user to use the orthosis for a range of activities. Unlike other designs out there, our design is easy to manufacture using common items and minimal skill level.

Dual ROM Orthosis For Mr. B

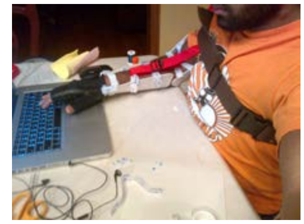
Genesis Innovations
F02-T03-1



Final Design: This design is what will be used to build the final product.

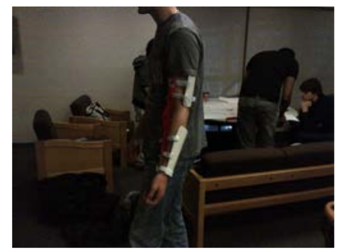


Writing



Typing

Adjustability: very simple to adjust with one hand



Walking

Problem Description

There is a patient, Mr. B, at the Hamilton Hand Clinic who was severely injured during a motorcycle accident. He suffers from a severed brachial plexus and dislocated shoulder rendering his arm nearly immobile. Mr. B's shoulder can barely support itself as is and its own weight is pulling it further from its socket meaning the device has to support reduce the load on the shoulder. He also suffers from a compound fracture and de-gloving of the wrist as well as nerve lacerations, further restricting his ability to use his right arm. Currently Mr. B has lost all motion in his right arm except for minor hand movements. Tara Packham is an occupational therapists that is seeking a solution to Mr. B's problem and others that have similar problems. She is asking for a method of increasing the patients assisted range of motion while supporting the arm and reducing the load on the shoulder. The device should allow for a variety different positions in which the arm can be locked. Users must be able to use this device independently, including putting it on and operating it without any assistance. The support of the arm must be done without further damaging the arm and associated body parts, therefore the solution must not stress the damaged body parts. Mr. B is currently pending drug charges and has the possibility for incarceration meaning ideally the device would be safe for an inmate to wear in prison.

Design

The design consists of two main thermoplastic casts that are bound to the arm with Velcro straps. They are connected by a tension lock, which allows the user to adjust the brace to lock in different positions vertically. A glove is worn by the user that has Velcro straps sewn upon it. These straps attach to the Velcro on the front rim of the forearm brace, to lock the user's arm in position rotationally. A strap that goes over the shoulder and around the chest is used to take load off the shoulder, and a cushion is placed under the arm for leverage in finding a comfortable position for various daily activities. The entire design weighs less than a single kilogram.

Functionality

The design allows the user to lock the arm in an infinite amount of positions rotationally and vertically, through use of the tension lock and the glove with Velcro strap. The shoulder strap accomplishes the function of supporting the shoulder by using tension to hold it in its socket, so it doesn't fall out.

Materials, Components, and Assembly

The brace consists of thermoplastic, Velcro straps, spongy material, a workout glove, and a tension lock. The clinic has an abundant supply of thermoplastic, and the Velcro straps can be obtained at Walmart or Michael's. A spongy material can be found very easily at the dollar store, the workout glove be bought at Walmart, and the tension lock can be bought at Canadian Tire.

To assemble the design, one must first cut out two square pieces of thermoplastic. The two pieces of thermoplastic must be heated and molded to the forearm and bicep respectively. Six rectangular holes must be cut into the forearm piece, and four into the bicep piece. This is for the Velcro straps. Thread the Velcro straps through the holes, and glue one end of the inward facing end of the thermoplastic piece. Insert and glue padding onto the inside of the brace. Sew Velcro straps to the glove. Attach the tension lock adjustable strap to the outside of the brace. Finally, attach a Velcro ring around the front of the brace for the user to attach the glove to.

It takes roughly an hour of labour to make, and the only special tools needed are knives and scissors for cutting the thermoplastic.

Cost

The total cost of parts and labour is $100, where the cost of materials is $85 and the labour costs $15. The price will be less for Tara to construct because she purchases her thermoplastic form wholesale distributors. This will eliminate the markup that was included in the 92$. Also, there will be leftover thermoplastic and various other materials used in splints meaning the average price of one device when making multiple devices will be less than $92.

User Acceptance and Compliance

The user's comfort is taken into account in the design, as the design is perforated to allow for maximum airflow and there is spongy material at the bottom of each thermoplastic piece for physical comfort. It is also very simplistic in design, so it is more visually appealing than a bulkier design alternative. Finally, it is very safe, as the thermoplastic's edges have been rounded, and the rest of the design consists of soft material.

The design will also satisfy the user's desires by giving his arm more function. With the infinite range of vertical and rotational motion, the user can accomplish a variety of activities with his arm. It is also easy enough to put on that the user can accomplish the task with only one working arm. To wear it, one simply slides the brace over the arm and tightens the straps.

Benefits

The design has many benefits over other orthoses of its kind. It is extremely low cost, costing one hundred dollars compared to the several hundred dollars most orthoses cost. It is extremely lightweight, weighing less than a single kilogram, and the shoulder strap reduces load on the shoulder. It is easy to adjust with just one arm, and there are infinitely many positions you can lock the brace in, rotationally and vertically!

ASEO
(Adjustable Supportive Elbow Orthosis)

Gear Heads Inc.
F02 – T03 - 2

Problem Description
The user (Mr. B) was in a motorcycle accident and has recently undergone surgery to repair severed nerves in his right shoulder, compound fractures in his right wrist, and has also dislocated his right shoulder. He has no muscle control in his right upper arm and forearm and very little in his shoulder. The loss of arm functionality severely limits the users ability to preform functions of daily living. The design must support the arm in a range of positions, and must minimize the load placed on shoulder. The client (The Hamilton Hand Clinic) needs to be able to build the device with the materials and tools they have at the clinic. The device will be used in and outside the home for tasks of daily living such as carrying, typing and walking.

Design
ASEO (The Adjustable Supportive Elbow Orthosis) has three parts to it, the forearm brace, the bicep brace, and the wooden dowel.

The Forearm Brace:

The forearm brace is made out of thermoplastic with loops attached at specific spots, this allows for supination and pronation with the users forearm. There are Velcro straps to allow for tightening and padding on the inside for comfort. The wooden dowel with hooks attached to each side of the bicep brace.

The Upper Brace

The upper arm brace is made out of thermoplastic and has brass loops attached to it, it has a Velcro strap attached to wrap around the torso to support the shoulder. The upper Velcro strap is used to fasten the brace to the upper arm.

Functionality

The elbow orthosis that Gear Heads Inc. designed performs many functions that comply with the clients and user's needs. The main functions that our orthosis accomplishes are; it stabilizes the arm at pronated, supinated, and anatomic positions while reducing the load on the shoulder through the use of an extended Velcro strap which wraps around the users torso. Another function that the orthosis performs is it also allows for a wide range of motion of flexion and extension in the 90 °, 135 ° and 180 ° angles through the use of hooks placed at various positions on the thermoplastic. The design can perform everything that the user requested, it provides an extended range of motion, while stabilizing the arm and supporting the shoulder. The only request that fails to meet the client's needs is for the elbow splint to be allowed in incarceration, there is a removable wooden dowel which may not be allowed if the user is incarcerated, aside from that, the functional needs requested by the client are fully fulfilled by the company's design.

Materials, Components, and Assembly

The design consists of thermoplastic, a wooden dowel, five Velcro straps, two small metal hooks, and screws. The thermoplastic can be obtained from a hospital while the rest of the materials can be obtained at hardware stores. The device takes around an hour to build, and doing so will require a handsaw to cut the dowel, a hammer to implant the screws into the thermoplastic, and a glue gun to attach the Velcro straps to the thermoplastic. The thermoplastic should be placed for a minute in water heated to 170 degrees Fahrenheit before moulding occurs. The assembly does not require any special instructions.

Cost

One of Gear Heads Inc. primary goals when designing the elbow orthosis was to minimize the cost. To achieve this, the company used a simple design, with parts that could easily be found in common households and hardware stores. The cost estimated is as follows:
Thermoplastic: $10 (May vary according to quality)
Velcro: $ 3
Wooden Dowel: $2
Brass Hooks: $2
Screws, washers etc.: $3
Total: $20
The clinic can expect the cost incurred when building the orthosis to be around $20 or less depending of the types of materials used.

User Acceptance and Compliance

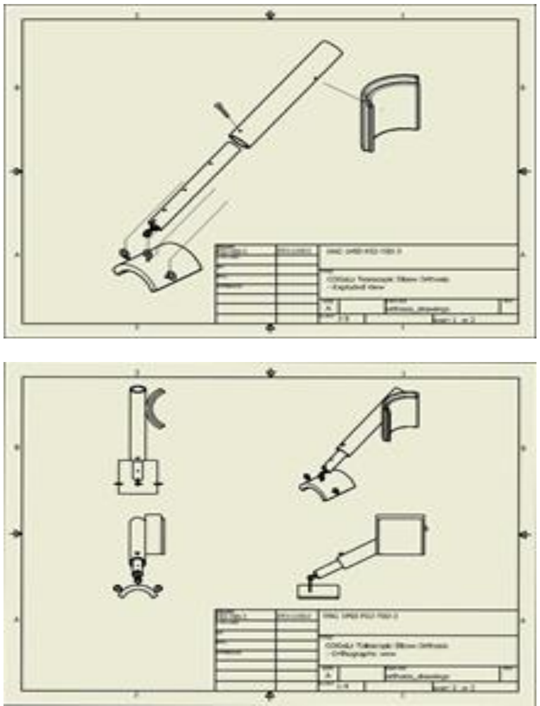
Getting ASEO on and off is easy. First attach the smaller piece of thermoplastic to forearm, then the larger piece to upper arm, and use the Velcro straps to wrap around each thermoplastic to keep it in place. Then loop a long piece of Velcro once around the upper arm, and once around the torso. To get the orthosis off m simply take off Velcro straps and remove the two pieces of thermoplastic. Using ASEO is very simple; just attach the hook at the ends of the dowel to the different hooks on thermoplastic to lock the arm at different positions. The thermoplastic material has been moulded in the shape of an arm to offer comfort and the ends have been folded inward to prevent injury from sharp edges. This prevents any hazards with the design. Lastly, ASEO is a very attractive, light weight, easy to adjust, and affordable device, and will comply with any user.

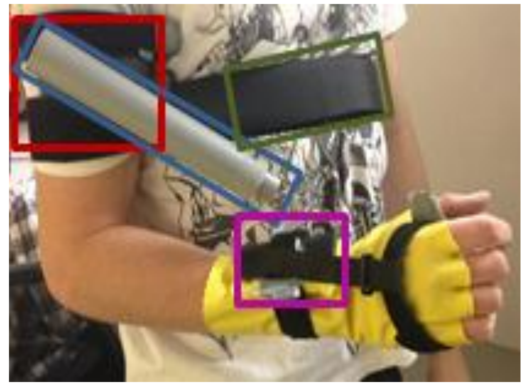
Benefits

ASEO is better than other existing in many ways. It is light weight, affordable, and uses a simple design. It can be adjusted using just one hand. Unlike other designs, it reduces the load on the shoulder for the user, and also, prevents the arm from swinging outward. Due to its lost cost materials and simple design, parts are easily replaceable and can commonly be found at hardware stores.

COGeLZ Telesopic Elbow Orthosis

COGeLZ Enterprise
F 02 - T 03 - 3





Above: Fully assembled and fully functional prototype of the COGeLZ Telescopic Elbow Orthosis (*please see Design section for explanation of components*).
Left: Computer-Aided-Design (CAD) models for the upper arm cuff, forearm cuff and telescopic pipe extender.

Problem Description

The COGeLZ Telscopic Elbow Orthosis was created with the user Mr. B in mind. Mr. B in particular has suffered from: damage to nerves, shoulder injuries and fractures.

COGeLZ Enterprise has addressed the many issues that face the client and user. The design needed to be able to compensate for the lack of muscles available to support the individual's right arm. This includes supporting the elbow, the forearm, and the wrist. This orthosis in particular also reduces the load that Mr. B will experience on his right shoulder.

An important feature of this design is that it allows Mr. B to be self-sufficient in his work, while under the benefits of splint rehabilitation. This can be accounted for by creating a wide range of adjustability options for the joints throughout the right arm.

COGeLZ Telescopic Elbow Orthosis options for customization and adjustability make it suitable for a variety of users.

Design

The design itself is very compact and light. It is weighed at less than half a kilogram making it manageable to operate. Also the device's compactness makes it relatively small and requires little storage space.

The orthosis consists of four main components. The upper arm cuff (red box from visual) is secured to the right arm and the torso belt (green box) is fastened around the upper body. The telescopic pipe extender (blue box) alters the lock position, and the forearm cuff (purple box) is tightened to the wrist.

Functionality

COGeLZ Telescopic Elbow Orthosis performs the functions one would expect from a dynamic elbow orthosis to a high degree of effectiveness.

The stress on the shoulder from the weight of the arm and splint is redistributed across the torso using a torso belt.

Supination and pronation is accomplished by adjusting which screw hook the telescopic pipe is connected to.

Elbow locking and adjustment of the range of motion is accomplished by changing the length of the pipe extender with the pin.

Extension and flexion of the wrist is also offered by adjusting the Velcro strap that connects the glove to the forearm cuff.

By completing these functions, maximum support is provided for the forearm, wrist, and elbow, as well as that it allows for Mr. B to be self-sufficient in meeting his personal goals.

Materials, Components, and Assembly

All of the materials used can be found in local hardware stores or general stores. PVC pipes of varying sizes are cut with a saw and used for the upper arm cuff, the forearm cuff, the small pipe extender and the large pipe extender. A simple keychain is glued to the smaller pipe extender. Two sponges are placed under the cuffs. Hot glue is often used to attach components to one another. Three screw hooks are inserted in the upper arm cuff, and general small-sized screws are used for securing the large PVC pipe extender to the upper arm cuff. A comfortable glove (i.e. kitchen glove or leather glove) is placed on the right hand. A large Velcro strap is used for the Torso belt, an additional smaller Velcro strap secures the cuffs to the arm and two more Velcro straps are used to attach the glove to the forearm cuff.

Standard tools are used in implementing this design. These include: scissors, a hot glue gun, a hand saw (and a clamp may be useful), and a power drill. A dremel or file may be used to smooth down irregularities in the PVC. Assuming the user is familiar with these tools, the entire construction process should take no longer than 3 hours.

The construction process does not require that the user be present; however for optimum results the product should be specifically fitted to the user.

Cost

The mechanism in essence is very cost-effective and requires very little and infrequent replacement of components. The total cost to implement this design is only $25.00, taking into account the materials to be purchased and the necessary fasteners (i.e. glue and screws).

User Acceptance and Complance

Compliance of the user has been heavily considered, to ensure the splint is used frequently and to its full extent.

The comfort of the device is ensured by using lightweight components and materials that are soft to the skin, such as sponges.

COGeLZ Telescopic Elbow Orthosis in particular allows for a great variety of customization to the specific user and allows for a variety of adjustability options. The use of Velcro straps throughout the design and a pin to adjust the telescopic member makes it a simple device to put on, remove and adjust.

Several steps are required for equipping the splint. First the glove is placed on the right hand. Secondly, the forearm cuff is attached and tightened to the wrist; the Velcro strap from the glove is strapped to the cuff. The upper arm cuff is placed on the upper portion of the arm and is secured with Velcro straps. The torso belt Velcro strap is tightened around the upper body. The pipe extender locks into position by placing the pin in the corresponding hole. The pipe extender is attached to the forearm cuff by locking the key chain hook on the appropriate screw hook of the forearm cuff.

With proper securing of the orthosis to the arm, the design appears sophisticated and retains a high level of aesthetic appeal.

Benefits

For the client this design is remarkably simple to construct, utilizing basic materials that can be found at local stores and within the Hand Clinic itself. Very few tools are required to manifest a fully functional orthosis within a relatively short time span. Along with this the resources required are very cost-effective, placing the total cost of the device at $25.00. Once the final product is implemented, little and infrequent maintenance is required.

For the user, there is a great variety of adjustability implemented into the device, making it useful for completing tasks. The accessibility of the splint allows for single-handed operation of the splint. Convenience was addressed by manufacturing a design that could be easily assembled and disassembled and requires very little storage space. Importantly the orthosis is comfortable. By using materials that fit snuggly, yet not over constrictive, the device feels natural and is in no way abrasive to the skin. It is a practical and effective design.

Tri-Tone Elbow Orthotic Device

Team Name
F 02 - T 03- 4

Problem Description

The Hamilton Hand Clinic asked the team to design a device for a patient, Mr. B, who suffered severe injuries to the right side of the body. He has no muscle function in the elbow or shoulder. Mr. B would like to be able to use the device to help him perform daily functions while working on assisted range of motion. The device must limit the weight placed on the patient's shoulder in order to prevent further injury and Mr. B has also expressed desire that the device be allowed in general population if incarcerated. Finally, it would be preferable for the Hamilton Hand Clinic if the device could be used for future patients with similar injuries.

Design

Our design is comprised of three pieces, a bicep cuff, a forearm cuff and a large back belt for support. The belt is attached the bicep cuff using two straps which aid in weight distribution and immobilizing the shoulder. The forearm and bicep cuffs wrap around the patient's arm, respectively. Both the forearm cuff and bicep cuff are lightweight in construction and minimal in size. The strap on the front of the bicep cuff goes across the front of the body to the left side of the belt. The strap on the back of the bicep cuff goes around the patient's back and over the left shoulder, attaching to the right side of the belt. On the two cuffs hooks have been placed, and an elastic is attached to the hooks to hold the injured arm in a range of positions.

Functionality

The user can type, write, and perform other simple daily functions while the device is supporting the arm. Because of the back brace, little to no weight is placed on the injured shoulder. The forearm can be placed in supination or pronation, as well as flexion or extension, allowing the arm to be locked in various positions, permitting the user to work on assisted range of motion. The device is also made of soft materials and therefore would be allowed in general population if the user were to be incarcerated. The device is also adjustable and could easily be modified if the client has the desire to use it for another patient.

Materials, Components, and Assembly

The materials needed to assemble this device are thermoplastic, foams sheets, Velcro, a tensor bandage, a back brace, plastic hooks and elastics. The foam sheets and Velcro can be found at a craft store, the plastic hooks and elastics can be purchased from a hardware store and a Back Brace can be purchased from any pharmacy. The tools required for the assembly of this device are a glue gun, scissors, an X-Acto Knife and water heat the thermoplastic. No special training or skills are required to assemble this device. To make this it, first cut the thermoplastic to the appropriate size for the users forearm and heat the thermoplastic so it can be molded. Next, use scissors to cut slits for the foam sheets to pass through. Then glue the foam sheets to one side of the thermoplastic, and directly attach the Velcro to the foam and thermoplastic. Hooks can be attached to the thermoplastic with a glue gun. Straps can be made by cutting a tensor bandage to the appropriate length depending on the patient and attached to the belt (and bicep cuff) with Velcro. The entire assembly takes approximately 25 minutes.

Cost

The cost of the thermoplastic is $75, but for this device only one third of a standard sheet of thermoplastic was used. The belt costs $30, foam sheets cost $2, the hooks cost $5, the Velcro costs $7, the tensor bandage costs $5 and the elastics cost $2. Similar to the thermoplastic, not all of the purchased materials were used and this lowers the cost of the device. The total cost is approximately $70 plus labour. In addition, the belt and straps could be removed if the patient does not require the load of their arm to be differed away from their shoulder. This reduces the total cost of the device to $35 plus labour.

User Acceptance and Compliance

The device was designed with user compliance in mind in several ways. The colours of the foam sheets, elastics and thermoplastic could be changed depending on the preference of the user. The design is simple and bulky, so a user could easily conceal it. The device is comfortable; it is molded into each user's arm. Also, it does not strain the shoulder and the Velcro makes the device easy to get on and off. This should increase a user’s willingness to wear the device. The device allows the user to perform daily tasks such as writing and typing. The hooks make it easy to control extension/flexion of the arm and also allow the arm to be rotated and locked in different positions. To take the device on and off, the user should first put on the belt (which is fastened with Velcro or a buckle). Next, the user should fasten the bicep piece with the Velcro, and then attach the straps from the bicep piece to the belt, also using Velcro. Next, the user should put the forearm piece and fasten it with Velcro. The elastics are then placed in the respective hooks for the degree of extension or flexion desired.

Benefits

Our device is cost effective and easy to manufacture. The materials are easily accessible and specialized training is not needed to construct the device. Our device is also very comfortable due to the soft foam sheets and molded thermoplastic. Our device has multiple customization options, including different tensions in elastic bands between hooks, different hook spacings and custom colours. This makes the device suitable for many different users. With the arm in full extension, our device can comfortably fit under a coat. Our device can match or blend with clothing depending on colours selected, and can be worn under or over clothing. Finally, our device is not weaponizable because soft, lightweight materials were used and there are no sharp edges.

Elbow Flex

Med-Tech
F 02-T03-5

User holding object at a flexed position with the help of Elbow Flew

User typing with the help of Elbow Flex.

Problem Description

An elbow orthosis is a device which is used to help in the recovery of an elbow injury. The client, Tara Packham from Hamilton General Hospital, Hand Clinic, approached the firm asking to design an elbow orthosis for a user with certain needs. The user, Mr. B, has no movement in his elbow and has a dislocated shoulder. He has most functionality in his hands (beyond his wrist) apart from extreme rotations. It should be designed so the user can perform everyday functions. The device needs to be adjusted and attached by the user without external help. The materials and the overall design should be cost-effective due to a small budget constraint.

Design

The Elbow Flex is made up of three distinct pieces: the shoulder cuff, the arm brace, and the rotational wrist brace. The design is lightweight, weighing 8.2 pounds, and is fairly compact making the design portable. Each of the brace pieces in contact with the arm are made of thermoplastic which is a relatively thin, sturdy material that does not make the design feel cumbersome. Each piece of thermoplastic is shaped to fit the body of the user so the design feels slim. The shoulder cuff attaches to two straps, one fastening the cuff of the arm and another constraining and securing the shoulder to the body. The arm brace fastens to the arm by Velcro straps and the upper arm connects to the forearm by the "V" strap, which is unique to our design. The rotational cuff at the end of the arm brace fits easily around the wrist and allows for rotation of the wrist brace. It is sitting inside and is constrained by Velcro lining the cuff.

Functionality

Functionally speaking the Elbow Flex can perform most of the user’s requests. The user wants to lock his elbow at various positions allowing him to do numerous tasks. The buckle strap design performs this function by tightening or loosening at several angles in the sagittal plane. The V-shaped end of the buckle ensures that the arm is locked in the transverse plane. Another function is the rotation of the wrist to allow tasks such as typing and writing with the use of Velcro. The Velcro permits the user to rotate his wrist to any angle and then lock it in place. The lightweight design satisfies the users request to reduce the load on the shoulder. The separate shoulder cuff attachment holds the arm close to the body also reducing the load on the shoulder. Elbow Flex is designed so that it can be put on without assistance. The client requested that the device be useable in prison, however in order for the device to meet the needs for majority of the users with Mr.B's condition, the request was not practical.

Materials, Components, and Assembly

The device requires common materials such as a pipe, tensor bandage, Velcro, straps of cloth and buckles. These components can be found at a local hardware store or a store such as Canadian Tire. Thermoplastic is the only material that is not common however the clinic has access to this material. Construction of the device requires few tools, such as a sewing machine, Xacto knife and a hot glue gun. Construction takes approximately two hours. The production of the device will require minimal instructions such as, how to mold the thermoplastic and where to attach the straps and buckles. Special instructions might be necessary in building the rotational cuff due to its complex design. The assembly of the device in general is very simple so many of the instructions will be repetitive.

Cost

The production of Elbow Flex will cost approximately $61.30 to the clinic. The firm's recommended selling price to the user is $149.99.

User Acceptance and Compliance

Elbow Flex, has been built in accordance to the needs of the user as specified in the problem statement. The user has only one fully functional hand therefore; Elbow Flex is designed so that any user can put the device on solely with one hand. The Elbow Flex contains numerous straps on the arm brace so that the user can: first place the device under his arm, second strap the device around his arm and then third tighten the straps depending on whether the user is wearing clothing or not. The user can then attach the two parts, for flexion and extension, using the strap and buckle. The shoulder brace is slipped onto the arm and it also comes with straps that secure the shoulder in place. Thus, the user will be able to put on/take off the device using only one arm. The Elbow Flex is designed for comfort because it is made of thermoplastic, which can be molded around the arm of any user to fit them perfectly. In addition to comfort, the design has been modified to minimize the risk factor of the device. The device was sanded down to remove all sharp edges and the strap around the chest contains soft padding to prevent bruising. To operate the device the user needs simply to tighten/loosen the buckle on the arm brace extending/flexing the device. The user can also lift the wrist with his other hand, turn it and then reattach it to the arm brace. The user will want to use this device due to its simplicity and short preparation time. The mechanism is also adjustable to any type of clothing. Overall, the device, though consisting of many parts, is safe, comfortable and easy to use making it the optimal choice for any user.

Benefits

Elbow Flex is a unique, user friendly design that is simple to use which outperforms existing designs. The V-shape at the end of the locking mechanism restricts movement in the transverse plane, whereas devices without this strap, place an unnecessary load on the shoulder. The rotational cuff allows the user to supinate his arm at any angle from 0 – 90 degrees. Similarly, the arm brace uses a locking mechanism that allows for full extension to full flexion. However, other devices only have fixed positions that restrict the user's motion. To further user friendliness the device adjusts to allow for any type of clothing helping the user to feel comfortable. Other devices that are not adjustable force the user to wear certain clothing. Elbow Flex is the ideal choice over the existing designs as it excels in all aspects in the design process.

The DYNALock

Sigma Engineering Inc.
F02-T04 -1

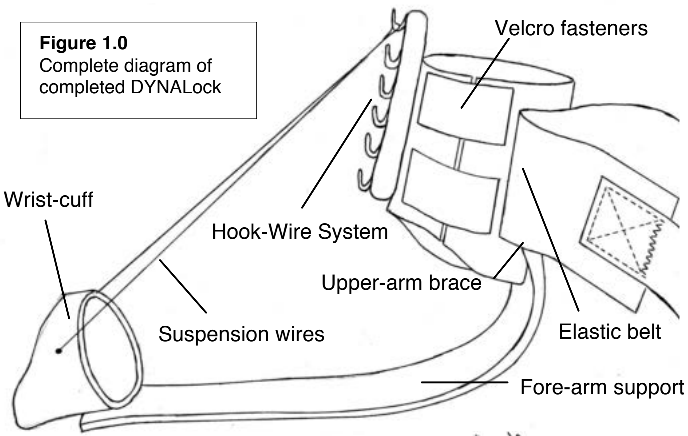


Figure 1.0
Complete diagram of completed DYNALock

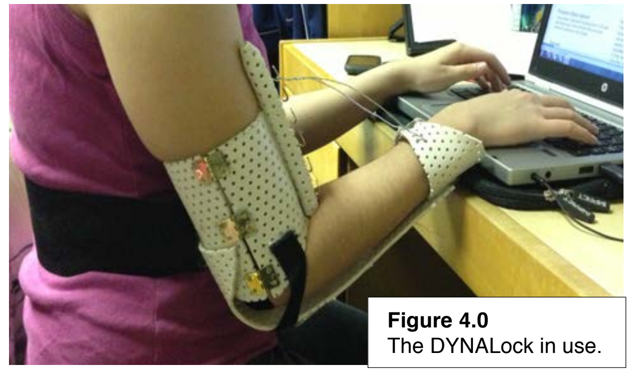


Figure 4.0
The DYNALock in use.

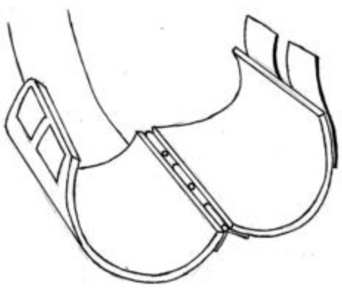


Figure 2.0
Opening mechanism of the upper-arm brace.

Figure 3.0
Reverse of upper-arm brace.

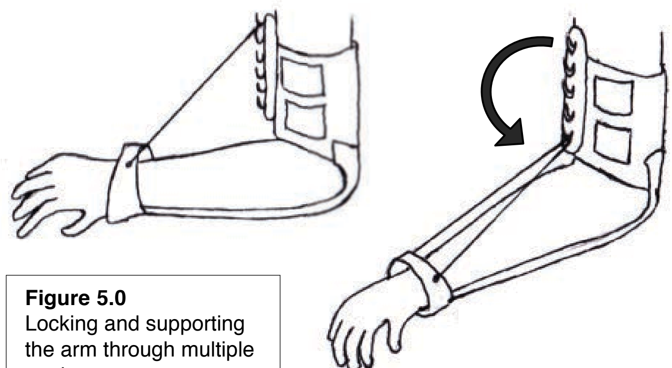


Figure 5.0
Locking and supporting the arm through multiple angles.

Problem Description

Due to a severe motorcycle accident, resulting in a fracture at both the upper arm and the wrist, degloving around the wrist and a brachial plexus injury, the user requires an elbow orthosis for rehabilitation. The device must immobilize the shoulder in order to prevent further injury. In addition, it must allow the user to lock the elbow at different positions to perform various daily activities. Ideally, the device would be very low in weight to reduce strain on the shoulder and the rest of the arm, while being more comfortable. The elbow splint must not restrict pronation and supination in the wrist. This elbow splint is being designed for the user, Mr. B.

Design

The design of the DYNALock is highly versatile and adjustable due to its functional components. It is primarily composed of an upper-arm brace, which is attached to an elastic belt (see Figure 1.0), which stretches. The upper-arm brace opens by a trio of hinges (see Figure 3.0) paired with Velcro fasteners to keep it closed (see Figure 2.0). From the brace is the fore-arm support, a rigid member of thermoplastic with a wrist-cuff at the end (see Figure 4.0). The cuff is suspended by pair of wires which loops onto different hooks on the brace. Flexion and extension in the forearm is simulated by adjusting the placement of the wire loop, while the fore-arm support flexes with the movement. The DYNALock covers most of the bicep, and spans the length of the arm until the wrist. It is secured against the body by the brace and elastic belt, which immobilizes the dislocated shoulder. It is relatively light, ranging from 0.15 – 0.3 kg, and puts virtually no load on the shoulder, as it immobilizes the shoulder from below.

Functionality

The DYNALock locks the user's elbow using the suspension wires attached to the wrist cuff and connecting them to one of the multiple hooks on the upper-arm brace. Placing the wires on to a higher hook provides flexion for rehabilitation and also allows the user to lock their elbow at a functional angle. This was a simple, cost-effective way to allow the user to reposition their arm using only one hand and without requiring any tools or expensive elbow locks. Wrist and finger movement is left unhindered by the loosely-fitting cuff. The DYNALock is also incredibly lightweight and the belt immobilizes the user's shoulder from below, preventing any further injury due to subluxation of the shoulder.

Materials, Components, and Assembly

The DYNALock is an integration of five main functional units: the upper-arm brace, the hook-wire system, the elastic belt, the fore-arm support and the wrist-cuff. These function to lock and support angular movement in the arm. The DYNALock can be constructed entirely from thermoplastic, hot glue, Velcro, thick fabric, picture frame hooks, wire, three small metal hinges and a rigid metal rod. Tools required are scissors, a hot glue gun, a utility knife and a sink with hot water to mold the thermoplastic. Thermoplastic can be ordered from a medical supplier such as Remington Medical, and the rest can be purchased at any hardware or fabric store. The metal rod was obtained from an old umbrella. The DYNALock can be fully constructed within 2 hours, and with experience, within an hour. Instruction required is limited, but a clear and concise instruction booklet could be provided. Templates according to user size would be provided. The only special instruction required would be for thermoplastic if the manufacturer did not have prior experience.

Cost

The cost of raw material for making the DYNALock can be estimated to be 36$, which is relatively cheap in comparison to other alternatives. This cost does not include costs for the required tools which would increase the cost by $15 - $20. However, these tools are likely already available and are reusable. There will be a labour cost for production, a total of 2 hours maximum. The most accurate approximation of the price would total to be $60 - $80, with the largest factor being cost of labour. Conclusively, the DYNALock would certainly be under the $100 range to the user.

User Acceptance and Compliance

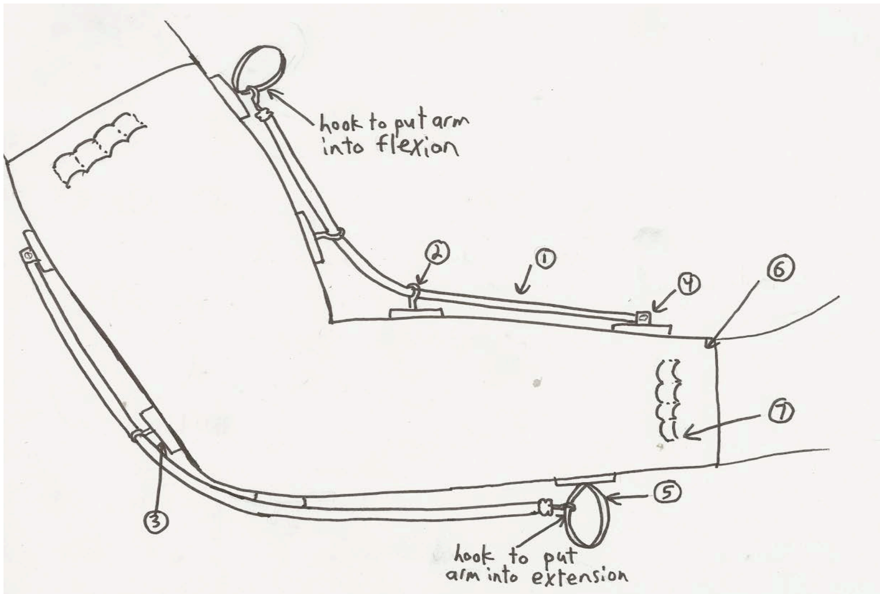
The DYNALock was designed to be easy to put on and remove with one hand, so the patient can use the orthosis without assistance. After undoing the Velcro and waist belt, the DYNALock slips off effortlessly. It is molded to the patient's arm and the Velcro can be adjusted for fit. The wrist support is extended through the forearm to decrease pressure with a large contact area. The patient can adjust the angle of the forearm by simply moving the support wire on to a different hook attached to the upper-arm component, the higher the hook the more acute the angle of the forearm will be. The DYNALock meets objectives to lock the forearm in different angles and to immobilize the shoulder. It is also safe as there are no sharp edges on the device. It also protects the user if they drop the arm while changing its position. The forearm support will not bend quickly, thus limiting the shock the arm may receive without the support. The DYNALock is can be worn over fitted clothing or a short-sleeved or sleeveless shirt, and is not visually overpowering; it is not bulky and is neutrally coloured.

Benefits

The DYNALock is extremely advantageous for the client because it is easily manufactured, and for the user as it is functional and comfortable. Firstly, it does not cause strain on the user's injured shoulder because it is secured below, attached by Velcro to an elastic belt across the torso. Also, the user can set their arm at varying positions using the interval hook-wire system. This allows tasks activities such as typing, writing, eating or holding a beverage. The Velcro on the upper-arm brace adjusts the tightness around the bicep as well, for comfort. Most importantly, the DYNALock can be put on and removed independently with a single arm. This means the user is independent and will not strain the injured shoulder. Finally, it is far more cost-effective than other alternatives in the market; it costs between $60 and $80.

The Tension Elbow Orthosis

Big Mac Eng Corporation.
F 02-T04-02



Problem Description

Mr. F has suffered from 2nd and 3rd degree burns to 20% of his body surface area as well as heterotrophic ossification in his left elbow. Heterotrophic ossification is the medical term for a formation of a new bone between the radius and the ulna bone slightly below the elbow. With our orthosis, the user will be able to regain the muscle strength he has lost as well as improve his elbow movement. We also predict that this orthosis will enable Mr. F to continue doing his daily activities without the assistance of another individual. This splint may be worn indoors and outdoors, under clothing during any season.

Design

The design consists of lightweight materials, which will minimize any discomfort of the patient. The entire orthosis will weigh between 1and 2 pounds permitting it to be worn with little stress on the arm. The use of pinewood provides support while still being desirably lightweight.

Cooling gel is added to the inside of the cuffs so it can be easily slid on and will be comfortable and soothing to the users skin. The design covers approximately two thirds of the arm, ranging from the mid upper arm to three quarters down the forearm. The neoprene allows the user to easily slide the orthosis onto their arm without using a great deal of strength and prevents the device from slipping down the arm. Overall the design provides optimal usability for the patient and meets the key requests presented by the client.

Functionality

The unique design of the bungee cords and hoops provides an effective way of applying a constant pressure to the arm forcing it into either flexion of extension. The tension of the cords can be changed allowing the therapist to increase the tension throughout the patient’s therapy. The orthosis caters to the specific need of application simplicity. In addition, the design allows the patient to slide it on without the requirement of finger dexterity. Functionality of the design is a key factor in client satisfaction and this unique design offers a high level of functionality.

Materials, Components, and Assembly

The design incorporates various popular materials. The main material used in our design is neoprene. The neoprene required to make the sleeve could be salvaged from a wetsuit, which may be purchased at Mountain Equipment Co-op in Hamilton, or purchased at: www.mcdavidusa.com, which sells neoprene arm sleeves. The orthosis also uses ¼” thick wood. This is used, as the hooks need to be attached to a solid material. Another material the design uses is a gold hanging hook. These are used to keep the bungee cord in place. The design uses bungee cords as a way to apply dynamic resistance to the arm, which can be bought from Canadian Tire. The design also uses ½” plastic hoops which are included with the bungee cords. These are used as a larger hook for the bungee cords to attach to when being adjusted. This is attached to the wood using steel strapping; which are held in place by #6, ½” long bolts, both can be purchased from Canadian Tire.

The construction of the orthosis is relatively easy. All that is needed to assemble the orthosis is a saw, a sewing machine, and a drill. As the orthosis is being manufactured out of a neoprene sheet, the manufacturer must have instructions on where to stitch the neoprene together, in order to create an effective sleeve. The individual must also need basic training with wood working, such as how to operate a hand held drill and a basic ability to sew. In total, it should take approximately 2 hours to manufacture the orthosis.

Cost

The orthosis is relatively inexpensive to build. The minimum it will cost the clinic and the user is $44.63, without factoring in expenses from the time spent building the orthosis. The neoprene sleeve costs $21.99. The bungee cord costs $9.99, the steel strapping costs $3.99, the gold hanging hooks costs $1.00, the ½” #6 bolts costs $5.00, and the ¼” thick pine costs $2.66.

User Acceptance and Compliance

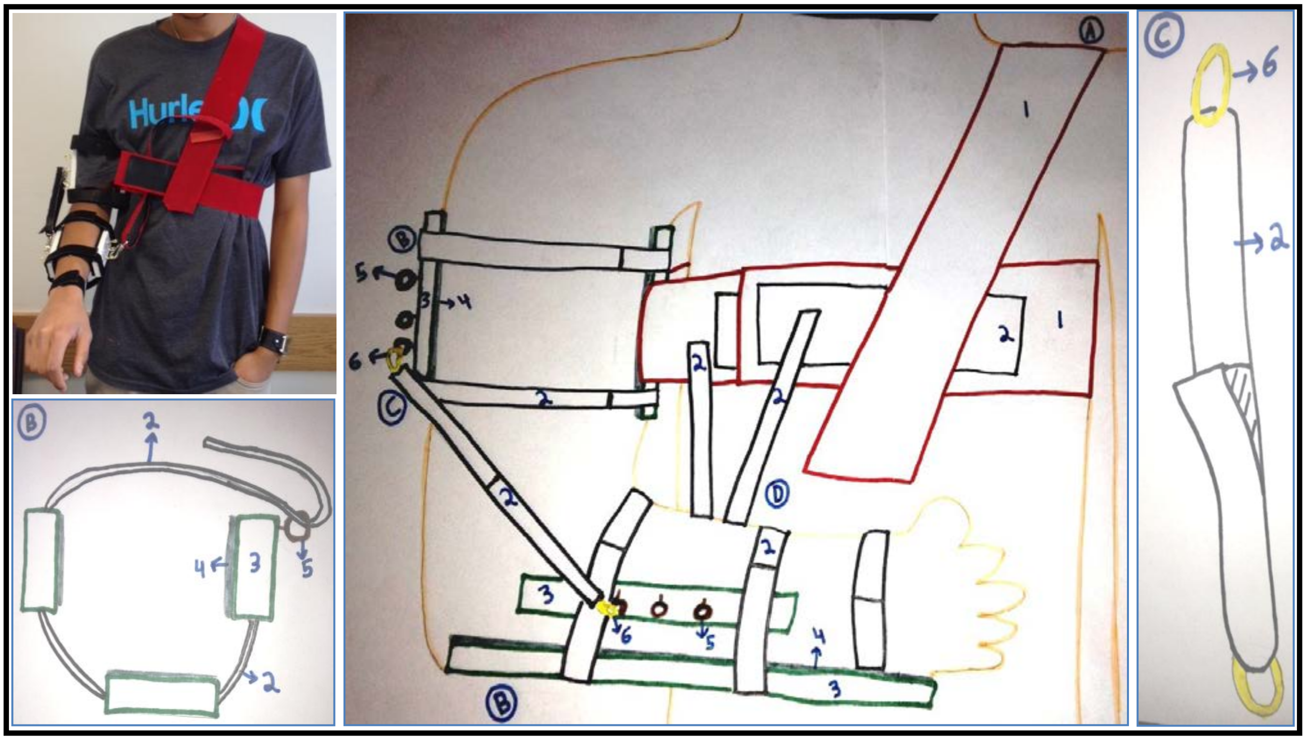
This design allows the user to simply slide the orthosis onto the arm. The elimination of straps makes it easier for all users to put it on, especially those who have other implications such as Mr. F. Furthermore, the design allows the user to slide the orthosis on even if the arm is not fully extended. This is important because at the beginning rehabilitation, the user may not be able to fully extend the arm. For users with second and third degree burns, comfort is very important. The surface area of the orthosis is increased so the contact made with the skin is spread out. A cooling gel is applied to the inside of the sleeve causing the skin to feel less irritated. Users are to wear the orthosis for a few hours a day while switching between extension and flexion. The orthosis is slim and low profile if the hoops may be minimized while maintaining strength.

Benefits

The Tension Orthosis not only satisfies the requirements of its users, but some features even exceed these requirements. Firstly, the device is extremely lightweight. Since Mr. F has severe burns, too much pressure would be uncomfortable and consequently make his injury worse. Secondly, the orthosis is inexpensive; all the materials can be purchased from local hardware and department stores as the design is aimed to be affordable and efficient. The elbow orthosis is designed to endure a substantial amount of stress due to the bungee cords, so the materials were chosen to make it durable. The orthosis can be easily applied and removed without the aid of another individual thus Mr. F would not have to ask for help. One of the largest medical benefits of the tension elbow orthosis is that it can be adjusted manually by Mr. F to apply a greater or weaker force on the arm. There are both inner and outer insulations; thus, substantially decreasing the influence of external collisions on the user. This product does not limit the user’s range of extension or flexion, as it allows the user a flexion of 30 degrees and a full 180-degree extension.

pHresh Orthosis

pHresh Solutions
F02 - T04 - 3



Problem Description

Tara Packham, an occupational therapist at the Hamilton General Hospital's Hand Clinic, has approached pHresh Solutions for the assistance in designing a device for a patient who goes by Mr. B. His injuries are due to a motorcycle accident in which caused the partial dislocation of his right arm shoulder, compound fracture, and de-gloving of his right/dominant arm's wrist. Mr. B also has a brachial plexus injury and damage in the nerves in his shoulder responsible for providing the shoulder and elbow with motor control. The device must improve Mr. B.'s right forearm motion, provide him with the ability to lock his arm into various positions, provide wrist support, and prevent further damage to his shoulder. The device must be built in the hand clinic with the tools, supplies and budget that they currently have.

Design

The design consists of three main components which are the upper and lower arm braces and the nylon strap that extends around the torso and left shoulder(1). Both braces consist of PVC plastic(3) with foam(4) on the surface that are fastened to the arms with velcro straps(2). The locking mechanism consists of a velcro strap attached to a screw eye(5) by a round eye baby snap(6) on the outer and inner arm. The outer arm strap connects from the upper to lower arm brace which restricts movement of the arm to the sagittal plane. It also allows the user to adjust the length of the strap(C) along with the position of the round eye baby snap(6) in order to reach the desired arm position. The inner arm strap attaches from the lower arm brace to the torso strap. Both straps can be adjusted to various screw eyes(5) to allow the arm to lock in various positions. The straps on the upper and lower arm brace(B) are designed for the user to only adjust one piece of velcro.

The device will be very lightweight and will not cause any further damage to Mr. B's shoulder through the use of the torso and shoulder strap which transfers the weight to the left shoulder. The device conforms to the size of Mr. B's arm and does not take up much additional space.

Functionality

The device is able to perform every function the client had requested. The pHresh Orthosis contains the arm, which provides forearm and wrist support, increases range of motion and locks the arm into various angular positions. The torso and shoulder straps also help the user alleviate pain off his right, dislocated, shoulder.

Materials, Components, and Assembly

The components that orthosis requires are: foam tape, Velcro, PVC (Door Stop), screw eyes, round eye baby snaps, nylon fabric, and metal loops. These materials can be purchased at any hardware store like Home Depot. The tools required to construct the pHresh orthosis are: sandpaper, a sewing kit, hot glue gun, a utility knife, hand saw, and a handheld drill. To assemble the product it requires two hours. First the PVC needs to be cut to length, then the foam tape is adhered to the PVC. To ensure that the device is safe, all the edges of the PVC need to be sanded. Afterwards, the Velcro straps are attached to the upper and lower brace by hot glue. Pilot holes are then drilled for the screw eyes to be screwed into. Then the shoulder brace is created by sewing two pieces of nylon (cut to length) together. Also, Velcro is sewed to the shoulder brace. To make the device easy to take off, the Velcro is to be centered on the torso. Then the shoulder brace is glued to the upper brace.

Cost

The orthosis will cost the client $38.42 for the materials. However the cost to the user will be around $100 as it will not only include the cost of materials but also the two hour cost of labour for assembling the product.

User Acceptance and Compliance

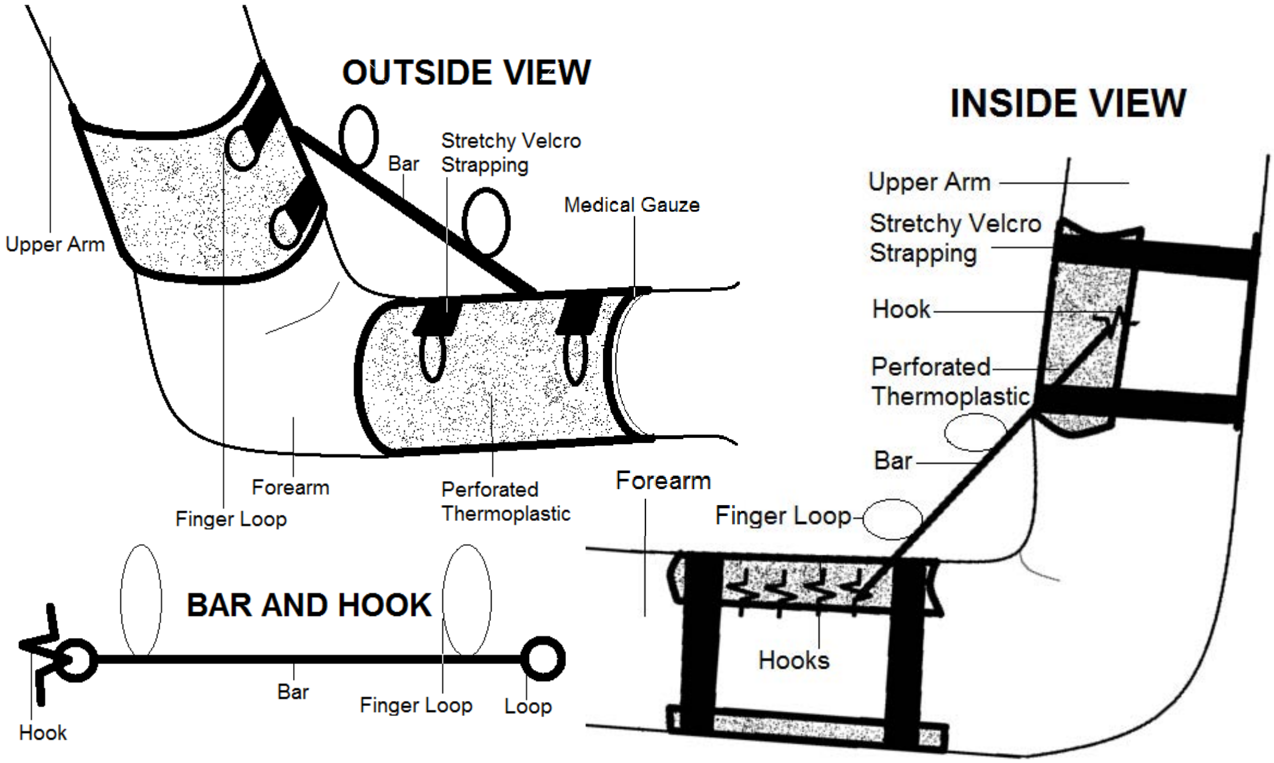
The design is made to cover minimal portion of the arm so it is aesthetically pleasing. The Velcro straps have been positioned in areas that are of reach to the useable arm for the adjustment of the device. The foam on the innermost regions of the device (i.e. the straps and the braces) give the user a comfortable wear. The foam located between the upper arm and the upper torso also aid in this comfort as more padding can be added or removed depending on where the user finds comfort. To use it, the user must simply slide his arm into the brace and fasten the Velcro. Safety has been considered in our design, as the materials are not sharp. The objectives were met in that the device allows for forearm rotation, contains a locking mechanism, takes weight off of the shoulder, and is user friendly regarding adjustability and removability.

Benefits

The design has good portability, for it is easy to assemble and disassemble. Second, the Velcro straps are attached at various positions on the lower and upper arm braces, which enable the user to lock his arm at desired positions. Also, the base support underneath the forearm provides enough forearm rotation to complete basic motor functions and the lower arm brace is extended for wrist support. It is simple to learn how to use this device for the first time because all parts are easily adjustable. In terms of client benefits, the materials used are variable and can be easily substituted. Apart from that, this orthotic device can be easily constructed within a short time as it is straightforward and not complex in design and the materials can be easily found at local hardware stores.

Proposal Outlining an Orthosis for Mr. F.

McMaster Students Engineering Services Ltd.
F02– T04 – 4



Problem Description

Tara Packham, an occupational therapist at Hamilton General Hospital's Hand Clinic, has identified that her client, Mr. F., requires a rehabilitation device. In an accident, he sustained 2nd and 3rd degree burns on a large portion of his body. The resulting hospital stay caused heterotrophic ossification in his left elbow and substantial muscle loss. These injuries caused a loss of dexterity in both hands, and weakened arm muscles. His left arm is especially of concern. Thus, a rehabilitation device should provide Mr. F.'s left arm with support and range of motion (ROM) therapy. The sensitivity of his burns and lack of dexterity must be considered. With the Hand Clinic in mind, the device should be buildable on-site with inexpensive, readily-available materials.

Design

This design features a three-part system: a thermoplastic cuff is slipped onto the upper arm and lower arm, just above and below the elbow. A rigid metal bar with end loops is used to connect the two cuffs. The cuffs are held onto the arm via stretchy Velcro straps which can be tightened appropriately by the user. As seen above, there is one hook on the upper cuff, and four hooks on the lower. The diagram labelled *Bar and Hook*, shows how the bar slides onto the hooks, joining the two cuffs and thus stabilizing the arm. Furthermore, the client can change the angle between the upper- and forearm, by changing which hooks the bar is attached to, enabling ROM therapy. The orthosis is designed to be quite light—dependent on the amount of thermoplastic used—but, it should be light enough not to cause the user discomfort. The device is also fairly compact as both of the cuffs are small and flush against the arm, and are joined by only the bar, which is also quite unimposing.

Functionality

Functionally, the orthosis satisfies the majority of the client's needs regarding support, ROM therapy, comfort, and ease of use. The movement functions of the design include providing ROM therapy in both the directions of flexion and extension. Hence, regular use should increase the client's range of motion in his elbow joint. The device is also rigid enough to provide the client's arm with ample support. Furthermore, the orthosis has been designed to minimize user discomfort heightened by the user's burns, which would be quite sensitive to pressure points, rubbing and sharp edges. The device is easy to put on, remove, and it is simple to adjust the angle between the forearm and upper arm sections. This design thoroughly considers the client's lack of dexterity.

Materials, Components, and Assembly

By referring to the diagram, it can be seen that assembly of this orthosis is a relatively simple process and can be completed with the tools in a regular workshop: needle-nose pliers, a hot glue gun, shears, and a heat source to soften the thermoplastic. Unless explicitly stated, materials and components used can be found at a local hardware store. Firstly, from a 6" X 10" sheet of perforated thermoplastic (source: medical supplier), two sections are cut, heated and moulded to the client's upper and lower arm, on each side of the elbow. Velcro straps are hot-glued to the stretchy cloth (both used in cheap sports padding), which is then glued to the thermoplastic—two per cuff. Then, a wire coat hanger is straightened, cut and bent into five zigzags, and the pieces are hot-glued to the edge of the thermoplastic. Another piece of coat hanger wire is cut, and the ends are curled into loops, forming the bar. Finally, loops of electrical wire are cut and hot-glued to each end of the bar and Velcro straps. If required, sheets of gauze (source: medical supplier) can be double-sided-taped to the inside of the moulds for additional comfort. For additional adhesion, epoxy can be substituted for hot glue. Overall assembly time is estimated to be approximated two hours.

Cost

The cost of the orthosis is predicted to fall between $40 and $50 dollars in total. The majority of the cost is due to the thermoplastic required. With assembly time expected to be around two hours, the cost to the Hand Clinic in regards to time is also fairly minimal.

User Acceptance and Compliance

User compliance and acceptance were prime considerations in the design of this orthosis. For the user to want to use it, the device must be comfortable—especially in relation to the user's burns—and easy-to-use. Hence, the device is moulded tightly to the client's arm to avoid chafing and irritation. To allow burnt skin to breathe, highly perforated thermoplastic is used, and gauze can be employed to prevent irritation. Multiple hooks allow for flexion and extension to be varied in increments by the client. Also, the device is easy to use. To put it on, the orthosis can be laid onto a table, and the client can easily lean into it. Furthermore, the Velcro straps are stretchy and mounted in convenient locations. Removal or adjustment of the device is easy, as finger loops are mounted on the bar and Velcro, which aids with the client's low dexterity. To minimize production costs, cosmetic features were set aside in favour of function. However, due to the minimalistic and unobtrusive nature of the device with its comfort and ease of use, it is expected that user compliance and acceptance would not be an issue. The user would wear the device 2-3 times per day for about an hour.

Benefits

The design of this orthosis is superior to those currently on the market, and other current designs for a number of reasons. This orthosis allows for ROM therapy in *both* the flexion and extension directions. There are few current designs that allow for this feature, while providing the same level of comfort and ease of use. Also, this orthosis is much easier to operate than other contemporary designs. It can easily be leaned into to put it on, while the finger loops allow the user to easily remove and adjust the device. Stretchy Velcro allows the user to secure and unsecure the orthosis, even with little arm strength. Furthermore the design considers the victim's burns, unlike most current designs. Perforated thermoplastic, a tight, non-chafing fit, and the use of gauze help to protect burnt, sensitive skin. The cost of producing the orthosis is estimated to be in the range of $40-$50 per unit—much less expensive than existing devices. Its components can be found at a local hardware store or at a common medical supplier, and can be assembled in the Hand Clinic's shop.

Animus Orthosis

Cross Goat Orthosis
F 0 2 - T 0 6 - 1


CAD model of the animus orthosis


Prototype

Problem Description

Our problem is to design a dynamic elbow orthosis. Our client is Tara Packham from the Hand Clinic at Hamilton General Hospital. We have chosen our user to be Mr.F, and in general anyone who suffers from the same condition, as Mr.F. The design is an elbow orthosis to aid Mr.F's rehabilitation. A main problem that we want to overcome is designing an inexpensive orthosis that aids the user's rehabilitation and does not irritate his/her skin. Also that can be used with minimal use of the other arm. The design's main function is to stretch the elbow muscles. This serves the purpose of helping the user recover from heterotopic ossification.

Design

Cross Goat Orthosis has devised a unique solution to this problem. We have created a simple, yet elegant device that makes use of the strength in the user's leg. The device has three main components: a cuff that goes on the bicep, a cuff that goes on the wrist, and elastic. A unique design implemented to allow Mr. F to be independent is a couple components built into both of the cuffs. Mr. F can attach the loop on each cuff to the hook on the wall and then rotate his body away from the wall to remove the cuff. In addition, the design will be fairly light (probably less than a pound) due to the use of light materials.

Functionality

The orthosis designed can do all four of the basic muscle movements desired; flexion extension, pronation and supination. By changing the location of the hook or string, the user can use the strength in their foot to pull their arm into flexion, extension, pronation or supination. This will allow the user to do a variety of stretches so that they can work their way back to completing their daily activities independently. The device functions completely under human control so that the user can pick the exact degree of stretch they require. This device allows the user to have an orthosis that they can use periodically throughout the day to stretch their muscles and rehabilitate the elbow.

Materials, Components, and Assembly

In order to assemble the device the following materials must be acquired: Hook, Neoprene, Velcro, Rope, Bungee Cord, Fabric Cord, Glue, Plastic Lid. The following tools are needed to assemble the device: Needle, Glue, Glue Gun (optional), and Sewing String. It takes less than 2 hours to construct the device; the construction of the device does require simple instructions but nothing special.

Cost

The proposed design is intended to be affordable and maintain a low overall cost without compromising safety and comfort. Components found in the design are comprised of everyday household items as well as parts that can be purchased in general hardware stores such as Canadian Tire, Rona and Home Depot to name a few. A general range for a single prototype goes from $15-$25 and does not exceed $30. Costs (approximate) for single components in this design include: $2 for a hook, $4 for a bungee cord, $15 for neoprene and $5 for Velcro straps. The cost of a prototype achieves the objective of making the device cheap yet reliable and affordable to the average user.

User Acceptance and Compliance

This design proposal takes heavily into consideration the physical limitations placed on Mr.F by his injuries. While the user will require a bit of assistance with putting on the device (depending from case to case), a lot of the functionality relies on the user's legs and thus they should be capable of operating it with minimal to no assistance.

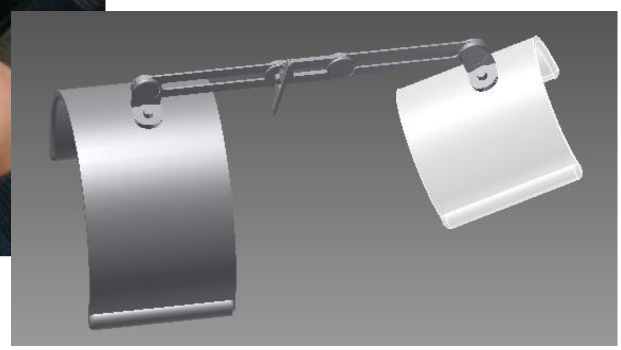
The user places the device on by wrapping the sleeve around their arm and adjusting it using the Velcro straps to achieve the desired fit and tightness (this will probably be done with the aid of someone else, depending on how much hand dexterity the user has). As for taking it off, a hook on a wall in the user's home will allow them to independently remove the device when they are not making use of it (by pulling it off with the hook, using a loop that is on the cuff). Changing the arm position (i.e. from flexion to supination) while the device is in use will require the user to move the appropriate hook to the desired position to achieve the movement they want. Depending on what position they wish to be in and the extent of their injuries, the user should be able to accomplish this without assistance. Overall the design has accomplished the desired objectives that were set at the beginning of the project; it is affordable to the user, it stretches out their elbow muscles and allows the user to place their arms in any of the four required positions (flexion, extension, supination and pronation). The material used in the making of this design is comfortable and takes into consideration the user's needs (it will not irritate Mr.F's skin) and at the same time it does not sacrifice his safety by being rigid and fully supporting the stress put onto his body. Also, the design can be worn over the user's clothing and does not present a problem in terms of being physically appealing. This design is comfortable, affordable, safe and visually likable and the user will be very encouraged by its use.

Benefits

The device stretches the elbow muscles of the user and allows for the 4 desired arm movements and positions. Our design approaches the problem uniquely by avoiding the use of the user's upper body, and focuses instead on utilizing his or her legs. This allows the user to take advantage of their legs' strength. This design is suitable not only for Mr. F, but also for anyone with a condition that restricts the use of ***both*** of his or her arms. The design is built from components that can be easily acquired from general hardware stores and have minimal construction cost. Materials aim to maximize comfort while at the same time maintaining the strengths and sturdiness of the design. Size and fit of the design can be adjusted to suit different users.

PADAC
Dynamic Orthosis

Team Name
F 0 2 - T 0 2 - 2



Problem Description

We are designing a dynamic elbow orthosis device for our client Tara Parkham representing the hand clinic at Hamilton Health Sciences, to be used by our user Mr. F, who is suffering from heterotopic ossification and muscular atrophy. We need to create a device which allows him to strengthen his muscles, via its artificial stretching and contraction. It must allow him to adjust it independently and to do so without the need for fine dexterity, or high strength. Furthermore, we need to design a device that is strong enough to create a level of force sufficiently high for maintaining the end (extension) range. Our device should also apply force for supination and pronation of the wrist to improve range of motion. Our orthosis also needs to account for our users poor skin quality by not causing unnecessary irritation. It must as well be simple enough to allow for independent removal and re-attachment. Our design must account for both indoor and outdoor use, at a minimum of standard room temperatures.

Design

Our design consists of two arm cuffs. One of the cuffs is placed on forearm near the wrist and the other one rests on the bicep, with a ridged rod between them. The ridged rod has a mounting bracket at both cuffs which are the components that attach the cuffs to the rod. At the forearm cuff, there is a Velcro tape section which allows for the ridged rod to be adjusted to the appropriate wrist position. The ridged rod is adjustable in length so that it can hold the arm at the appropriate angular positions. Our design is particularly small in size, and can fold down to an even smaller size (less than 25cm^3). Our design is quite light, consisting of only small metal components and small pieces of thermoplastic. Furthermore, when the device is attached to the arm, it will cover about half of the arm’s total length. Protruding components are minimal and do not extend far from the arm.

Functionality
Our dynamic elbow orthosis allows for suitable elbow support. As primarily requested by the client, the elbow orthosis will effectively stretch the user's range of motion in terms of extension and flexion. In addition, the device also stretches the user's range of motion at the wrist in terms of supination and pronation as requested by the client. As an added bonus, the wrist and elbow joint may be stretched simultaneously with our device. Our device has been designed with strategically placed straps that do not require fine dexterity or a high level of strength to use for removal of the device.

Materials, Components, and Assembly
Our device is very simple design and requires a limited number of components. Our device only requires a 1/3 sheet of thermoplastic, 3 bolts, 3 washers, 2 nuts, a wing nut, two shelving brackets, a portion of Velcro, hot glue, and a length of nylon strapping. All of the materials were obtained or can be purchased from a common department store. During the construction, a frying pan of water was used to heat the thermoplastic and then it was appropriately molded to the arm to make the forearm and bicep cuffs. Bolts were driven through the appropriate locations on the cuffs by heating the sections and pushing the screw through the plastic. The shelving brackets were mounted to the cuffs by using the bolts and nuts. The nuts, washers, Velcro, straps and bolts were put into their appropriate locations.

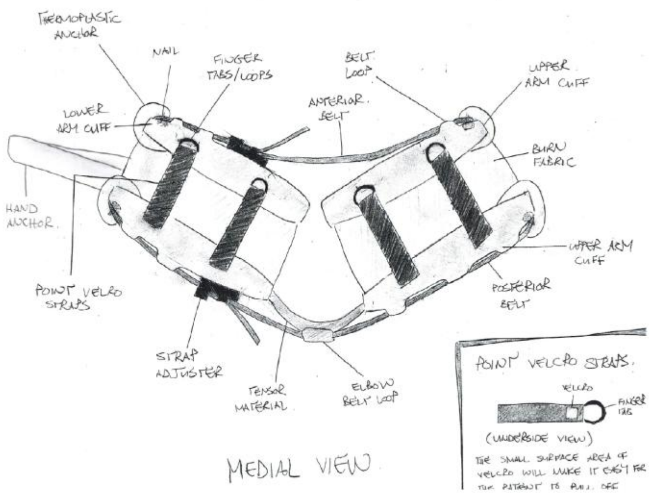
Cost
Our design requires a small amount of actual components, and so it translates to a relatively low cost. In total, the materials for our design cost about $35, the bulk of which is derived from the cost of thermoplastic. We expect the user will pay less than $100 for this product after assembly.

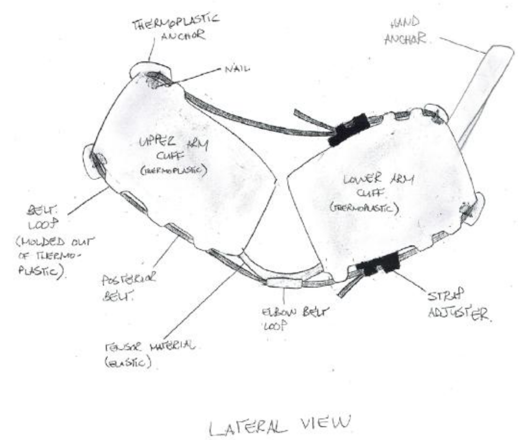
User Acceptance and Compliance
As discussed in the Design section of the proposal, our design is quite light; therefore, we expect a high level of user compliance. The light-weight design allows for comfortable use; there should be minimal strain on the user's body. Large, easily usable straps have been strategically placed for easy removal of the device to compliment the incredible ease of putting it on. The device is moulded to the shape of the users arm and is meant to fit overtop of clothing. Consequently, the user should find it quite comfortable and convenient to use. The moulded cuffs have a lip that has been rounded off and they cover minimal skin surface area in order to try and prevent any accidental damage to the user's sensitive skin. With these aspects in mind, we expect a very high level of user compliance.

Benefits
One of the major benefits of this design is that it allows for improved range of motion in the elbow while simultaneously extending range of motion in the wrist. This design is highly efficient in that is allows for both exercises to be completed at the same time. Our design was geared heavily towards high user compliance; the device is lightweight, simple to use, easy to put on and take off. Finally, due to the simplicity of our design, our device is relatively low cost and should be easily assembled by the Hamilton Hand clinic.

The Flexor/Extensor Elbow Orthosis

Global Engineering
F 0 2 - T 0 6 - 3





Problem Description

The objective is to build a dynamic elbow orthosis that stretches the arm (left) by holding it in multiple positions of maximal flexion and extension. The orthosis must be easy to handle, specifically easy to don (put on) and remove, as well as adjust settings. The orthosis will provide enough force to maintain the widest possible angle during extension. The orthosis must also be gentle to skin sensitivities and relatively inexpensive compared to pre-existing models on the market. All these objectives must be met. The client, Tara Packham, wishes to restore functional range of motion for the user, Mr. F, who had ossification in his left arm.

Design

As can be seen from the diagram, the flexor/extensor belt orthosis is composed of two cuffs of thermoplastic, for the upper and lower arms, and anterior and posterior belts. The belts may be tightened and loosened to induce flexion or extension. The cuff on the forearm will have a thumb loop that will hold the cuff in the desired position and prevent it from slipping, which will minimize skin irritation. Velcro straps with easy-pull finger tabs/loops secure the orthosis to the arm. The interior of the orthosis is lined with burn fabric to prevent damage to sensitive skin. An elbow protector covers the posterior skin of the elbow to prevent skin irritation and guide the posterior belt.

The device will weigh less than 2 kg and cover half the length of the upper arm and the whole length of the lower arm. The precise size and shape will depend on the individual, as the thermoplastic can be moulded to custom fit the user.

Functionality

The device is designed to meet many of the user's requirements such as having the ability to move the arm with little effort. This design was purposely made to assist the user's arm to extend and reflect to its maximum potential, so the arm can be fully functional. Based on the user's conditions, the device can be easily adjusted with minimal force by using the strap adjusters.

Materials, Components, and Assembly

Materials used include thermoplastics, nylon belts, sticky Velcro straps, burn fabric, hair elastics, thumbtacks and a sewing kit. The Thermoplastics and burn fabric can be special ordered by the Hand Clinic, while the remainder of the materials can be bought at a local hardware store and drugstore. No special tools are required to build the device; tools used are common household items (scissors, knife, etc.) The orthosis can be constructed within an hour once a standard procedure has been developed. No special instructions are required; the device can be built simply from examining the above illustration, though specific instructions are provided in the final report. The only part of the assembly that posed some difficulty is the carving of the belt loops out of the thermoplastic splint. However, this is easily done by cutting two slits (one inch in diameter) in the thermoplastic cuff and popping the plastic up in order to form a sturdy arch.

Cost

All tools and materials used can easily be found in the home or local hardware store. Alternatively, we were able to find some cheaper alternatives online. Using the least inexpensive combinations of items, our device will cost roughly $40-50 to manufacture. Considering advertised prices of elbow orthoses on the market, our model is significantly cheaper than most. Depending on whether the hand clinic wishes to make a profit on sales of the design, they could charge the patients $50 or more per orthosis sold.

User Acceptance and Compliance

A very important consideration that went into the development of our orthosis was user compliance. The comfort of the user and ease-of-use were paramount factors in the design of the device. We have incorporated a number of features that make the device easy to wear and adjust, such as finger loops for the Velcro straps and easy-to-pull belts with loops. In addition, we have lined our model with burn fabric to enhance the comfort of users with potential skin sensitivities.

Aesthetics was another consideration that went into the development of our design. We attempted to reduce excess bulk as much as possible by using light materials that did not protrude any more than necessary from the arm. We also decided to implement a blue colour scheme to enhance cosmetic appeal.

Though safety was not a major requirement by the client, our device is safe for users. Specifically, it does not contain any sharp protruding edges and the interior is lined with burn fabric to protect the skin.

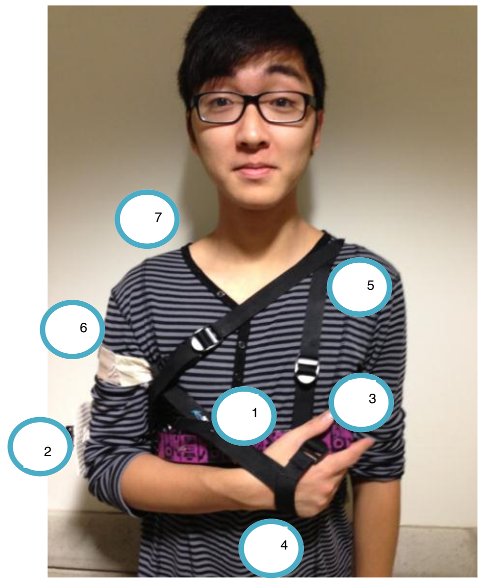
Benefits

Comfort and lightweight are some of the factors that set this design from existing ones. The burn fabric that is attached to the inside of the device is specifically designed for burnt skin. Therefore, it provides added comfort for the user. In addition, this design is made with minimal materials, making it lightweight and simple. Also, the simplicity makes it easy to produce which creates a reasonable price for more people to buy it. This design allows the patient to put on, take off the device with ease. The use of straps and strap adjusters allows for easy adjustments while changing the angle of the device, therefore it can be done with one hand. Also, the use of Velcro straps provides extra stability for the device to be securely strapped onto the arm and it can also be easily removed with the minimal Velcro used on the device.

Cross Shoulder Orthosis

Novel Joint Therapy
F02 - T07 - 1

1. This strap holds the arm at a right angle, making it easier to perform everyday functions.
2. The thermoplastic is used to protect the elbow as well as to hold the forearm at a right angle to the torso.
3. The belt is the centerpiece of the device, holding it together and allowing the user to tuck his arm away via a buckle on the back side.
4. The hand strap allows the user to hold his hand at different angles, and grants him the ability to use his existing wrist muscles.
5. “Seatbelt” strap keeps the device secure and supports the arm, taking the weight off the shoulder without applying too much pressure in one area.
6. This strap pulls the upper arm inwards and is wide to distribute the pressure and promote circulation
7. The buckles, adjustors and belt size make the device adjustable for a wide range of users.



Problem Description

The client, Tara Packham from HHS, has presented the group with the problem; a user named “Mr. B” has suffered multiple injuries to his arm and shoulder, rendering him unable to perform essential daily tasks. Mr. B. suffers from nerve lacerations, most notably his brachial plexus injury which regards severe damage to the nerves in his right shoulder, arm and hand. Due to these issues, along with tendon lacerations and healed (but sensitive) compound fractures, Mr. B has little to no movement in his right arm and his right shoulder risks complete or partial dislocation at all times. The engineering team, Novel Joint Therapy, must come up with a solution to design a device that must aid the user to perform common daily tasks in comfort, such as typing, writing, and carrying light objects. As these functions are performed, the device must also promote recovery and rehabilitation. Although the client has implied solutions, the situation is completely open-ended.

Design

The design is a fully functional device that conforms to the user’s needs and solves the problem statement. The overall design was chosen due to the amount of objectives it fulfilled successfully. The purpose of the orthosis built is to provide support and improve the user’s range of motion by using lightweight and flexible components. These features implicated in a complex support system aided in providing the support necessary to protect the subluxed shoulder. If the design is observed from a qualitative standing point, the shoulder strap positions are similar to that of a car “seatbelt”. This was a completely intentional choice, since a seat belt has functions similar to that of the shoulder straps in a design: support and distribution of pressure. Another aspect of the design inspired from actual systems is the 90 degree vertical rotation system. The arm clips in via straps to a ninety degree angle with the user's torso for optimal use during Mr. B.'s daily tasks. The arm can also be secured and tucked away while the user is inactive. This position keeps it out of the way and keeps it from being injured when the inanimate arm is not in use. This aspect of the design resembles the wings of a bird, which fold in to protect their fragile structure, and provide a comfortable position. Using existing mechanisms for inspiration improved our device, and has made it extremely reliable.

Functionality

The main function of this device is to allow the user to perform everyday tasks. The device supports his arm at a right angle without putting pressure on his injured shoulder. His arm can be secured so it's flat against his torso or pointing straight out. His wrist can be rotated to any desired position and will stay there. These degrees of freedom allow him to do most daily tasks. In addition to being functional, this device is also comfortable.

Materials, Components, and Assembly

The materials needed for this device are a belt, straps, velcro, wire, buckles, adjustors and thermoplastic. Most of these are already available in the hand clinic. Any that are not can be found in any department store. The tools required to construct it are scissors, hot water and a pan for the thermoplastic and sewing materials. The device should take no more than 30 minutes to assemble from start to finish. Simple instructions will be needed for where to sew on the straps and how to assemble the device once all straps are sewn.

Cost

The cost of the device is around $20; less if some of the parts are bought in bulk.

User Acceptance and Compliance

The Cross Shoulder Orthosis is designed so that it is functional, comfortable and aesthetic. Every component is completely customizable to the user's needs and style; both straps can be replaced and changed. This feature of the device will allow patients a degree of creative freedom, for example: A little girl can bring her favourite belt and can also choose her favourite coloured straps to be part of the orthosis. The user will find that the lightweight and innovative design provides a small adaptation period to daily usage. The device gives the patient the option of positioning the forearm out or against their body, depending on the level of activity. All straps distribute pressure, and the "car seatbelt" shoulder straps provide a tremendous amount of support for the injured shoulder. The client will also like this device because of its low fabrication cost (~$20). Overall, the device has exceeded all of the important objectives and the device will please the client, patient and future users of the device.

Benefits

One of the benefits of using our dynamic orthosis device is it fulfills all the objectives from the client. The device is extremely convenient to wear even with only one hand. It does not apply any weight to the shoulder and pulls the shoulder toward the body; thus restraining the patient's upper arm from any undesired movement. Thanks to the belt and strap system, the weight of the device and the patient's arm are distributed onto the uninjured shoulder, back and waist. Furthermore, the device has a thermoplastic board to protect patient's elbow, hence, while patient does some subconscious movement such as siting down against some hard surface, his elbow is prevented from injury. Our device also allows range of motion for the patient. For example, the strap that suspends the forearms does not hold tightly; therefore, his arm is not forced to conform to a certain angle during typing or some other daily task. In addition, patient is allowed to rotate his arm along a vertical axis within an angle of 90 degrees; thus, his forearm remains at a comfortable angle to the body and can be tucked away when not using it. Last but not least, the wrist strap holds the hand in various angles and grants him range of motion in his wrist joint.

BiROM Elbow Orthosis

Fantastic Firm
F02 - T07 - 2

Problem Description

Mr. F., a patient of Tara Packam at the Hamilton Health Science Hand Clinic, had a fire accident in which he sustained heavy second and third degree burns to his arms and body. Multiple skin grafts to his arms have led to extremely sensitive skin. His body chemistry changed during his hospitalization which has resulted in limited finger dexterity and strength and heterotrophic ossification build up in his elbow. Due to long immobilization his muscle density has decreased. Special consideration of his sensitive skin was taken when materials were chosen. This device is to increase his range of motion and personal independence.

Design

A simple design is behind the BiROM elbow orthosis. The basic concept of this design makes use of feet, chest harness and straps to provide flexion and extension to an injured arm. As seen in the picture (left) the right foot, when extended provides extension. A strap on the upper leg allows the arm to be locked in extension to a specific range of motion via a Velcro locking mechanism. The left leg provides flexion in the same manner. Flexion range of motion can be locked in place using our Velcro locking mechanism on the chest harness. The chest harness spreads the force of the operation around while fixing the injured arm in place making use of the elbow as the hinge. The cuff, (picture left), was designed with consideration to sensitive skin. Silk lining and cotton padding provide sufficient air flow and comfort for safe and comfortable use with sensitive skin. Additional levels can be attached to all Velcro fastenings to aid unfastening the Velcro. Although the device is quite large with respect to the arm, covering the upper body and extending to the feet, the device weighs no more than an article of clothing that would be worn in daily routine. The BiROM elbow orthosis is a simple, light weight, comfortable design that keeps the end user in mind.

Functionality

This device effectively increases limited arm movements to superior range of motion. Fixed stretch distances are obtained through our Velcro support locking mechanism. Force from the legs and feet provide optimum end range of motion.

Materials, Components, and Assembly

Materials for this device include thermoplastic, padding, Velcro and straps. The arm cuff is manufactured with custom molded thermoplastic or padded arm cuff. The main device supports are made with straps. Basic tools necessary to manufacture the device include sewing machine, knives, scissors and a hot water bath to mold thermoplastic. The device can be made in one to two hours. Assembly requires instructions.

Cost

The BiROM elbow orthosis is a device that fits anyone's budget with an overall cost of just $72.35. The materials will cost the clinic no more than $49.00. Labour costs for the device are low, no more than $24.00. End user costs for the device would be approximately the same as the clinics.

User Acceptance and Compliance

The device is created with a go-everywhere design. Its light, compatible and portability enables the user to bring the device anywhere s/he goes. Sufficient padding at key pressure points increases overall comfort. Levers on all Velcro straps increases the ease of undoing the fasteners. The simplicity of the design increases user compliance and ease of use. Skin sensitive material reduces stress on grafted skin increasing user acceptance.

Benefits

The key benefits to this device is due to its light weight, portability and low cost. Its compactable design enables easy storage and simple portability. Decreased splint load reduces overall stress on the body. The design innovatively uses the legs and feet to increase the arms range of motion while also providing necessary exercise the legs and feet.

The Ratchet Orthosis

Fabricaid
F 02 - T 07 - 3

Problem Description

Our client, Tara Packham, from the Hand Clinic at Hamilton General Hospital, has asked for the design of a dynamic elbow orthosis for the user, Mr. B. Mr. B has sustained some serious injuries to his arm so that it is difficult for him to accomplish daily tasks. He therefore needs a device that will be able to assist him in the completion of activities of daily life. The device created by our design team, Fabricaid, successfully allows for range of motion in the elbow, support of the shoulder and supination and pronation of the wrist. All of these functions are critical to allowing Mr. B to continue his daily activities and to help him recover from his injuries.

Design

The Ratchet Orthosis has been designed to be as simple as possible, keeping that in mind we have also made it as functional as possible. A very important part of our design is that the orthosis itself weighs only as much as the ratchet used in it, as the weight of the rest of the materials is negligible. Due to this feature the orthosis can weigh under 500g. The orthosis will have a length that goes from the base of the wrist, around the elbow and go halfway up the tricep and will add only an extra 2cm of thickness at it’s largest point.

Functionality

Our prototype fulfills many of the functions requested by the client. The Ratchet Orthosis allows for range of elbow in the elbow, supination and pronation in the wrist and provides support to the shoulder.

Materials, Components, and Assembly

The main components of the orthosis include a 6” by 2” piece of wood that is ¼” thick, a ½” screw, a ratchet, a quick release skewer, a Robertson head for the wrench, Velcro, metal wire, a flexible material for the cuffs (we used a flexible kitchen plate mat instead of thermoplastic), straps, paper clips, soft cloth. These components were all acquired from three different locations: a bicycle co-op (McMaster), a dollar store and Home depot. Assembly takes no more than an hour and a half, and requires a vice, bonding glue (gorilla glue), pliers, sewing kit and a saw. The assembly is simple and can be done in three steps: make the cuffs, join the skewer and the wrench and finally, join the cuff and the wrench system.

In order to make the cuff, the placemat was cut to fit over the bicep. Glue was used to bond a soft cloth onto the inside of the cuff and to bond Velcro straps onto the outside of the cuff.

The skewer was then jammed into the head of the Robertson head of the ratchet, effectively merging them securely together. This was done through the use of a vice grip available at the bicycle co-op. However, a hammer would also work for this step.

With the cuff and the ratchet-skewer system constructed, the next step is combining them together to create the completed orthosis. To do this, two small pieces of wood were bonded to the upper cuff as a guide for the ratchet. The ratchet was held against the pieces of wood by a thin wire loop, imbedded in each piece of wood.

Cost

The orthosis will cost just under $100 if all of the components are bought new. However, many of the parts can easily be found around the house, or acquired from free services. Therefore, this design costs just about $20 for parts that needed to be purchased.

User Acceptance and Compliance

The Ratchet Orthosis is incredibly user friendly. By using Velcro straps, the user can take the cuff on and off with ease, even given their physical limitations. Once the user has the Ratchet Orthosis secured to their arm, the angle in the elbow can easily be set by use of the ratchet. The ratchet only allows for motion in one direction, so that it can be set to a desired angle and then locked so this angle cannot change. In this manner, the user will be able to accomplish many of the things that he has not been able to do, as a result of his injuries.

The Ratchet Orthosis is also very comfortable for the user. The shoulder strap relieves much of the weight of the orthosis by spreading it out across areas of the body that have not been injured. The orthosis also contains soft cloth on the inside of the cuff to create a comforting layer with which the arm will come into contact.

In terms of cosmetic considerations, the Ratchet Orthosis can easily be worn under baggy clothing, as the orthosis does not have much thickness to it. However, if the orthosis is to be worn over the user’s clothing, it will still remain aesthetically appealing, as the majority of the components are on the inside of the arm. In this manner, they are mostly hidden from sight.

Benefits

The Ratchet Orthosis has many benefits. The main benefit of this design is that the majority of the materials can be found in any household setting and are also very simple materials. Therefore, the device can be assembled very easily.

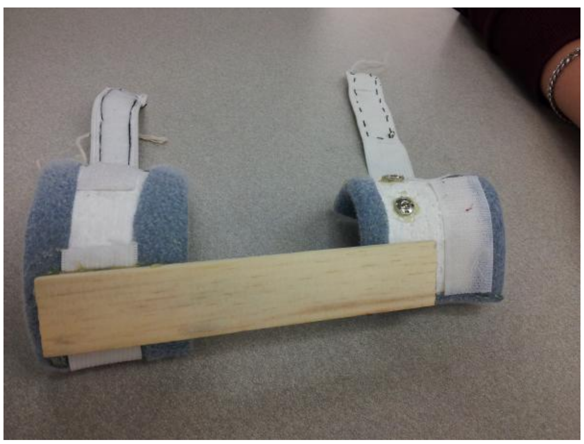
For the user, this device is beneficial because the ratchet allows the user to set any angle in the bend of the elbow. Therefore, the user will be able to have more control over the extent of his movements. In addition, this device is very lightweight, so it will be very easy for the user to handle. These benefits clearly make the Ratchet Orthosis more beneficial than other designs.

U-SPLINT

MADE WITH YOU IN MIND

AdAPT ENGINEERING LTD.

AdAPT Engineering Inc.
F02 – T07 - 4



Problem Description

Tara Packham from the Hamilton Hand-Clinic presented a patient's situation. The patient is a twenty-three year old male, who sustained extensive injuries to his right arm in a motorcycle accident. He suffered from a brachial plexus injury, a compound fracture in the wrist and a subluxed shoulder. The patient wishes to be able to participate in day to day activities that required the use of his hand. However, he lacks control in his right arm due to the nerve damage sustained in the brachial plexus injury. The patent would like to immobilize and mobilize the upper arm at will. Over time, he would like to increase his range of motion and rotation in the arm. Therefore, the device must be able to allow him to conduct everyday activities independently. Additionally, the device should minimize load on his subluxed shoulder and be easily manufactured by the Hand Clinic. Ideally, the device should allow for easy installation, removal and adjustment.

Design

Through the objectives and constraints from the problem statement, the U-Splint was born. The U-Splint is a light weight dynamic elbow splint, weighting less than 250 grams. The U-Splint was made with you in mind; the compact nature of the device ensures that the U-splint is portable enough for all traveling needs. As shown in the pictures above, most of the adjustments can be found on the inside of the arm making them easily assessable to the user.

Functionality

The U-Splint can achieve 4 main functions, supporting the shoulder, immobilizing the shoulder, locking in supination/pronation and locking in different flexion / extension positions in the arm. The U-Splint does it all; it is able to lock in certain flexion, extension, supination and pronation positions customized to the user's needs. The shoulder is then immobilized and supported by the upper arm and triangular foam components of the device. The user is able to comfortably take part in everyday activities most important to them.

Materials, Components, and Assembly

Our Prototype	Hand-Clinic Alternative	Availability
Old shirt	Slings/Straps	Available at Hand Clinic
Elastic Straps		
Paint Stick	Thermoplastic	Available at Hand Clinic
Plaster		
Felt	Velfoam	Available Online
Velcro		
Sewing Kit		Available at Hand Clinic
Snap Buttons		Available at Fabric Stores
Hot Glue Gun		Available at Hand Clinic
String		Available at Hand Clinic
Foam	Memory Foam	Available Online
Hooks		Available at Hand Clinic

The chart above outlines the materials used in the prototype and recommended alternatives for the Hand Clinic. In brief, the assembly of the U-Splint is comprised of molding the thermoplastic to the clients arm on the inside of the bicep, on the forearm above the wrist and below the elbow. The snaps, foam, hooks and straps are positioned into custom places depending on the user's requirements and comfort.

Some special considerations to keep in mind while manufacturing the U-Splint: the use of a sewing machine will decrease manufacturing time substantially. Other recommended tools include a drill and hot glue gun. Every snap and hook is specific to the user and must be placed in the correct spot, this placement is determined during the manufacturing period after the device has been moulded to the patient's arm.

Assembly may take up two hours with two people working on the device.

Cost

Material	Cost	Hand-Clinic Material	Cost
Old Shirt	0	Slings/Straps	\$3 – 10
Elastic Strap	\$1		
Paint Stick	0	Thermoplastic	\$50 / Sheet
Plaster	\$5		
Felt	\$2	Velfoam	\$20
Velcro	\$5		
Sewing Kit	0	Sewing Kit	\$5
Snap Buttons	0	Snap Buttons	\$1
Hot Glue Gun	0	Hot Glue Gun	\$10
String	\$3	String	\$3
Foam	0	Memory Foam	\$15
Hooks	0	Hooks	\$1

In total, the U-Splint will cost the user \$115. This cost is a high-end estimate; as the cost is variable depending on the resources used. A decrease in the cost can be found in the thermoplastic, and other materials like string, snap buttons, velfoam and hooks which come in quantities that are in excess of what is needed to manufacture one U-Splint. The cost of labour for manufacturing the device is dependent on the Hand Clinic and their charge for two hours of labour by two people.

User Acceptance and Compliance

The U-Splint can easily be taken on and off by the user without difficulty. The colour coded straps leave no ambiguity when it comes to installation. Comfort for the user has been taken into consideration as a layer of foam covers the inside of the brace pieces, acting as a comforter. The Velcro straps are easily adjustable to make the user feel comfortable at all times.

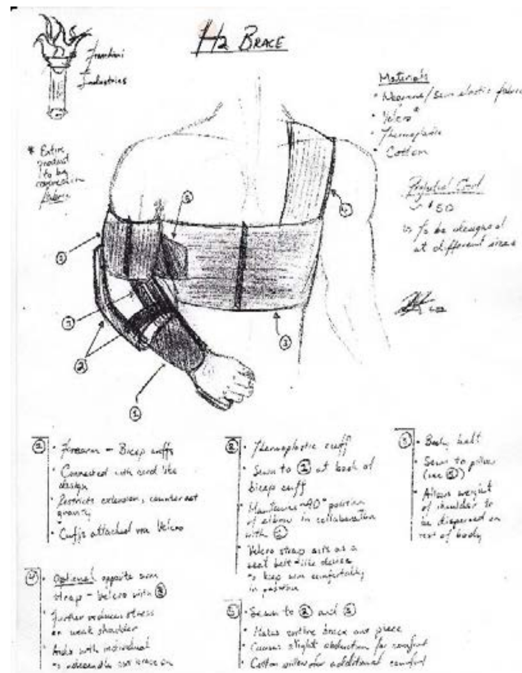
Benefits

The benefits to the U-Splint over other market place devices include:

- Lightweight – less than 250 grams.
- Allows for flexion / extension / supination / pronation positions in the arm.
- Supports and immobilizes the shoulder / upper arm.
- Comparatively inexpensive to produce, this keeps the cost to the user at a minimum.

H_2 Orthosis

Team Name: Fracchioni Industries
F02 – T08 - 2



Problem Description

The user's shoulder needs to be supported, as he cannot do this himself. The device has to help the user with his recovery, and allow him to retain some basic functions. Finally, the device must be simple to construct, and be allowed into incarceration.

Design

The design is minimalist and lightweight. It has two cuffs, attached to each other by a belt, supporting the arm and shoulder. The upper cuff is attached to a belt, and is cushioned by a soft material. The belt and cuffs have small hooks, allowing for the arm to be put into a rest position. Finally, a thermal plastic cup supports the elbow.

Functionality

The device supports the lower arm via a belt attached between the two cuffs. The belt attachment also helps support the shoulder. The device puts the arm in a position that allows for daily functions, such as typing, to be performed. The device can be taken into incarceration, is easy to construct, and is inexpensive. Finally, the device can be put on by oneself.

Materials, Components, and Assembly

The device requires ~1m of fabric, ~20cm of cushioning agent, 4 sets of Velcro, 4 small hooks,(all of which can be obtained at a fabric of craft store, such as Michaels of Fabricland),

and an ~6x6 inch sheet of thermal plastic, which can be ordered. The only tools required are a sewing kit, scissors, and hot water. The device takes ~90 minutes to construct.

Cost

The device is intended to be very cost effective. The fabric costs 15-20$, the Velcro ~17$, the thread and hooks 1-2$, and the thermal plastic ~6$. About 90 minutes are needed to construct the device. The total cost works out to 39-45$. The cost to the user would depend on his method of obtaining it. (IE- a retailer would have to make a profit, whereas the Hand Clinic may only have to cover costs)

User Acceptance and Compliance

The user was considered first and foremost in the design. The device can be put on and taken off by oneself. The materials and design are comfortable, and do not put undue stress on the shoulder. The device is intended to allow for the performance of daily functions, such as typing or writing. Also, the device allows for a rest position, using the hooks on the belt and cuffs, while also letting the user exercise his joints, using the belt between the two cuffs. The device is also intended to be appealing, and is therefore made from fashionable black fabric. Also, the upper portion can be covered by clothing. Finally, the user's request to have the device be allowed in incarceration has been met.

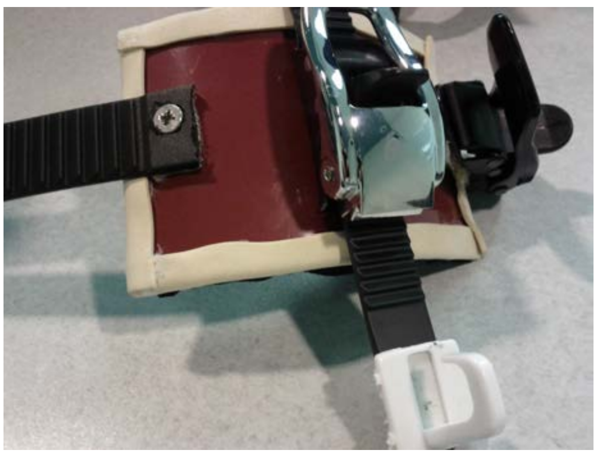
Benefits

The design is much more comfortable and lightweight than current available options. The cost is also quite low, making it more financially available to the user. The device allows for stress relief on the shoulder, lets the user exercise his joints, as well as work on supination and pronation. The device also takes into consideration the user's request for it to be allowed in incarceration, thus meeting a vast number of the user's specifications.

Elastictron 5000

Dynamic Orthosis of the Future

HUMATECK
Team Name
F02 - T08 - 3



Problem Description

Our client, Tara Packham (occupational therapist at the Hamilton General Hospital) has commissioned our company, HumaTeck to design a dynamic elbow orthosis for Mr. F (Mr.Fire). He currently suffers from heterotrophic ossification in his elbow joint, a calcium buildup that prevents the elbow from functioning normally (symptoms include tight joints, limited arm movement), as well as severely burnt skin (20% of his body was burnt). The orthosis must be able to provide a force to the arm in order to stretch and increase the range of motion of the elbow.

Design

In order to strengthen user compliance, a lightweight design was incorporated (~1 lb) as well as an increased surface area will prevent pressure on the entire arm, allowing the skin to properly heal.

Functionality

Keeping in mind that the user has extremely sensitive skin, we have chosen to use a breathable material with soft padding that is tailored to patients with severe skin aliments. To provide an easily adjustable mechanism, we have used a ski boot strap that would allow a patient with limited hand dexterity to effortlessly put on the orthosis. Using a combination of hooks and elastics (of various tensions), we're able to provide a constant dynamic force to provide flexion and extension in the arm.

Materials, Components, and Assembly

Keeping in mind that the orthosis had to be constructed at the hospital, we have decided to incorporate materials that were readily available to members of the hospital staff. Furthermore, our design can be easily constructed by an occupational therapist in absence of comprehensive tools and machinery.

Materials incorporated in our design were readily acquired by our team. Malleable plastic was the material chosen to act as the frame and primary support of our design. This plastic was acquired from common household items and can be substituted for a variety of similar materials. Materials for the inner lining consisted of foam lining and a light, breathable material. A combination of hooks and elastics was used to provide the function of the orthosis. Since the design was created with ease of construction in mind, only glue and a pair of scissors are necessary for production. Our design can be easily created under an hour. No special assembly required.

Cost

The approximate cost of materials is $12. An hour of building time was used.

User Acceptance and Compliance

The large buckle of the ski boot strap allowed a patient with rigid and stiff hands to easily make adjustments to the orthosis as well as putting the orthosis on and off. Soft padding and flat edges make the device safe for the user as well as the general public. A variety of colours can be incorporated into the design. A large surface area allows minimal pressure applied to skin which can promote healing of the damaged skin. The device underwent testing with metrics to assess how well the design meets intended objectives.

Benefits

Not only did our design promote affordability, it is also very easy to construct. Our product is extremely easy to get on and off, which encourages user compliance. By using a simple system of hooks and elastics, we can allow adjustable amounts of force which permits a wide degree of movement. The forearm buckle can be adjusted to provide both flexion and extension through various elastic tensions. The release mechanism is designed as a one-touch system, the orthosis will release the elastic tension with the push of the buckle lever. The benefits of HumaTeck's device make the design unique and an excellent alternative to current market options.

Mr. B

GASSK 3000

G.A.S.S.K.
F 03 - T 01 - 1

Problem Description

Our team will design and build an elbow orthosis that is lightweight, inexpensive, adjustable and allows basic forearm movement.

Design

The design consists of a side-body strap that holds the arm against the body. There is a shoulder strap that holds up the arm. This strap is adjustable. It will be about 3 lbs. It is able to fold up and is made out of fully flexible materials. This allows for compact storage.

Functionality

It immobilizes the shoulder joint. Supports the forearm and allows the user to perform basic arm movement. Angle of the elbow is adjustable to suit the users' need.

Materials, Components, and Assembly

The design requires a paintball pod pack, which has a sleeve for the arm and can be tightened around the users body. An adjustable strap which was acquired from a backpack. A glove was used to support the users wrist, which attaches to the shoulder strap. These can all be acquired from Wal-Mart or any big box store. Sewing supplies will be needed to put all the parts together. The design is simple and easy to put together.

Cost

It will cost the Clinic approximately $50.

User Acceptance and Compliance

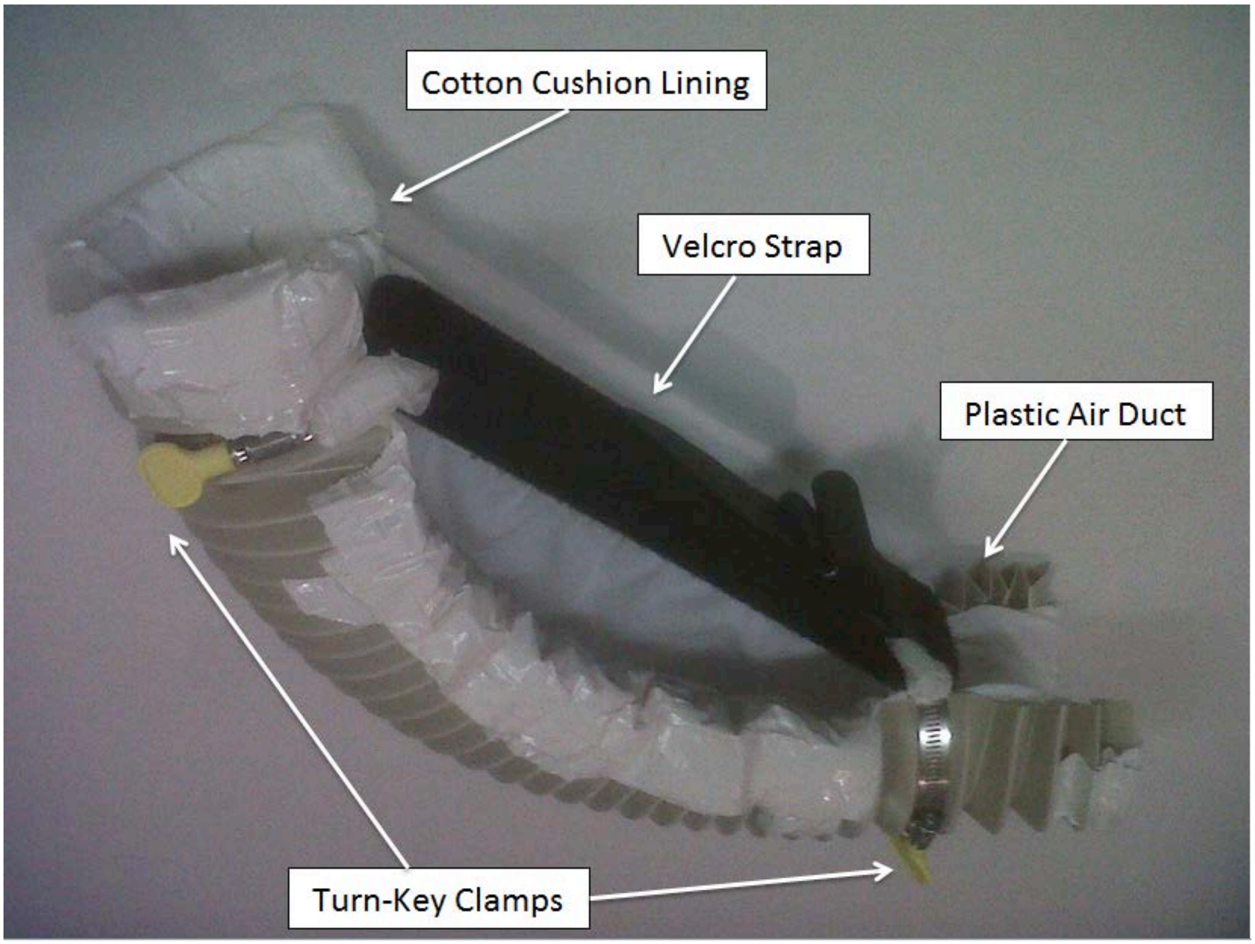
The orthosis is comfortable and effective for its intended purpose. This will encourage the user to wear the devices as prescribed. The user is unable to put the device on alone. This is the draw back of our design. The design is comfortable because the material used is soft and the design has no rigid materials. From a medical perspective the device will be above clothing however the device is simple. The device is made of stylish straps and fabrics, which will minimize the cosmetic impact.

Benefits

Our design is cost effective and very simple to construct. It is made of commonly obtainable items.

V.A.D.O.
Velcro Air Duct Orthosis

Mac-Engers
F03–T01-2



Problem Description
The problem presented to the team involves Mr. B, a 23 year old male that was involved in a motorcycle accident. His shoulder was partially dislocated, and, because of this, Mr. B's shoulder can support very little weight. In addition to his shoulder injury, Mr. B's elbow was severely damaged, and, therefore, he has limited movement in his elbow. Simple everyday tasks have become very difficult or, in some cases, impossible for Mr. B. to perform. Tara Packman of the Hamilton General Hospital Hand Clinic has asked the team to design a device which will satisfy the following criteria. It must provide support for the arm and elbow. The device must allow Mr. B. to work on range of motion exercises and perform a number of activities. The weight added to the shoulder from the device must be minimal. The device must also be inexpensive. Mr. B must be able to use this orthosis outside his home, such as in the hand clinic, in public areas and possibly in prison should Mr. B. be incarcerated.

Design
The proposed design will be made from an adjustable plastic air duct. The duct will be cut in

half to form a half-pipe. This material is bendable to almost any angle and will allow full range of motion in Mr. B.'s arm. At each end of the air duct will be a turn-key clamp. These clamps have large yellow nobs on their sides which are very easy to turn one handed and will allow Mr. B. to put on the orthosis by himself. These clamps will allow for easy adjustability and will also provide a place to attach a Velcro strap. The Velcro strap runs between the two connectors. When the Velcro strap is shortened, it pulls the two clamps towards each other. In this way, the orthosis can be adjusted to many different angles. The range of the orthosis is almost 180 degrees. The inside of the orthosis will be lined with a soft material that will cushion Mr. B.'s arm to prevent his arm from rubbing on the plastic air duct. The orthosis will be the same size as the arm running from the wrist to just below the shoulder.

Functionality

The orthosis will provide support for Mr. B.'s elbow. The air duct will hold the arm and the Velcro will pull it up to a comfortable position and support it at this position. The plastic air duct will also protect Mr. B.'s elbow from hitting anything and injuring his elbow further. The orthosis will be very flexible, so it will be very easy to work on range of motion exercises while wearing the orthosis. Using the Velcro, the orthosis can be set to specific positions to be used static range of motion exercises. Since the orthosis is flexible and can be set to specific positions, Mr. B. will be able to perform a number of activities with the device. The orthosis is also lightweight, so it will not add a significant amount of weight to the shoulder. The V.A.D.O. weighs only 0.8 pounds.

Materials, Components, and Assembly

There are only a few materials needed to assemble the V.A.D.O., namely, an adjustable plastic air duct, two turn-key clamps, an adjustable Velcro strap and padding. All of these materials can be found at a hardware store such as Home Depot. The assembly will take about one hour. The only tools that needed are a knife and a pair of scissors. The first and longest step to assemble the device is cutting the air duct into a half-pipe being sure to cut the air duct the proper length needed for the patient's arm. This can be done using the knife and the scissors. The next step is putting the turn-key clamps around the air duct and looping the Velcro around each of the clamps. Following this, the padding can be put on the inside of the air vent and around any sharp edges that have been cut.

Cost

The cost of the materials needed to assemble the V.A.D.O. is Thirty Dollars ($30.00).

User Acceptance and Compliance

The V.A.D.O. has been designed so it is easy to put on and to adjust. The connectors used to secure the orthosis to Mr. B.'s arm are very easy to tighten with one hand. The Velcro is also easy to adjust which will help with the range of motion exercises. To put the V.A.D.O. on Mr. B.'s arm, he only has to slip his arm through the turn-key clamps and tighten them. He can then adjust the Velcro to any position he desires. The inside of the V.A.D.O. is padded, this will make it comfortable to wear. The V.A.D.O. is light-weight and, therefore, very little extra load is put on the shoulder. Since there is minimal weight added, Mr. B. is more likely to wear the orthosis. The edges of the air duct can be sharp when they are cut, so to remedy this, the edges have been covered with padding to make it safe.

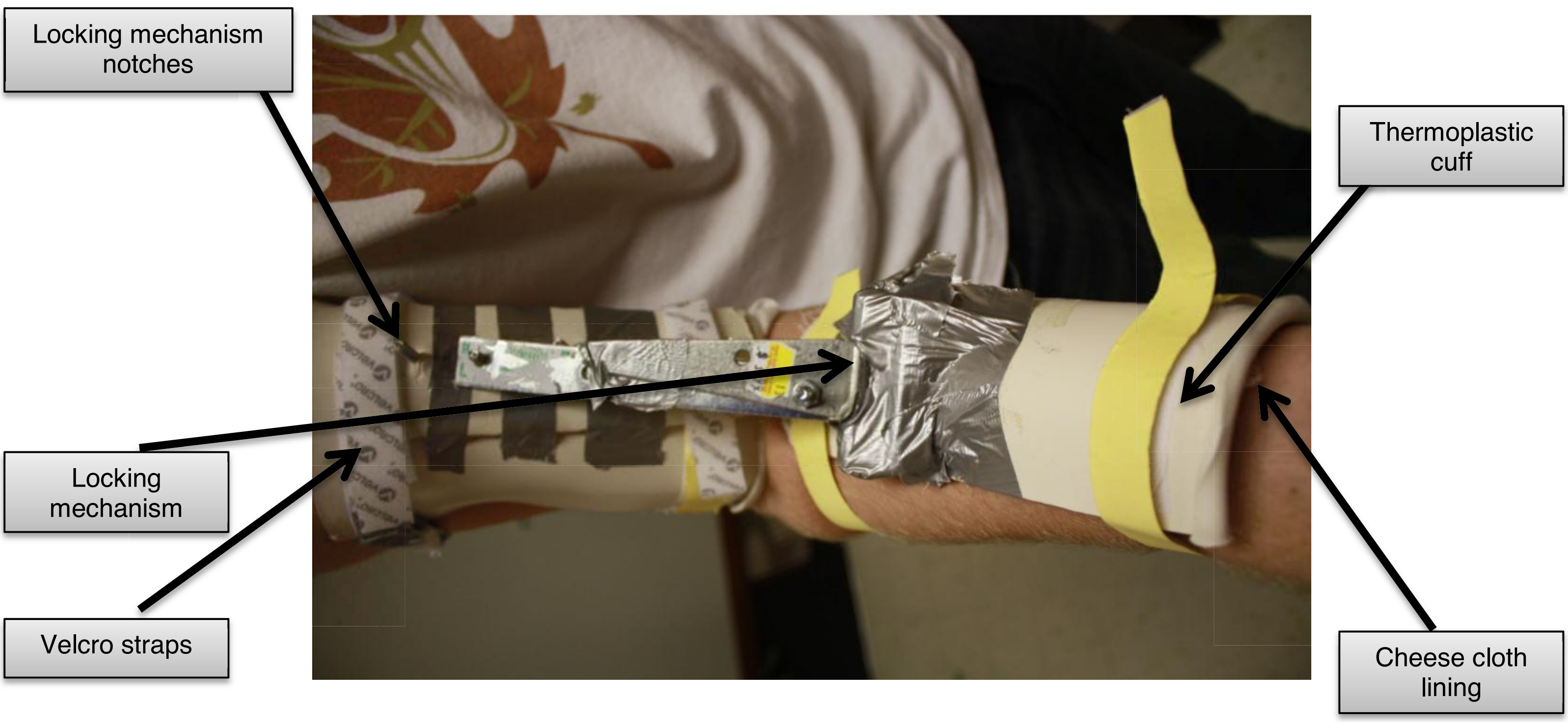
Benefits

The benefits which make the V.A.D.O. different from other designs are that it takes no special tools to make, it is made out of materials that could be bought at any hardware store, and it is very inexpensive to assemble. Many other orthosis are made with specifically made parts and special tools are needed to put it together. Other orthosis can also be very expensive. For example, a sheet of thermoplastic sometimes used for braces can cost Fifty Dollars ($50.00) a sheet.

Dynamic Elbow Orthotic

K.B.V.S.S Orthotics
F 03 - T 01 - 3

This is the space for your visual. Do not change its size. Your visual may contain any combination of well-done sketches, drawings, photographs and CAD models. All visuals must be original. Use annotations.



Problem Description

The problem presented to KBVSS Orthotics by Tara Packham, an occupational therapist from the Hand Clinic at Hamilton General Hospital, is the following. Mr. F, a 29 year old single male who was burned in a house fire, currently suffers from 2nd and 3rd degree burns on his upper body. He has had numerous surgeries and requires an elbow orthotic for rehabilitation from heterotrophic ossification at the elbow, fusion of the elbow joint (at a 70^{o} angle) as a result of surgery. Some challenges he currently faces are; he has very limited hand function causing difficulty with fine motor movements in his hands, he has very poor skin quality (from burns), stiffness, and swelling which prevents him from extending his arm. Ideally, he would like to be able to use the orthotic by himself so that he can be more independent. The device that we have designed allows Mr. F to carry out day to day activities at home while minimizing pain and stabilizing the arm. It should also cater to his delicate skin as much as possible. The device must be easy to take on and off independently. Overall the device would allow Mr. F to have an improved quality of life and make rehabilitation easier.

Design

The design will be made of two separate components. The first component will be attached to the inside of the forearm where Velcro straps will hold it in place and will have the hinge which will lock into different positions. The second component will be attached on top of the bicep and will contain the notches that the hinge will use to hook into place. The orthotic will weigh about two and a half pounds to about three and a half. Each component will cover about half of the arm while the straps wrap around the full arm.

Functionality

The main function of our elbow orthotic was to be able to lock into different positions, promoting elbow flexion and extension. The orthotic was designed so that the user would be able to use it on a day to day basis as well as during rehabilitation therapy. The orthotic was able to meet all of the user's needs in terms of flexing and extending his arm.

Materials, Components, and Assembly

The body of the splint was made out of thermoplastic and was lined with cheese cloth. The locking mechanism was made out of a hinge and the notches were bolts that were placed in the thermoplastic. All of the materials used other than the thermoplastic could be obtained from any hardware store. A sharp knife will be required to cut through the thermoplastic. A kettle will also be needed to boil water to melt the thermoplastic. Scissors and tongs will also be useful when working with the thermoplastic. Construction time will take approximately 1-2 hours depending on how easy you can work with the thermoplastic. When constructing the splint, the first step will be to lay paper towels on top of the arm and bicep in order to measure approximately how much thermoplastic will be needed. An additional piece of thermoplastic will be needed to attach the screws to the bicep cuff and these locations should be measured before placing the thermoplastic in the hot water. The paper towel will then be placed on the thermoplastic and traced out. The thermoplastic will be cut out and placed in boiling water for about 1 minute in order for it to become mouldable. After taking the thermoplastic out, mould it into the cuffs for the arm and bicep and fold up any sharp edges of the cuffs. Also, while the thermoplastic is still soft, holes must be pierced in the additional piece of thermoplastic with markings which will be placed on top of the bicep cuff. Gloves are strongly recommended for this part. Put screws in the holes then attach the piece to the top of the bicep cuff using Velcro. Attach Velcro to the bottom cuff as well to hold it in place. Once dried, line both cuffs with cheese cloth. The final step is to attach the locking mechanism with duct tape to the bottom cuff and make sure it's positioned so that the rod can reach all of the screws.

Cost

The cost of materials for the splint will be approximately $50 for the clinic. Any additional charges for time and labour will be decided upon by the clinic.

User Acceptance and Compliance

User Compliance has been considered by designing an orthotic that has the least amount of extruding material, so it does not stick out. The User can easily put it on and off by placing the mould into the arm and doing up 4 Velcro straps. The splint was made comfortable by lining the inside with which provides padding. The corners of the splint we also bent so that it does not protrude into his skin. The User simply has to adjust the metal rod in order to adjust the angle. The user will want to wear this orthotic because not only does it provide the rehabilitation that he requires, but it is also lightweight and quite comfortable to wear. The device will be safe to use by the user since we have taken action to eliminate any rough or sharp edges that might inflict pain upon the skin.

Benefits

Our design is better than other existing solutions because it is affordable, easy to build, easy to put one, and easy to manage. Any user of this splint will be quite happy that they would be able to get a splint that not only will help them in their healing process, but will also keep them from spending too much money and it will provide them with independence as this splint does not require assistance from anyone else.

EZ Sling

Team Name
F 03 - T 01 - 5

Problem Description

Mr. B is a 23 year old single male who was severely injured in a motorcycle accident leading to compound fracture and dislocation and degloving of his right wrist with tendon/nerve lacerations. He also suffers from a brachial plexus injury on his right arm, and got nerve grafting 6 months later. The patient's finger and wrist muscles are fine; however, he has no working muscles on the elbow and very little working muscles on the shoulder. Due to this, a harness that is light weight would not apply harmful pressure on his shoulder which is already subluxed from the weight of his arm as to not hinder its rehabilitation. Our client Tara must be able to construct this brace mechanism in a manner that is simple and cost effective. She does not have access to any high end manufacturing equipment and the design must follow suit. The user desires a device that will allow him to adjust the elbow splint at various positions which will allow him to use his hand. He would also like to be able to rotate his forearm and work on active assisted range of motion with the brace on. Furthermore due to him awaiting trial on drug charges, a splint that will be allowed if he is incarcerated should be made. It would be ideal that the design could be used by other people if they have similar cases such as shoulder or elbow injuries.

Design

Our design was to incorporate, giving restriction while also, using minimal parts as possible. What we included was two arm bands, as well as an elastic band in between. The elastic band is where all the restriction of the arm generates from, it is the connection between the bicep and the wrist, which causes the 90 degree resting position.

Functionality

The functionality of the EZ sling is that it allows for the user to keep their arm relaxed at a right angle. Its light weight nature does not increase the load on the user's arm and allows for the supination and pronation of the user's forearm. The sling also reduces the weight carried by the elbow. Minimizes load, minimizes cost, easily used independently.

Materials, Components, and Assembly

Materials: two straps, resisting band, fastener
They can be found easily in any local hardware shop.
Tools: sewing kit and some thread.
The design can be easily done within one hour maximum.
Instructions:
Take each strap and sew it in a circle which allows the fastener to adjust the length of the strap.
Then, sew the resisting band into each strap.
Our design does not need any special instructions, it is just easy , simple and safe to construct.

Cost

The only materials used in our design were three parts. The arm bands came to a total of ten dollars, and the elastic band came to only six dollars. When researching the materials, we also found they were all cheaper to buy in bulk.

Benefits

The benefits to the design is that is not only is it inexpensive, but it can be folded and compressed to make it much more portable and easier for travel and everyday life. Its reduced weight is attributed to the absence of any metals which allow it to be used in correctional facilities. The sling's simple nature makes it easily to build and construct as well as put on and take off solely by the user.

User Acceptance and Compliance

The design is user friendly as it is really easy to put in and take it off. He can wear it either underneath or above the clothes and it will still perform the same functions. No load on shoulders or elbow because it is very light. Moreover, it does not contain any metals and this makes it not weaponized which was one of this user's specific needs. Also, it gives him the range of motion he needs whether the rotation of the forearm or being held in a 90 degree position. The design is really small and simple which makes it look good with no modifications. May

The Arm-adillo

IPOETICS
F03-T01-6

The Armadillo Final Design

Problem Description

The problem presented to the team involves Mr. F., a person who has suffered heterotopic ossification due to change in body chemistry from a severe burn injury over 20% of his body surface area. He has undergone treatment through orthopaedic surgery and received a hinged elbow splint in his arm for arm movement exercises. He has limited hand movement bilaterally, resulting in poor dexterity. His arm is also stiff and swells, leading to an uncomfortable experiences with standard elbow splints, because the Velcro straps are rough on his skin causing blisters which raises the risk of infection. Tara Packham, an occupational therapist from the hand clinic at Hamilton General Hospital, has asked the team to design an elbow orthosis that can satisfy the patient's needs. The elbow orthosis must be able to change arm position and mobilize the arm. The orthosis must be user friendly in the sense that it is gentle on the burn areas on the arm, easy to adjust the angle, and not difficult to put on and take off due to the patient's lack of dexterity The elbow orthosis must also be affordable due to the limited funding available to Mr. F. and the clinic. Optimally, the orthosis should be cost-efficient, light weight and portable.

Design

One of the biggest strengths of this design is its sleek and simple nature. It is designed to fit onto the arm minimalizing the surface area of contact while still performing the same tasks that a more complex design could. The design is based on a simple idea similar to the mechanic of a backpack strap. There is a strap of webbing that is attached in two spots, one of the forearm and one of the upper arm, and by pulling on the strap it tightens, which pulls up on the user's arm giving it support. The size is relatively small, as the design mainly consists of two solid half-cuffs of thermoplastic, which are attached through the webbing and buckle system. It is very lightweight which is one of our key features and strengths of the design. This lightweight nature allows the user much comfort as it puts very little strain on the arm. The actual size is relatively non important, as it fit onto the arm almost like a glove. Each part of thermoplastic was customized to fit to the prototype user's arm, and can be custom moulded to any user's needs and individual attributes.

Functionality

Our design is one that was made with the user in mind. Functionality was the main goal behind this idea, and the simplistic nature was our means in reaching this goal. The prototype allows the user virtually free movement of the arm, bilateral hand movement included. Since the users arm was custom moulded to fit the prototype the user can do everyday activities with ease, while still having that necessary support that the design was made for. Most of the client's needs were met with this design. One key feature of our device's functionality is that it gives the user the ability to tighten and loosen the device independently with only the use of one hand. This allows the user much freedom, as they don't need to depend on others to help them adjust the device periodically through the day as deemed necessary. We believe that any user who needs a device similar to this would be very happy with the functionality of our design, as this would last them through the entire extent of their recovery period.

Materials, Components, and Assembly

This device requires the following materials; 9 x 5.5" sheet of thermoplastic, 0.5m of webbing, a slide buckle, four Velcro utility straps. In addition to the listed materials, the fabrication also requires a method of heating water to 70 degrees Celsius, glue, a utility knife (or alternative apparatus for cutting plastic), scissors, and someone with minimal experience working with thermoplastic. The assembly takes one hour, with half of the time allotted to moulding the plastic. When casting the users arm to produce the two cuffs, the arm should be in a supinated position.

Cost

In addition to the hour of labour, the materials used to construct this device total $10.88. The cost is subject to the size of the user's arm, which may alter the dimensions of thermoplastic required.

User Acceptance and Compliance

An orthosis that is hard to put on may be detrimental to Mr. F's health, considering that wounds may caused by the friction between the orthosis and the burns on his arms. The user may struggle put on the orthosis due to lack of dexterity in his fingers, thus it must be easy to put on/take off. To get it on/off, the user just needs to perform several easy movements. To attach a Velcro connection, the user just loops one end around the arm, and sticks it against the stationary Velcro. The four connections can all be tied with one hand, and the thermoplastic is light and easy to position. The time it takes to put on the orthosis is approximately less than 1 minute. Due to Mr. F's burns, the surface area of which the orthosis makes with the arm has been minimized. The materials used, particularly the thermoplastic, has been used with comfort in mind. The Velcro straps are used in the design are thin, and hook end is only present in a small area on the strap.

Benefits

The design presented focuses on user-friendliness and simplicity, and the solutions it provides are efficient and more practical than existing solutions. It is much lighter than the existing designs, and is arguably faster to put on as well. It has been tailored for a victim of burns on the arms, minimizing surface contact area involving thermoplastic, and can be adjusted even with a user with low finger dexterity. It is also very cost-efficient, and easy to assemble. It is clear that our design has considered user's and client's set constraints, and fulfilled objectives that the design team has set.

Green Sleeve

Creative Arm/Joint
Rehabilitation Devices Inc.
Team Name
F03 - T02 -1


Problem Description

The Hamilton Health Sciences Hand Clinic has a client named Mr. B. He had a motorcycle accident where he dislocated, fractured, and degloved his right wrist. Along with these injuries, Mr. B lacerated tendons and nerves in his wrist. Finally, Mr. B sustained a right brachial plexus injury which restricts movement in his right shoulder and arm. There is evidence that stabilizing after an accident allows the injury to heal more effectively. Therefore, Mrs. Tara Packham, and occupational therapist from the hand clinic, wants a device that's stable, easily adjustable and low cost. After consulting Mr. B, he wishes the device to rotate about the forearm to be comfortable, easily adjustable and meet prison safety standards. Finally, he would prefer not to have any additional load on his shoulder that would stress his muscles.

Design

Describe the design referring to the visuals.

The weight of our design will be 0.4lbs, reducing weight on the shoulder by being lightweight. The design is made to easily slide onto the arm, provided by the elasticity of the material. The length of the sleeve of the orthosis will be adjusted to the length of the user's arm and the glove will be the size of the palm of their hand. Lastly, the body strap will be long enough to wrap around the user's ribcage and the right arm.

Functionality

The design meets the constraint given: it must be easily assembled in the Hand Clinic. Our design satisfies the constraint because it utilizes cloth and Velcro as the main body, and sewing materials as the main method of assembly. These materials are both easily found and economic. The design also meets most of the objectives described in the problem statement. Firstly, our elbow orthosis is user friendly. Since the cost is under $15 dollars, the device is affordable. It is also very comfortable: the material for the sleeve does not cause skin irritation and is easily put on. The body strap takes weight off of the injured shoulder so that pain is reduced. Our device is stable because it does not allow the arm to freely move about. Velcro allows the device to be easily adjustable to different positions of flexion and extension. Mr. B wished that it would rotate about the forearm, and the device satisfies this by having a glove and Velcro attachment to allow for pronation and supination. Ultimately, because the design achieves the objectives without the use of sharp pieces or metal parts, the device could be worn in prison.

Materials, Components, and Assembly

The design requires the Hand Clinic to have elastic and inelastic cloth, long Velcro straps and sewing materials. The fabric and sewing materials can be obtained at a fabric store (ex: FabricLand) and Velcro can be bought at any utility store (ex: Home Hardware, Shoppera, Dollar Store, Canadian Tire). The only tools needed to make the design are a sewing needle, thread and fabric scissors. For our group to construct the design, it took a total of 4 hours. The user will have to be present during the assembly for a fitting: measurement of the hand, arm, and chest are necessary for the effectiveness of the design.

Cost

The overall cost to the clinic and user will be extremely low. The projected cost of the design is $15 dollars. Velcro used in this design cost $4 dollars. The fabric can be bought for $10 dollars.

User Acceptance and Compliance

The user compliance has been considered throughout the design process. Our device is easy to slide onto the arm and has Velcro on it to make it very adjustable. The elastic material for the sleeve is soft, does not cause skin irritation and does not cut off circulation to the hand. To use the device, the user must wear it with a short sleeved shirt and over their clothing. They must slip the sleeve on first, attach the glove to their hand, position the hand into supination or pronation with the given straps, position the arm into flexion or extension with the given strap, and finally place the body strap over their chest and arm. The design is not conspicuous because it is worn over the clothing, which might not be desirable for the user. However, the cloth used is comfortable, which may increase user compliance. Cosmetics have been considered in the design, as you are able to buy a different colour of cloth for the preferences of the user. You may also sew stickers onto the cloth. Specific to Mr. B, the design enforces user compliance by adding a body strap to ease the pain of a load on the shoulder. Since the design is made out of cloth, the design is safe because you cannot harm anyone with it, intentionally or unintentionally.

Benefits

The design is better than existing solutions because it is comfortable and user friendly while achieving the given constraint and most objectives. It is also easy to assemble and cost friendly.

The Auxilium

Hamilton Orthosis Incorporated
F 0 3 - T 0 2 - 2

A side view (on left) and a front view (on right) of H.O.I.'s elbow orthosis prototype featured on a user.

Problem Description

The client, Tara Packham, is an occupational therapist who works for the hand clinic at the Hamilton Health Sciences. She assists her clients to recover through a variety of different activities and studies their ability to perform those activities as well as how they improve with treatment from the clinic. The user, Mr.B, has been in a motorcycle accident and is now in need of an elbow orthosis as he has injured multiple bones, tendons, arteries, and nerves in his elbow of his right (dominant) arm. The device will have a main function of supporting the elbow in different predetermined positions. With this function, Mr. B will gain the ability to do many different tasks, including many simple yet necessary ones like writing. The device will be usable both indoors and outdoors. The user may also require its use in a correctional facility, since Mr. B is currently awaiting trial for drug charges. As a result, it must not be able to be used as a weapon and must be accepted as an appropriate splint in prison. Lastly, this device will not negatively affect the user's current abilities and movements any more than his current injuries; it will not limit the minimal movement he has now.

Design

The design is a fully functional yet lightweight elbow orthosis. The whole splint weighs less than a pound (roughly half a pound) and is therefore very user friendly as it is incredibly easy to carry around and support. The size of the device relative to the arm is visible in the image above, where the elbow orthosis is featured on a user. The splint fits comfortably along the length of the arm and extends from the wrist to almost the shoulder without hindering any movement. In addition, it is thin enough to fit under loose clothing.

Functionality
The orthosis can successfully lock the user's elbow into an infinite number of positions and therefore allows them to perform a variety of activities in which they currently experience pain and difficulty performing with their injury. This function is achieved with an adjustable strap that connects the two ends of the splint, providing extension and flexion of the arm. The user can easily adjust it without any help needed from others. When the strap is pulled, it tightens and lessens the angle at the elbow. Conversely, when the strap is loosened, it increases the angle at the elbow and the arm becomes straighter. The splint also provides comfort to the user because it does not put a strain on their shoulder due to its minimal weight. This extremely lightweight design was achievable through the use of the specific materials used to manufacture the orthosis, namely its SAM splint component. In addition, if the need arises, this device cannot be deemed a weapon and thus Mr. B would be able to use the device in a correctional facility in the presence of others.

Materials, Components, and Assembly
H.O.I.'s simple elbow orthosis design requires few materials and components. These include a SAM splint, Velcro straps, an adjustable strap, and an arm sleeve. The SAM splint material can be found in several medical stores, in first aid kits, and is available for purchase online through www.scoutstuff.org. It is uniquely composed of a thin aluminum alloy core sandwiched between two layers of closed-cell foam. Both the Velcro straps and the adjustable strap can be found in many stores such as Walmart or Home Depot. Lastly, arm sleeves are sold in athletic stores like Sport Check, National Sports, Hamilton Sporting Goods, or Mini Sport Store. Before giving the device to a user, it needs to be individually moulded to their arm. The client, Tara, will normally do this for her patients. This process will be clearly described in an easy-to-follow set of instructions provided to the user with the splint. Moulding the splint will only take a short amount of time because its main component, the SAM splint material, is one which immediately holds its shape as it is bent. Pliers may be used to help mould the material, however it can be done by hand and this may in fact be found to be the easiest way to fit the splint for most clients. This is because the material is malleable enough that no tools are necessarily needed.

Cost
The total cost for the manufacturing of H.O.I.'s elbow orthosis device is approximately $30. This small amount covers the cost of all the materials; $15 SAM splint material, $10 arm sleeve, $5 Velcro straps, $5 adjustable strap.

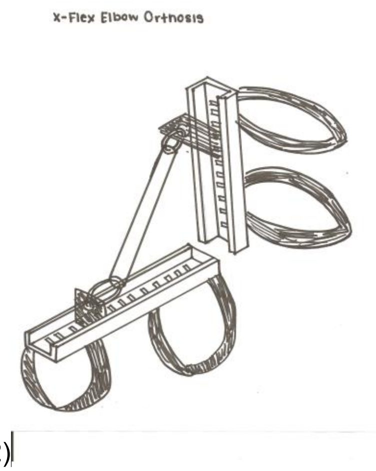
User Acceptance and Compliance
This elbow splint is very easy for the user to individually get on and off. The Velcro straps are easy to adjust without any help and they offer a custom fit for the patient. The user will find the device comfortable to wear due to the soft materials and how light it is. Cosmetically, the elbow orthosis is not expected to greatly affect the user. It can be made in a variety of different colours, for example all black if the user is looking for a splint that will not stand out. The safety of the design has been thoroughly considered during the entire design process. The end result is completely safe for the user as well as surrounding individuals. There are no sharp edges or hard metal parts included. The device would also be accepted in prisons if needed.

Benefits
This design is better than existing solutions for many reasons; its extremely low cost, low weight, simple design, adjustability, high level of comfort, and custom fit. In addition, it is easy to assemble for the client as well as easy to put on and take off for the user. Its most important element, the SAM splint, provides an extremely strong and reliable support for the elbow. The arm sleeve is made is made up of a material commonly used in sportswear; it can be worn during any season as its moisture-wicking polyester can easily absorb any sweat from the arm. The Velcro straps provide custom adjustability for the user so they can tighten or loosen their elbow splint with ease.

X-Flex Orthosis

Lightening Fast Orthotics
F 0 3 - T 0 2 - 4

(1)

(2)

Problem Description

Tara Packham of the Hamilton Health Sciences Hand Clinic met with the design team of Lightning Fast Orthotics to discuss a problem concerning an individual, Mr. F, who was injured in a house fire. Mr. F suffers from second and third degree burns to twenty percent of his body. Consequently, Mr. F has from heterotrophic ossification in his left elbow, forearm and hand. In order to facilitate his recovery, Mr. F has been forced to relocate to live with his parents and become very dependent on their help. Tara challenged the team to design an elbow orthosis capable of increasing the possible range of motion in Mr. F's injured elbow. Due to the burn's Mr. F suffers from the device should minimize skin irritation as well as the possibility for blisters and chaffing that could put Mr. F at risk of infections. With Mr. F's limited mobility and wish to remain as independent as possible the device should be easy to use, require little adjustment and fine motor skills for operation.

Design

The X-Flex Elbow Orthosis consists of a variety of everyday parts to accomplish the task of increasing the range of motion of the fixated limb. The entire device, refer to appendix 13, consists of 2 pieces of track each attached to the arm using 2 bands. The first band is situated on the forearm 2-3inches in the proximal direction from the wrist, the second band is placed 2-3 inches in the distal direction from the elbow (2). A slender piece of track about eight inches long is fixated on top of these brackets in the ventral or anterior plane (2). On the upper arm rests the third and fourth bands each 1-2 inches in the distal or proximal directions respectively. These two pieces of track are connected by a rod of adjustable length that is fixed on to L-brackets (2) by small screws. This rod is adjusted through a pin that fits into holes in the rod. The entire device ranges from entirely extended at 24cm by 10cm to entirely collapsed at 21 cm by 25 cm and weighs 0.3 kg.

Functionality

The device is used to promote the extension and flexion of the elbow joint. It provides a simple and easy way to adjust the angle of the arm by adjusting the length of the rod. Pushing or pulling on the metal bar attached to the rod and locking it into place using a locking pin (1) achieves this function. The pin allows Mr. F to lock the device into place without any fine finger movements, and the metal bar (1) allows for adjustment of the length of the rod without strenuous hand or wrist movements. Furthermore, the level of comfort is increased, as there is little contact between the device and the users skin, and padding to provide comfort. Since the bands are adjusted to predetermine sizes, the device must slide up the arm, which can be difficult considering Mr. F's burnt skin. However, once the device is on, it can be worn for an extended period of time without great discomfort.

Materials, Components, and Assembly

The team's design is cost effective and easy to make. All the parts can be found at a local hardware store. The components are two metal tracks that attach to the arm via padded bands, an adjustable rod, connecting L-bracket (2), a chain link (1), screws, a locking pin and epoxy. Construction begins by using epoxy to attach the padding (2) to the inside of the metal bands, and the metal bands are then attached to the metal track. The pieces of track must be cut to the appropriate length based on the user's arm size. The L-bracket is screwed to the track and the rod is hooked on to the L-bracket using the chain link, which can be opened or closed. The rod contains an inner and outer rod, with holes placed intermediately. This can be purchased or made by drilling holes into an existing rod. To assemble the device takes less than an hour, once all the pieces are purchased. The only additional instruction required is how to use a drill if necessary and how to use the epoxy.

Cost

The orthotic device will cost approximately $44.00.

User Acceptance and Compliance

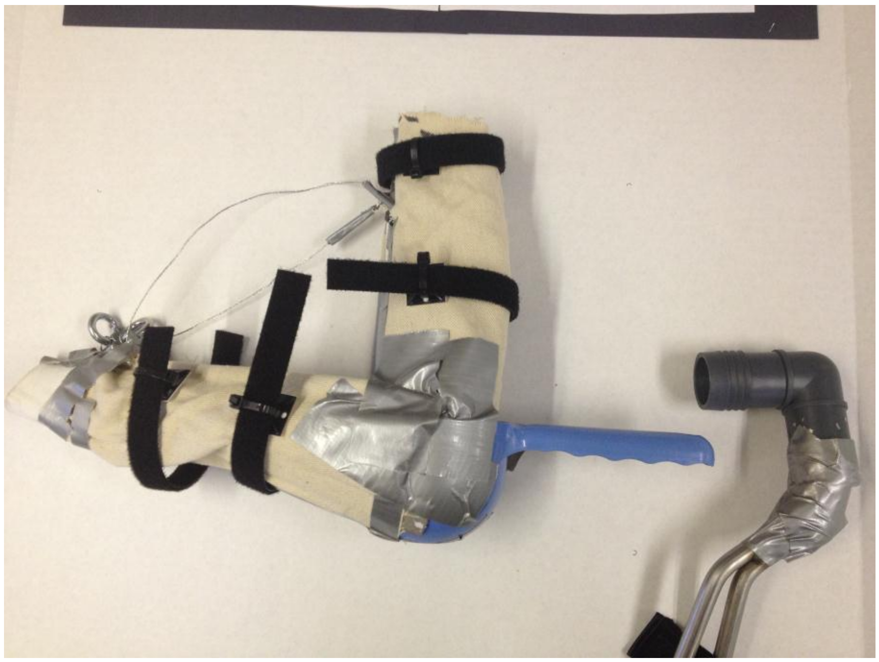
The team first considered increasing the ROM of the user's arm, then increasing comfort, and finally the team considered independence when putting on the orthosis. The device has minimal skin contact and comfortable material is used under the tracks and the bands to reduce friction between the skin and the device. The device is put on by slipping the four bands (2) on and then attaching the rod into the desired place. A pin will be inserted into the desired rod holes to lock the angle of the arm. Most of the objectives were met, such as increasing comfort and reducing assistance and reducing weight. To reduce the assistance needed, the need to replace the rod with a spring has been eliminated; instead an extending and contracting rod has been used. The maintenance has been taken into account by making the device using metal tracks and rods, to allow for easy cleaning. Although the design uses metal, which may provide some risk to the user, it is assumed that the user will not participate in many activities that require a lot of movement.

Benefits

The design of the team's orthosis is cost efficient compared to other devices found in stores. This will enable our device to be mass-produced for numerous users. One of the advantages of our design is the minimal skin contact (2). The team has eliminated the need for large amounts of non-irritable material. However, for the parts of the orthosis that are in contact with the skin, a comfortable fabric was found to protect the skin from the metal components. The design maximizes breathability and comfort. The rigidity of the metal pieces is very successful in promoting extension and flexion. The arm was easily kept in a static position when tested with the prototype.

Elbow Orthotic

Team Name
F03 – T02 – 5



Problem Description

As a result of an accident the patient sustained injuries affecting the range of motion in his elbow and the ability support the arm with their shoulder in its current state. The *Thumbs Up Elbow Orthotic* must support the arm while allowing for a range of motion needed for everyday tasks in a more comfortable manor. Both flexion and extension as well as supination pronation should be feasible with easy adjustments. To avoid added strain to the injured shoulder the device must be able to support the arm. The device must meet these needs to ensure user compliance.

Design

The *Thumbs Up Elbow Orthotic* consists of two braces with one on the lower arm and the other on the upper arm. They envelop the arm and are found where the wire/winch system is attached to for providing the range of motion. A scoop is inserted on the lower arm brace and adds additional cushioning to the elbow. The scoop also has handle that can insert to the resting mount attached to the patients' hip.

Functionality

The *Thumbs Up Elbow Orthotic* allows the user to easily adjust and lock the device in a range of positions to make daily tasks possible. Permitting flexion, extension, pronation and supination the patient will virtually have a full range of motion. For added support to the shoulder, a resting mount attached to the hip is available for easy insertion of the elbow brace when needed.

Materials, Components, and Assembly

The brace component of the device requires four metal rods with a piece of fabric to encompass and act similar to a stretcher when constructed. Velcro straps hold it on while the winches and wire support the device and control positioning. A padded scoop is inserted into the lower arm brace. The mounting hip support is made of a rod with a clip for a belt and an elbow pipe where the scoop inserts to provide support. All parts can be found at a local hardware store though pieces for the mounting support could be substituted with thermoplastics.

Cost

Fabric	$2
Velcro	$12
Metal Rods(reusable)	$10
Winch x2	$7
Wire (roll for mult. users)	$6
Scoop	$3
Elbow Pipe	$1.50
Rod for Mount Support	$6
Tapes and Sewing Material	$10
Total	$57.50

User Acceptance and Compliance

The *Thumbs Up Elbow Orthotic* was developed to provide maximum comfort, support and adjustability. With the comfortable fabric, irritation is not an issue and user compliance can be increased with a variety of fabric designs to choose from. Wearing this device does not impede range of motion due to the set of wires to provide flexion, extension, pronation and supination. These adjustment possibilities allows for the patient to do basic daily tasks like writing when the device is adjusted. Support was not compromised to provide the high level of adjustability. The wires are more than strong enough to support the arm and the resting mount support alleviates almost all pressure on the patients shoulder.

Benefits

The *Thumbs Up Elbow Orthotic* is provides maximum range of motion at a fraction of the price of comparable designs. All parts are available locally though some components such as the material for the rest mount support could be substituted for thermoplastic. The design is made to be durable and with some parts that can be reused for future patients use.

Helpful Harness

bluebird Consulting Engineers Co.

Team Name
F 03 - T 05 - 3

The image on the left shows how the designed orthosis appears when looking at it from a front-left side view, as you can see there is a forearm Velcro band connected to a bicep Velcro band, via a backpack strap. The image on the right shows how the orthosis appears when examined from behind, mainly showing the shoulder strap and how it connects to the elbow of the user.

Problem Description

After analyzing the client Tara Packham's presentation, our company was able to take away the key issues at hand. The issues we chose to focus on for our user included; supporting his shoulder because of his brachial plexus injury sustained during his motorcycle accident. We also wanted Mr. B to be able to lock his elbow at various angles of flexion and extension. While doing this we wanted our orthosis to be easy to use, meaning he could use his one good hand to put it on/off and also adjust everything. Another thing we needed to accomplish was ensure that Mr. B could have pronation/supination in his forearm. Lastly, we chose to make this device as safe as possible so that it may be used if the user ends up going to prison.

Design

The visuals shown above illustrate our final design. The shoulder strap as shown in both images provides ample support for Mr. B's brachial plexus injury. There is a loop around the elbow that is connected to the shoulder strap. It has been placed here so it does not hinder the range of motion of the users elbow. The forearm and bicep straps are connected by a simple backpack strap, that when pulled allows the user to easily adjust the angle between his forearm and bicep. We chose to use Velcro for our design for two reasons; because it is lightweight, and also because it is easily adjustable. The ease of adjustability allows users with one usable hand to be self-reliant. Our design is meant to be worn over clothing, unless the user is wearing a T-shirt. Lastly, we feel we have created a design that is not as bulky as other comparable orthotics.

Functionality

The Helpful harness accomplishes four main functions. The functions include; supporting the shoulder, locking elbow at fixed angles of flexion and extension, ease of use, and allowing pronation/supination of the forearm. Our design can do all of the functions the client requested. However, it does some functions better then others. For example it was difficult to create shoulder support without knowing what the maximum load the user can withstand, or without hindering elbow movement. That being said we believe our design is a viable solution for the clients needs.

Materials, Components, and Assembly

The main material used in our design is Velcro because it is so versatile, and abundant. We also used a backpack strap, and padding. You can dress it up cosmetically speaking by stitching materials to the back of the Velcro. All of the materials required to build the orthosis can be obtained at a retail store such as Canadian Tire. It should take about 30 minutes to construct one orthosis. Visual instructions would be needed, so that all the Velcro would be connected at the right places, and for attaching the forearm band to the bicep band. Essentially scissors are the only tool needed to construct the Helpful Harness.

Cost

One of the great things about the design we have created is its low cost. When estimating the cost of a good, two factors must be considered. First, we will consider the cost of the raw materials. The materials we chose were quite basic in nature and can all be found at almost all retail stores at reasonable costs. To create the working prototype our company invested approximately $40 dollars of capital. Second, the cost of manufacturing needs to be considered. As of right now our company has yet to begin manufacturing the Helpful Harness. So we will be offering you the opportunity to purchase the materials from us, along with the sole right to produce our orthosis. We estimate a 30-minute manufacturing time for one of your occupational therapists. This will add an additional estimated cost of $18 dollars per unit manufactured. Bringing the total cost to a miniscule $58 dollars per unit.

User Acceptance and Compliance

User compliance and acceptance was important when generating our orthosis. If the user would not use it, then the orthotic would be completely useless. Our innovative design is remarkably easy to use because the user can put it on or remove it with one hand. It has been made comfortable by adding padding in specific places. The user will use the device to lock his elbow at various points of flexion and extension, which will rehabilitate his injury. The orthosis also provides ample shoulder support via a shoulder strap. Since Mr. B rides motorcycles we have elected to cover the exterior of the Velcro in leather. Lastly, we have considered the safety of the user and public, the orthosis has no metal or sharp edges.

Benefits

Most orthotics are only capable of achieving one or two functions. We at Blue Bird Consulting Engineers believe we have created an innovative design that will revolutionize orthotics for years to come. We have created the Helpful Harness, which is able to complete several functions easily and efficiently. The functions our orthosis executes include; ease of use, shoulder support, pronation & supination of forearm, and the ability to lock the elbow at various stages of flexion and extension. We believe that with regular use, users can regain motion in their arms, and enjoy a better life after recovery.

Humerus Engineering

Humerus Engineering
F 0 3 - T 0 3 - 6

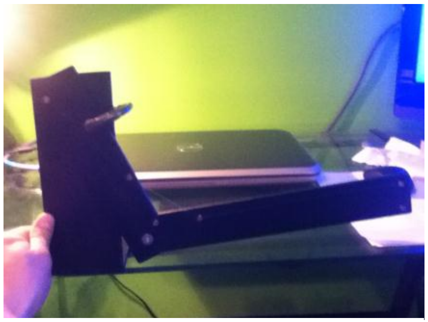


Figure 1: Photo of a prototype demonstrating the functionality of our design.

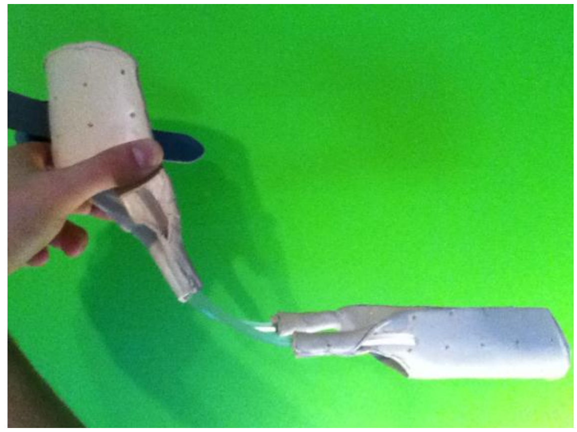


Figure 2: Photo of the final protoype

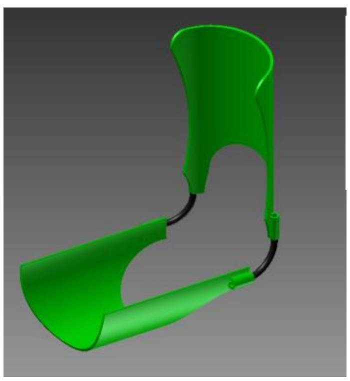


Figure 3: CAD model of our final prototype.

Problem Description

The Hamilton Health Sciences Clinic presented our team with a design challenge to assist with the rehabilitation and the rejuvination of the health of our client, Mr. F. Mr. F is a 29-year old male that has suffered from second and third degree burns to twenty percent of the skin on his body, including his face, arms, and upper back. Due to this injury, he suffers from the heterotopic ossification of his left elbow and this limits the movement of his entire arm. Mr. F finds daily activities involving the use of his elbow extremely difficult and painful. The elbow orthosis to be designed by the engineers here at Humerus Engineering must improve the range of motion in his elbow so that will allow him to perform such daily activities. Due to the severe sensitivity of his skin and his limited bilateral hand function, it is challenging for Mr. F to put on and remove straps. This new device must be comfortable for him to use on a regular basis and minimize the pain involved in performing these activities. Mr. F's current device makes it very difficult to change the angle mechanism. The new device we will design must be very effective in changing the angle of flexion and extension so he can complete it independently.

Design

Our prototype is designed to demonstrate the functions of the orthosis we developed to be used by Mr. F. The shape of the orthosis was design around the function of providing comfort. The orthosis has two braces made of thermoplastic, one on the upper arm and one on the forearm, connected by tubing running on both sides of the elbow. There is an adjustable knob placed on the outside of the upper part and there is wire running through the tubes, around screws on the braces, and around the adjustable knob. As one could see the orthosis is not big and bulk- it is small and light weight. It provides a unique method of extension and flexion that is suited to work with Mr. F's needs.

Functionality

Static progressive orthoses apply torque to a joint to place it as close to the desired end range as possible. These orthoses provide a series of advancing positions to bring the user to this desired end range over time. The mechanism present will provide Mr. F with many degrees of flexion and extension so eventually he can move his arm through all angles of flexion and extension. This orthosis is designed to be as easy as possible for Mr. F to use through the use of the adjustable knob and the Velcro straps. The adjustable knob is very beneficial because it requires very little pressure to turn it. The knob allows the angle to change, thus completing the main function of our orthosis successfully.

Materials, Components, and Assembly

This device provides a very simple method for the client to replicate this arm orthosis. Both pieces of the thermoplastic must be molded to the user's arm- one to the upper arm, the other to the forearm. They are to be attached by the flexible rubber tube, which will run on both sides of the outside of the brackets and will be attached by fasteners. The adjustable knob will then be attached on the desired position on the upper bracket, within easy reach of the user. The wiring must then be fed through the rubber tubing, around the adjustable knobs, and around the fasteners placed strategically on the brackets, according to the arm movement demonstration provided. Velcro is to be attached to the centre of the strips of neoprene and the neoprene is then to be attached to the brackets by the fasteners. The memory foam is then to be fastened to the inside of the thermoplastic brackets.

Cost

Please note that this is the cost of a single orthosis, manufactured independently. However, the clinic will likely produce multiple and therefore will buy a majority of the materials in bulk, thus reducing the cost significantly. The sheet of thermoplastic will cost $20, the Velcro straps will cost $6, the wire will cost $2.50, the rivets will cost $2.50, the neoprene will cost $15, and the memory foam will cost $5. The total cost for the client will be $51.The total cost for the user will be approximately $65.

User Acceptance and Compliance

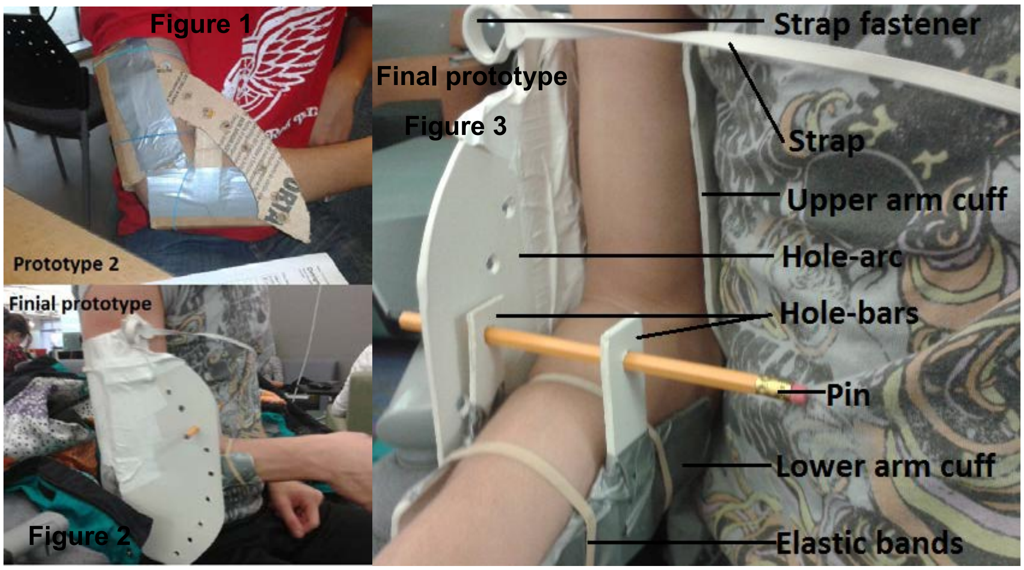
This orthosis is designed for Mr. F to use on a daily basis, because it increases his range of motion progressively. He can easily wear this over clothes, without it being too uncomfortable. The neoprene straps can stretch to fit around layers of clothing. As well, the memory foam can compress to allow more layers of clothing into the device. This device does not put any restrictions on the clothes Mr. F can wear because it is made to be compatible with all articles of clothing. Mr. F can out the device on independently, using his one functional arm. He must place the orthosis on a flat surface, and then put his arm inside. Next, Mr. F can use one arm to secure the Velcro on the both straps. He then must turn the knob to adjust the angle to the desired position. These three steps will be very easy for Mr. F to do easily, independently, and without any additional pain.

Benefits

Our design is better than existing designs due to the effective means of achieving the functions. One area where our design is more effective is its mechanism for adjusting the angle. The design uses a Boa ratchet system, which allows the user to switch the angle by simply turning a knob. Other designs feature the pulling out of a pin to change the angle, which is not an easy task for some with only one arm available for use. The weight of the orthoses is another area in which the design we created differs from existing designs. Our design approach allows for a device with reduced weight. The design does not use a heavy metal hinge at the elbow which allows for the orthoses to be very lightweight and less bulky. Previous designs have a large hinge making the design heavy and not desirable for users to wear. Lastly, another area where our design is more effective than previous is in the cost of the orthoses. The orthoses that was created is very inexpensive compared to the existing orthoses sold through private manufacturers. Our design would approximately cost $65 for the user, where competing orthoses could range from 300$ to 1500$ depending on the quality and the function desired.

Pin- Hole Orthosis

Freshmen Tech
F 0 3 - T 0 3 - 7



Problem Description

The task is to make a dynamic elbow orthosis for the right arm of the user that is easily adjusted to different degrees of flexion and extension by the user, is easily fastened to the arm of the user by the user, is comfortable, supports the elbow, and is light on the user's shoulder.

Design

The final design will be approximately the size of the whole arm. The device has been designed to fit over clothing because it is too large to fit under. The upper arm cuff is the length of the bicep, ending slightly above the crease of the elbow (figure 3). The lower arm cuff runs the length from the elbow to approximately halfway down the forearm (figure 3). The hole-arc on the final design will look similar to figure 1 (with an arced rectangle shape) but longer/with more holes, as a lot of excess thermoplastic was left uncut on the final prototype (figure 2). The hole-arc will be fixed to the upper arm cuff at approximately halfway down the bicep (figure 3). The strap fastener is fixed to the top of the upper arm cuff. The strap will be fixed to the upper arm cuff at one end, and the other end will have a hole that can be hooked onto the strap fastener. The hole-bars will be approximately 2" by 1" rectangles with a hole drilled into one side of each. They will be attached to the middle of the lower arm cuff. In the final design, the elastic bands that are used to hold the orthosis to the arm would be replaced with Velcro straps. These Velcro straps would be attached to both the upper and lower arm cuffs, rather than just the lower arm cuff as in the final prototype. The final prototype is very light weight, but weighs more than the final product will as the final product will not have the extra thermoplastic on the hole-arc.

Functionality

The device is capable of holding the shoulder in place with straps that go around the body, as well as supporting the arm. It can also be adjusted for different degrees of elbow flexion and extension. The client will also be able to achieve supianation and pronation of the forearm while wearing the device. The device has been made comfortable by molding the thermoplastic to the shape of the arm of the user. Although it was decided not to address the material it was made from to be safe in the general public of jail, this design does achieve this, as it has no sharp edges and is made from a malleable plastic.

Materials, Components, and Assembly

This device will require thermoplastic, an epoxy to attach pieces of thermoplastic together, Velcro for attaching the orthosis to the arm, a strap for holding the orthosis to the body, and a dowel to act as a pin. The epoxy, dowel, and Velcro can be purchased at a hardware store. The hand clinic should already have thermoplastic available. The strap on this orthosis was made of thermoplastic that was stretched out very thinly. The tools needed to assemble this device are a drill, a drill bit that will make holes that the dowel will fit snugly in, an exacto-knife to cut the thermoplastic, and warm water to make the thermoplastic malleable. The whole construction process should take approximately three hours. To build this device, the hand clinic will need the shapes to cut the thermoplastic, how to align the holes correctly with the motion of the elbow joint, and how everything is attached. As well, the hand clinic will need to know how to manipulate the thermoplastic after it has been heated.

Cost

The cost to the client will be approximately fifty dollars: five dollars for Velcro straps, anywhere from fifty cents to three dollars for a dowel (depending on the thickness used), three dollars for epoxy glue, and roughly forty dollars worth of thermoplastic. A sheet of thermoplastic was purchased for $80, but only half of it was used. The hand clinic would not need to purchase a whole sheet; rather, they would use what they need from what they already have. The cost to the user will be up to the hand clinic to decide, but if it were to be sold on par with how much it costs to make, it would cost the user approximately fifty dollars.

User Acceptance and Compliance

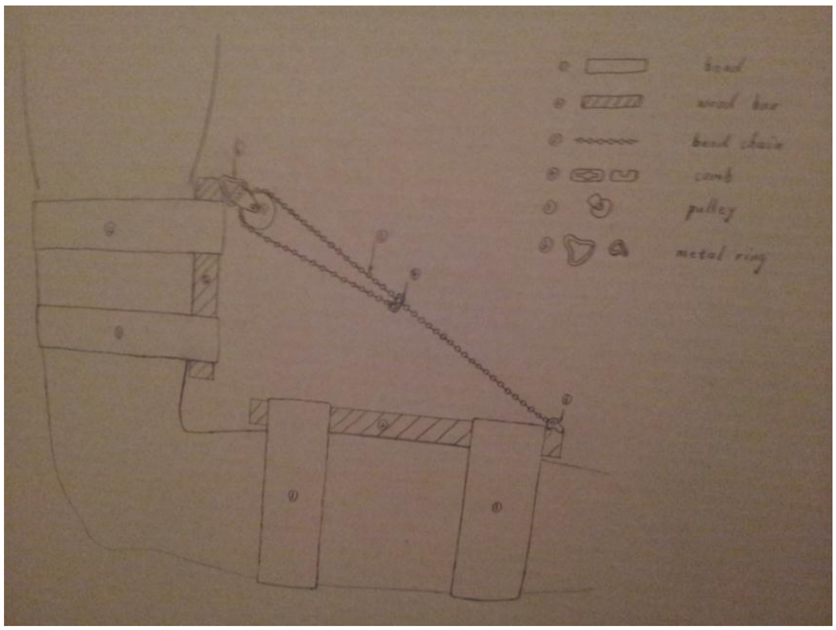
The device is molded to the arm to make it more comfortable to wear. The thermoplastic has a surprisingly soft surface, so it will not irritate the skin. The device is also lightweight, which will minimize strain on the shoulder of the user. The user will put it on by placing the upper arm cuff on his upper arm, then tightening the straps. The thermoplastic of the upper arm cuff has been molded so that it will stay on the arm without the user holding it in place, so his other hand is free to tighten the Velcro straps. The forearm cuff of the orthosis will then be put on through the same method. Once both cuffs have been put on, the user will use a table or something of the like to push his forearm against, which will adjust the angle of the elbow. Once he has the angle he wants, he will place the pin through the holes that align with that angle, thereby locking the device in place. The strap to help minimize the load on the shoulder will be put on after the device is locked in place. The user will want to wear this device, as it is a pain-free method of allowing for different degrees of flexion and extension in the forearm. Above all else, it works. The orthosis is minimalistic and will not draw much attention to itself.

Benefits

There are a number of benefits associated with this design. First, it fits over most clothes, so Mr. B could wear it during almost any point in the year. It is simple to make, and the components are all easily found. It is also easy for Mr. B to put on and use by himself.

Dynamic Elbow Orthosis

Team Name
F 0 3 - T 0 3 - 8



Problem Description

The problem presented involves our intended user, Mr. F. Mr. F. is a 29 year-old male who was burned in a house fire and has second and third degree burns on 20% of his body surface area. The regions of his body that were specifically affected are his face, arms and upper back. Mr. F. also suffered heterotrophic ossification and needed surgery to unfuse his elbow bones. Currently, Mr. F. is using a commercial elbow orthosis during his recovery and is experiencing many challenges.

This brings us to our intended client, Tara. Tara works at the Hamilton Hand Clinic helping patients during their recoveries from recent injuries. Tara works with many pantients just like Mr. F and believes there is a need for a better orthosis. Tara approached Dr. Fleisig and first-year engineers with the challenge of designing a new orthosis for Mr. F as well as future patient with similar challenges.

The ideal device must then be easily adjustable so that Mr. F can adjust the angle of flexion and extension despite his burnt hands and limited hand function. The device must also be comfortable for users with poor skin conditions, Mr. F, and most patients would like to maintain their independence while having to use the device. Therefore, it should be portable; it should allow the user to move around with it rather than be confined to a sitting position. The device must also be easily accessible as most alternatives are expensive and not usually covered by OHIP/Insurance. However, cost should not affect the quality of the device. The device must also be durable since most patients use these devices long-term. Keeping these considerations in mind, we came up with our own design for a dynamic elbow orthosis.

Design
The final design consists of two blocks of wood that are securely fastened to the arm by velcro straps. A pulley is screwed into the wood at the top of the wood held to the bicep and a bead chain is hot glued to the bottom of the wood held at the forearm. The bead chain is then threaded through the pulley and is cut to the length requested. Finally a comb is submitted between the beads in the bead chain to constrict the movement of the arm.

Functionality
The orthosis can restrict the extension of the arm. As well, the orthosis can keep the arm steady and in one place.

Materials, Components, and Assembly
The materials required are:
- Two thin pieces of wood to sit along the user's forearm
- One bead chain of optimal length
- One comb
- Hot glue gun
- Small Pulley
- One Screw
- Cloth to wrap the pieces of wood
- Velcro to strap the wood to the user
- Screwdriver

The list of instructions include:
1. Measure and cut the two pieces of wood to comfortable lengths on the forearm and the bicep.
2. On the piece of wood to be used on the bicep, screw a pulley on the top of the wood, closest to the shoulder.
3. On the piece of wood to be used on the forearm, hot glue the end of the bead chain to the top, closest to the hand.
4. Cut bead chain to preferred range of motions.
5. Loop chain through pulley
6. Insert part of comb in between two beads of the bead chain in order to lock in place.
7. Hot glue Velcro straps to the top and bottom of both the forearm and bicep pieces of wood.
8. Place each wood on the corresponding arm.
9. Strap Velcro to keep wood and arm in place.
10. Remove and adjust comb to desired length.
11. Pull on bead chain to increase flexion

Cost
The cost of the orthosis is around $20-30

User Acceptance and Compliance
The User is able to adjust this orthosis with the use of the bead chain, the pulley and the comb. The user removes the comb in the bead chain, adjust the length of the bead chain to a desirable extension and then insert the comb once again. The user can take the orthosis on and off with the use of velcro straps and can adjust to fit most comfortably on the arm.

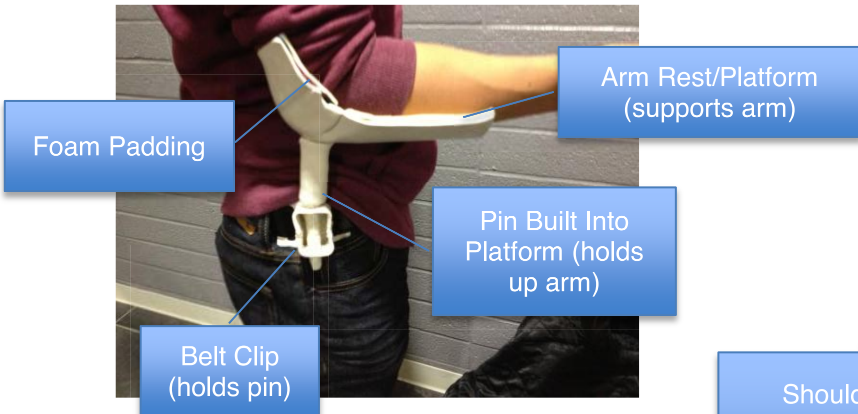
Our design can pose a few hazards to Mr. F due to his sensitive and delicate skin due to the extensive skin grafting. One of the ways our design deals with this is by being lightweight since that helps to reduce the force on the arm.

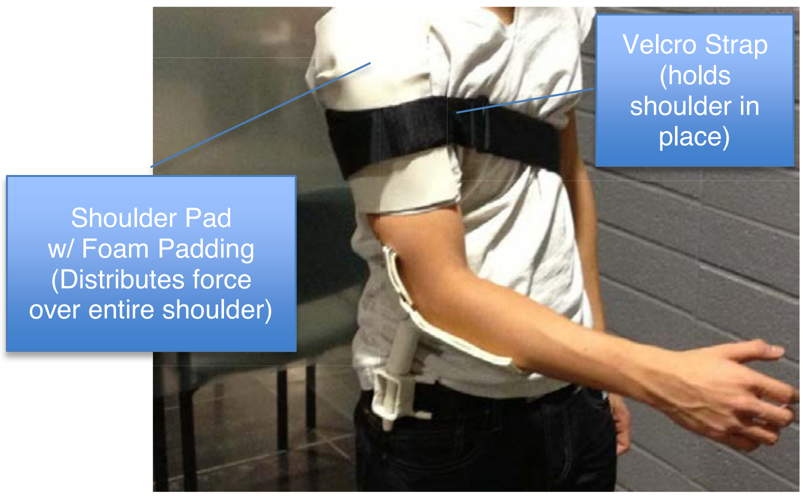
Benefits
The purpose of creating an orthosis was to create benefits over other designs. Our focus was for the orthosis to be easily used and made so that a clinic can make its design. The benefits of our orthosis include:
- Cheap – The price of the orthosis ranges between the price of $20-30.
- Supplies are easy to find. – Every piece of material used in the orthosis can be found at a local Canadian Tire and a Shopper's Drug Mart.
- Easy to Assemble – Tools used and instructions are user friendly
- Easy to Use – The orthosis is easily adjustable and easy to remove.

Semi Dynamic Elbow Orthosis

think smart engineering

Team Name
F03 – T03 – 9





Problem Description

The problem at hand involves Mr. B. who during a motorcycle accident, sustained injuries to his right wrist and shoulder. Mr. B. is unable to use his right arm from his shoulder to his hand due to damage to his Brachial Plexus. He is unable to use his hand and forearm unless his shoulder is locked back into its socket. As such, Mr. B. requires an orthosis that takes the load off of his shoulder while locking his shoulder in place to allow him to use his hand and forearm. As to not over constrain his forearm, the orthotic is required to allow for a great range of motion and rotation for his wrist and forearm. The hand clinic in charge of implementing the design would like the design to be inexpensive and easy to reproduce inside of the hand clinic.

Design

The design consists of a concaved platform fit to the shape of the users arm, a belt clip, and a shoulder strap also fit to the shape of the users shoulder. There is a pin on the platform that fits into a socket on the belt clip, which then acts as a hinge to allow for horizontal rotation of the platform. The platform is approximately 18cm long, 12.5 cm wide, and 9 cm in height, and is also very lightweight (1.5 kg approx.).

Functionality

The device is able to lock the users shoulder into place as to allow him to be able to use his hand and rotate his wrist and forearm. The device is lightweight and takes a lot of the load of the arm off of the shoulder as to prevent further injury to the user. The device allows the user to rotate his wrist and forearm as the platform is not very long. The platform rotates about the y axis approximately 30 degrees to allow the user to perform daily activities such as writing, using the computer, texting on the phone, etc.

Materials, Components, and Assembly

The orthosis is made almost entirely out of thermal plastic, along with foam padding for the arm rest and shoulder cup, and some Velcro straps. The finished product used a 18”x24” piece of thermal plastic, a foam floor mat obtained from a dollar store, and 6 feet of Velcro straps. To build the device, one requires a hot glue gun with glue sticks, a hot water bath to soften the thermal plastic, a construction knife to cut the thermal plastic, and a ruler. On the first construction of the device, expect the construction time to take around an hour, but as one becomes more familiar with the design process, the time could be reduced to around 30 minutes. The assembly of the device requires special instructions to create the orthosis and especially the belt clip which can be particularly difficult to construct without instruction.

Cost

Cost of materials:

- ½ of a 24”x36” sheet of thermal plastic (½ of $75.00 = $32.50)
- Foam floor mat: $2.00
- 2x3’ of Velcro straps: $10.00
- Glue sticks for glue gun: $1.00

Total Cost of materials: $45.50

Cost of Tools:

- Construction knife: $10.00
- Glue gun: $10.00

Total Cost of Tools: $20.00

User Acceptance and Compliance

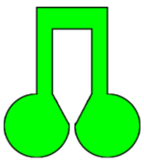
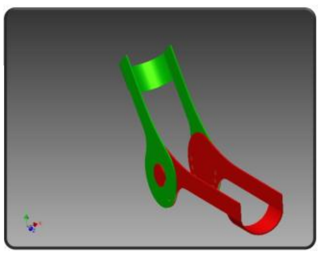
The device has been made such that putting on and taking off the device is very simple. The shoulder pad is fitted to the user’s shoulder and will cup and sit on the user’s arm comfortably. The Velcro straps make it very easy for the user to put on the device by themselves and using only one arm. The user can put on the shoulder pad by slipping their useable arm through the strap then lifting the strap over and around their head and placing the pad onto their shoulder then tightening the Velcro strap. The arm rest has foam padding and is very comfortable. The platform slides in and out of the belt clip easily which can be done with the useable arm. The user can then simply rest their arm on this platform and perform daily activities. The device is a very simple device with very few components, this allows the aesthetics of the device to appear very clean and presentable. The device will help to take much load off of the users shoulder which will help prevent further injury, the device is not overly constraining and will not cause discomfort or injury to the user while in use.

Benefits

The design is firstly very lightweight, which makes it very portable and easy to use and wear. The design takes the load of the arm off of the users shoulder which will allow the shoulder to heal and also prevents further injury. The user will be able to rotate and move their hand and forearm as freely as their injury allows them to, since the design does not hold onto the arm. The design allows a platform to aid the user in performing daily activities by stabilizing the arm. The cost of constructing the device is very low which will allow for clinics to produce the device in large amounts, and will be affordable for users. The device is fairly simple and easy to construct, which will allow the hand clinic to quickly put together the orthosis when needed. The use of thermal plastic allows the device to be fitted to all ranges of users and makes the design quite durable. The device is comfortable, easy to put on, and very supportive.

MEHDco. – "The Note"

Team Name
F 0 3 - T 0 4 - 2

Problem Description

This team has been formed to design and generate a prototype of an elbow orthosis device for Mr. F, a patient under the care of Tera Packham, an occupational therapist at Hamilton General's Hand Clinic. Mr. F is a burn victim who suffered a heterotrophic ossification in his left elbow (fusing of the elbow). The ossification has been surgically fixed and an orthosis device must now be created to ensure maximum range of motion. The design must meet several specific objectives, including being easy to put on, cause minimal irritation, and be easily adjusted.

Design

The orthosis is built up by two pieces of note-shaped thermoplastic, a lock system is attached in the middle and two straps are fixed at each end of thermoplastic. When the needed angle is reached, 4 holes line up on the same level, and user only need to plug in the rod, after which the device is fixed to a certain position. Because the orthosis is totally made out of thermoplastic, the total net weight of the whole device is relatively lighter compared to other metallic materials. It weights no more than 1 kg and its size can be adjusted suitable to user's arm by using the Velcro on each side. The lower part of the thermoplastic is 1/3 longer than the upper part which appeals to user's comfort. In conclusion, the device is fairly easy to use, very light to put on and properly shaped in a good size.

Functionality

The main function of MEHDco's orthosis design is to lock the arm at varying angles of flexion and extension. This is achieved by a pin and lock mechanism located on the circular hinge which connects the upper and lower arm supports. The angle of flexion and extension can be easily adjusted by removing the pin and inserting it into a different hole located on the hinge. In addition to locking the arm in flexion and extension, the device is also light and relatively inexpensive; both satisfy the requests made by the client. As well, the device minimizes contact with the patient, which, in Mr.'s case is beneficial due to his poor skin quality, thus reducing the risk of irritation. The device has two main contact areas, one located near the wrist and other on the upper arm. These contact areas are large enough so that there is no local pressure point but small enough so the majority of the patients arm is not in contact with the orthosis.

Materials, Components, and Assembly

The materials needed to build this device are thermoplastic, Velcro straps, adhesive, padding, screws and nuts. The tools needed include a compass set, scissors/box cutter, and a drill. All these materials can be obtained through a hardware store. The first step in the process is to take the length and circumference of the patient's arm. The basic outline that has been created is meant to be scaled to these measurements. A sheet of thermoplastic is cut out to the shape of this outline and then warped to fit around the patient's forearm. This is the lower half of the orthosis. The process is repeated again, albeit the length of the outline is meant to be shorter. This is the piece for the upper arm. Velcro straps are attached to the cuffs of the device via adhesives. Holes are then drilled through the 4 circles in the molds. The molds are then lined up according to the holes, with the upper arm piece wrapped around the lower, and attached via nuts and screws. The assembled device is then bent into the desired angle, and a hole is drilled through the 4 circles. In the case of Mr. F, padding was added to the straps and shell of the design to reduce the risk of injury and blistering. The estimated time required for assembly is 90-120 minutes.

Cost

The total cost of all the items necessary to recreate this orthosis is no greater than one hundred dollars.

User Acceptance and Compliance

One of the goals in designing the elbow orthosis was for it to be user-friendly. It has been designed such that it is simple to take on and off; however, to ensure that it performed as efficiently as possible, it had to be made in a way that would make it hard for Mr. F to apply and remove it by himself. Independence was hindered in favor of functionality. The device is applied by placing the forearm and the upper arm inside the plastic shell. Once resting inside, the device is fastened to the user's arms by way of Velcro straps. Taking into consideration Mr. F's injuries, padding was added to the straps to reduce the excess friction that would occur on his hands. The orthosis was designed to be used over long periods of time, and in doing so, it had to be comfortable. The thermoplastic shell already possessed a smooth surface, and any rough edges that occurred during the cutting process were evened out. Furthermore, Styrofoam padding was added to the inside of the shell, where the user would rest their arm. This is all in addition to the padded Velcro mentioned before. The device functions by allowing the arm to move into a desired position, and then locking it into that angle by bracing it with a support beam. In theory, the device can be locked in any angle; it is solely dependent on the material used as the beam. A thinner beam would allow increments of 5-10 degrees, whereas bulkier beams could be much more.

Benefits

The orthosis not only benefits the users, but also the client. Compare to the existing designs, the splint is lighter, easy to put on and take off for the users. It also has a wider range of motion that can be adjusted up to any necessary positions. The splint has less contact with the patient's skin than others, minimizing the risk of infection and blister. Another important thing is that the orthosis is cheaper for renting and even cheaper for purchasing. For the client, the design is easier to make which is almost entirely made of thermal plastic. And it is also simple to repair because of the concise assembly process. It will bring a brighter economic future for the clinic than other device, the orthosis is cheap to manufacture so that there is a wider space for deciding the market price.

Arm Assist- Elbow Orthosis

Bioteknics
F03-T04-4

Figure 1: Final Design shown on the arm of a user.

Problem Description

The Hamilton Hand Clinic has a patient named Mr. B that has recently been involved in a motorcycle accident. The patient suffered a brachial plexus injury to his right arm. Due to this injury, the patient has little working muscle at his shoulder and elbow. The Hand Clinic desires a device that would be able to work on active assisted range of motion by being able to lock in various positions. The device has to minimalize strain on the injured shoulder. The design should be independently usable by Mr. B and should allow for some movement of the wrist and hand. The cost of the device should also be minimized.

Design

This design consists of two thermoplastic braces, one along the forearm and one on the bicep. Each brace encircles half of the arm and is attached to the arm by Velcro straps. The two braces then each have a hinge that is attached by a zip-tie. The two hinges are connected by a screw, nut, and some washers, and this connects the two braces. The forearm cuff has a piece of nylon strapping sewed on to the end near the wrist. This nylon strap then goes up around the neck and down the left side of the body. This acts as a sling for holding the arm up. The strap passes through a backpack strap that rests on the neck. On the bicep cuff, a third piece of thermoplastic is melted on top of the first so that there is a thin gap in between the two. A second nylon strap passes through this gap and encircles the torso. This nylon strap passes through a backpack buckle so that it is adjustable by the user.

Functionality

This design successfully completes the required functions. Being able to lock the arm at different angles was accomplished by having an adjustable sling and by having the braces connected by the hinges. The sling can be pulled or released on the left side of the user's body to the desired length. This will either pull the right arm further upwards or let it rest lower. The back-pack strap on the sling provides padding to reduce the friction on the neck when pulling the sling. The hinges that connect the two braces can be locked in place by tightening the nut between them or allowed to move by loosening this nut. When locked, the hinges will prevent any movement of the elbow. The sling also works to keep the weight of the arm off of the injured shoulder by spreading some of the load across the neck. The torso strap also helps to distribute some of the weight across the body. The forearm cuff is loosely fitted which allows for some rotation of the wrist. The hand is also free to move for this design. This orthosis also allows for independent use. One is able to put on the device with one hand if there is a place to rest the injured arm while doing this. One can also adjust the angle of the hinges and strap with one hand.

Materials, Components, and Assembly

The list of materials required for this design is fairly short. It consists of thermoplastic, screws, nuts, washers, Velcro straps, two nylon straps, a backpack buckle, superglue, two hinges, a backpack strap, zip-ties, and thread. The entire design consists of two thermoplastic braces, a cross-neck sling, and a torso strap. All of the materials can be obtained by visiting a local hardware store along with a dollar store. The only tools required for construction are a screwdriver, a lighter, a kettle, scissors, and pliers. Total construction time would take between one and two hours. Construction of this brace does require some simple instructions. Two thermoplastic braces first need to be made for the forearm and bicep. Each brace should encircle approximately half of the arm. Each brace then requires a hinge to be attached by passing zip-ties through the holes in the thermoplastic. The two hinges from each brace are then connected with a screw, washers, and a nut. One nylon strap is then sowed on to the forearm cuff and fitted through the backpack strap.

Cost

The total cost of the materials not including thermoplastic was approximately $15. The amount of thermoplastic used would probably cost about $15. This would bring the entire cost of the device to around $25.

User Acceptance and Compliance

User compliance has been taken into account for this design. The user is able to put on the elbow orthosis with only one hand, although a table would be required to rest the injured arm on. The braces on the forearm and bicep have been made to fit fairly loosely on the arm. This reduces irritation with the thermoplastic on the arm. This design also includes a neck strap to reduce irritation between the sling and the neck. The user can change the angle at which the arm rests by loosening the hinges and then pulling or releasing the sling. This will either raise or drop the arm. Cosmetically, this design is very flexible. Many aspects of it can be changed to fit the specific user. Nylon straps come in a variety of colours as does the thermoplastic. The design can be worn either over or under clothes because it is not skin tight. This design encourages the user to use it consistently because it is easy to get on, easy to adjust, and is customizable cosmetically.

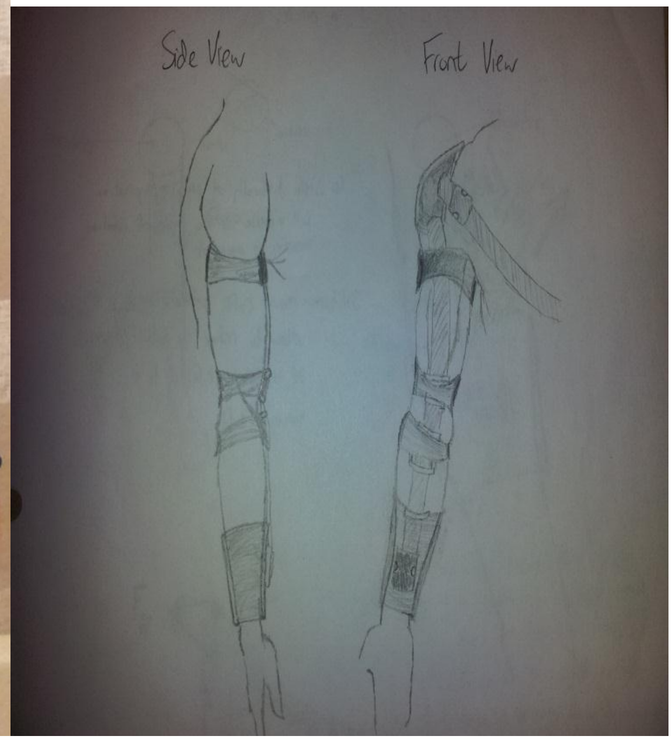
Benefits

One benefit of this design is that it holds the arm close to the body. This reduces stress on the shoulder and protects the right elbow. It is also easily adjustable to different angles and does not have pre-set angles that the brace must lock in to. This design also takes into account the fact that Mr. B does have some movement in his wrist. Because the braces are looser fitting, it allows for some rotation of the wrist.

Mr. B

Advanced ARM Orthosis

F03-T04-5



Problem Description

The user is Mr. B, who was injured in a motorcycle accident. His injuries include compound fracture, and brachial plexus injury. He can move his wrist and fingers; however, there is very little working muscle at the shoulder and none at the elbow. There are several requirements for his device. First, he must to be able to lock elbow device at various positions to allow a range of flexion and extension of the elbow, and it should allow him to pronate and supinate his wrist. Also, it should support the weight of both itself and the arm. He hopes to work on active assisted ROM with the brace on awaiting trial; the design should be permitted in general population if he is incarcerated.

Design

The device needed to allow wrist supination and pronation while still applying force to the forearm to cause flexion. To solve this, a forearm cuff was placed between the wrist and the elbow, allowing wrist pronation and supination. The design includes a shoulder pad attached to the main tension that lifts up the forearm for flexion, and another strap that goes around the torso under the opposite arm. The design used the force of tension to help support the shoulder. It has only one moving part and is very durable, and is simple to manufacture due to the lack of glues or adhesives.

Functionality

The elbow splint allows the user adjust his elbow at various positions and is of very simple design, which requires very few parts; it incorporates the use of straps and cuffs to achieve functionality. The combination of the device's minimalistic design and the use of lightweight materials allows for a finished product that would be comfortable for a patient with a subluxed shoulder. Due to minimal components and simplicity of the components used, the device is also quite inexpensive. The device allows but does not actively aid in supination and pronation.

Materials, Components, Assembly

The materials needed were Velcro, backpack straps (1), adjustable straps (3), camera case cover (2), plastic buckles (clip (2) male/female, adjustable (2)). The tools needed are needle, thread, scissors, and a ruler. Estimated completion time is under 3 hours. Some special instructions are to accurately measure the angle that correctly opposes the tension force from the forearm that attaches to the shoulder, and the attachment of the adjustable buckle to the forearm cuff must be able to withstand a force of approximately 15N of force.

Cost

The device is relatively inexpensive. In total the design cost under $10 to construct. The shoulder cuff was used from a $1.50 camera carrying case, and several of the buckles on the case were utilized in our design. The forearm and bicep cuffs were made from $4 backpack straps. The Velcro straps that are used for adjustment of the cuffs were purchased for $1.50.

User Acceptance and Compliance

The user should be able to remove and put on the device without difficulty. This has been allowed by the use of simple straps and plastic clips, which are easy to adjust. The level of comfort has also been a major consideration throughout the design process. The device is made out of light, simple straps and pads and lining was added wherever the device came into contact with the arm to ensure there was minimal chafing of the skin. The amount of contact that the device has with the skin has also been minimized so that it is not unnecessarily hot. It is used by fastening the cuffs to the on the arm, then putting on the shoulder support and adjusting straps as needed. The device is of uniform colour, and it is not bulky or unwieldy to enhance aesthetics. The device can be worn under clothing.

Benefits

This design is superior to existing solutions currently on the market because it was tailored to specifically suit the user's unique problem, which were not all solved by these existing devices.

Silicone Based Elbow Orthosis

Vector Engineering

F03 –T04 – 6

PROBLEM DESCRIPTION

The problem presented to our team by the client, the Hamilton Hand clinic is to build an elbow orthosis. This device should enable the user to increase their range of motion (ROM), help the user to lock their elbow at different positions and assist in the rehabilitation of the injured and adjacent muscles. Overall, the device should facilitate the user in their daily activities. The device is based on the needs of a client of the Hamilton hand clinic, Mr.B, who was involved in an accident. In addition to a dislocated shoulder, he has a compound fracture of the wrist and damage to the brachial plexus, tendons and nerves. Mr.B has great difficulty in using his elbow, and cannot subject his shoulder to even minimal weight due to the dislocation. Furthermore Mr. B, may be incarcerated so the device must comply with Ontario Provincial Penitentiary regulations, namely that it cannot be weaponized. These aspects have been taken into consideration as well as the design team's goal to generalize the design to suit a larger population. As such the final design should also be low cost and have a high degree of ease of use.

DESIGN

The Silicone Orthotic device employs a design that is versatile and has a strong emphasis on user compliance and functionality. This design is light weight, approximately 2.5 lbs, flexible and compact for easy storage and durable allowing the device to endure unusually large forces acting on it. As can be seen from figure 6, the design involves two independent pieces, or shells for the upper arm and the forearm that can easily adapt to arms of varying sizes. These two shells are about 1-1.5cm in thickness, adding in total a maximum of 3 cm to the average diameter of the covered portions of the arm when worn, as in figures 1-5. In addition to being lightweight as previously mentioned, the design also enables a support to be worn on either shoulder as shown in figures 4 and 5. Figures 1-3 illustrate the device locking the elbow in different positions with the use of a high tensile elastic on different attachment points embedded into the shells.

FUNCTIONALITY

This design was originally intended to suit the needs of Mr. B but ultimately expanded to incorporate additional functions that also serve a larger population. First and foremost the device allows the user to extend their range of motion (ROM), enables the user to lock the elbow in different positions and rehabilitates and stimulates muscles through the light resistance elasticity of the locking mechanism. The secondary functions include the orthosis allowing the user to supinate and pronate, in other words rotate their forearm with full ROM and displacing the weight of the arm and the device to the rest of the body.

MATERIALS, COMPONENTS AND ASSEMBLY

Construction of the device is easy, quick and simple in nature. Assembly is largely incorporated into the construction phase as all components are embedded into the liquid silicone as it sets and solidifies. In short the construction process begins with the chosen underlay fabric for the on-skin contact to be used as the base from which the rest of process starts. The first layer of the semi-liquid silicone is placed on top of the underlay and all components are embedded within this layer. These components include the points of attachment for the elastic joining both upper arm and forearm shells, supports for rigidity and Velcro straps for ease of use. A second and final layer is placed on top and the entire device is left to set. This assembly process is carried out to construct two shells, one for the upper arm and the other for the forearm. The whole construction process takes about 30-45 minutes and the silicone is left to set overnight.

COST

While the design may be very efficient in accomplishing its intended functions and more, it is also very cost efficient to the client to produce and to the user to purchase. The prototype for example had the majority of construction costs lie in the silicone itself, which may be purchased from hardware stores in 300ml tubes for $9 each, the remaining materials were obtained each for under $3. In total the prototype cost roughly $30 to construct which puts an estimate on a professional device based on this design at approximately $35-$50.

USER ACCEPTANCE AND COMPLIANCE

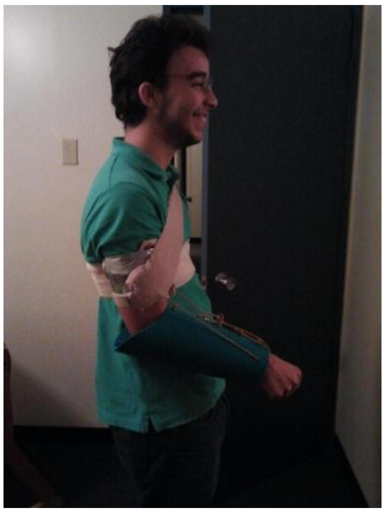
While a design may be very effective and efficient in fulfilling its intended purpose and functions, its success, is ultimately based on the compliance that the user has towards the design. The design provides maximum comfort and minimum weight and size to prevent it from getting in the way of daily activities which it is also able to assist. Ease of access and independence of use eliminates reliance on others. Putting on the device starts with the support placed over the opposite shoulder. The upper arm shell attached to the support is then tightened in place. The high tensile elastic attaches the upper arm shell to the forearm shell, which is tightened into position using the Velcro straps. The fabric underlay provides smooth and irritation-free contact with the skin increasing comfort in using the device. In addition to these methods of increasing user compliance and as a result use, an aesthetic appeal may also have a similar effect as personalization is taken into consideration. The external silicone can be molded into various designs and shapes as desired by the user. Furthermore the colour of the device may be changed by adding a dye to the liquid silicone before it is used in constructing the device. The aesthetics play a strong role compliance especially for users that are children.

BENEFITS

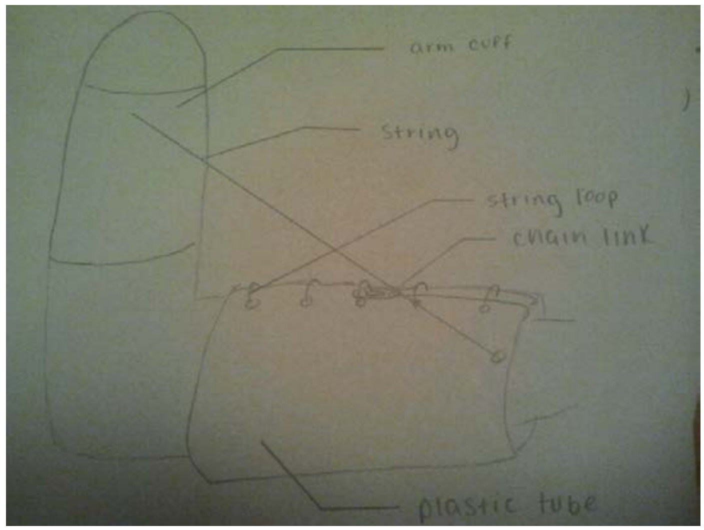
The silicone based orthotic device is based on a design that is entirely unique and effective in its purpose and function. While this design shares many functions similar to its competitors, it also possesses qualities about it that make it unique on the market. The user requires minimum assistance in putting on or taking off the device while its adaptability allows it to fit a wide variety of arm sizes all due to the easy access Velcro straps. The use of soft materials not only prevents it from being weaponized but allows the device to be used by children and the mentally disabled. In addition the very properties of silicone makes the device very flexible, strong and durable. Lastly the construction process can be applied to construct orthoses pertaining to any other joint as well as various other medical and physiotherapeutic devices.

Proposal for the Elbow Orthosis for Mr. B

inS.A.N.E Engineering Design
F 03 - T 04 - 7



Elbow Orthosis Prototype



Toilet Brush and Holder

Problem Description

Our client ,Tara Packham, is an Occupational Therapist of the Hand Therapy Clinic at the Hamilton Health Sciences Centre. She has received a patient who has endured a painful accident in the form of a motorcycle crash. The 23 year old patient, Mr. B, has a compound fracture, a degloved wrist, along with nerve (brachial plexus) and tendon lacerations. Due to these injuries, Mr. B cannot perform his day to day activities. Thus, the clinic requires a device that will support his elbow, angle the elbow, not strain his shoulder, and enable forearm rotation. Such a device would ideally be applicable with other elbow injuries as well as being accessible and comfortable.

Design
The elbow orthosis designed by our team is composed of a light tube covering the forearm. This tube is covered in a blue coloured cloth to make it more aesthetically pleasing. A string, wrapped around a soft cuff around the bicep, possesses a hook which connects to the various loops attached to the tube. Tensor bandages are then wrapped around the torso and shoulder. The entire elbow orthosis is relatively lightweight and is the width of Mr. B's forearm.

Functionality
The elbow orthosis performs various functions requested by the client, Tara Packham. The orthosis supports the elbow by cradling it via the use of the plastic tube. The elbow is also able to be angled as well as held in place through the use of the hook and loop string system. This system works by altering the string length to prevent the elbow from falling, thus angling it. The circular tube allows the patient to rotate his forearm whilst still supporting and angling the elbow. A tensor bandage wrapped around the shoulder is connected to the arm and prevents unwanted strain on the patient's shoulder. Soft cloth and cuffs will provide comfort to the patient despite his various injuries. The orthosis, however, cannot meet every requirement requested by the client. The string may potentially be banned from the prison if Mr. B does get incarcerated and the tensor bandage around the body is also quite difficult for Mr. B to put on independently.

Materials, Components, and Assembly
The materials required for the orthosis include a plastic tube, tensor bandages, two chain links, shoelace, Velcro, tape and cloth. The plastic tube in this instance was built from a toilet brush holder. The majority of the components were purchased at a local drugstore (Shopper's Drug Mart) while the Velcro and chain links were purchased from a local hardware store (Home Hardware). Tools used in the construction of the orthosis were a saw, a knife with a sharp edge, scissors and a lighter. The orthosis was assembled in less than 2 hours, and can be assembled in a few easy steps. First, the bottom of the tube was cut off using the saw. Holes were punctured into the top of the tube using the sharp knife and around 2 inches of shoelace was threaded through. A lighter was used to seal the knots to ensure that they do not unravel. Next, a cloth in the form of a shirt sleeve covered the entire tube and was taped onto the inside. Holes were cut into the sleeve to allow access to the shoelace loops. A tensor bandage was fastened into an arm cuff and Velcro was used to allow it to be removed and assembled easily. Attached to this tensor bandage is a string with a chain link on it. This chain link is able to be attached to the loops on the tube in order to angle the elbow. A tensor bandage is wrapped around the body and there is another bandage wrapped around the shoulder.

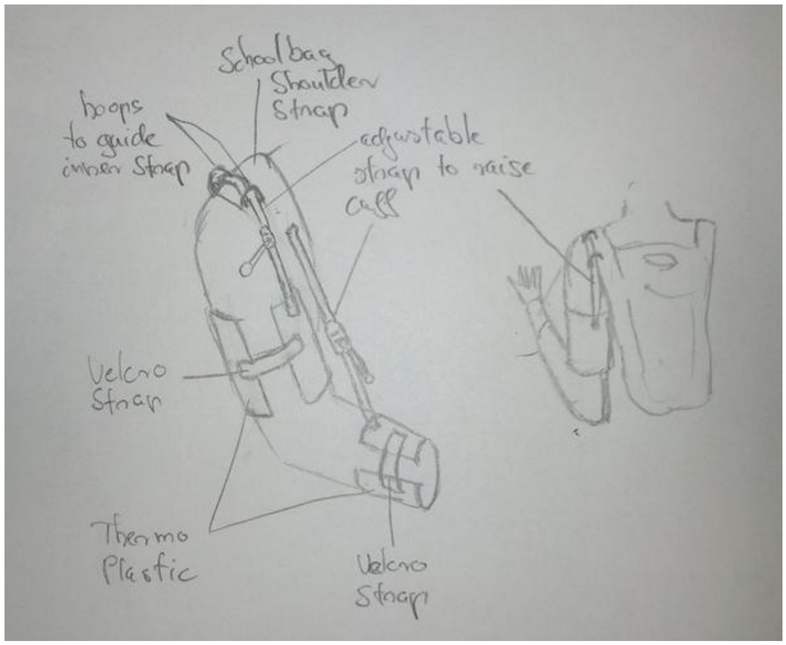
Cost
In total, the orthosis cost $50 dollars and was all bought at local stores. This meets the objective of a low cost orthosis as the majority of existing devices cost around $200. Our device will be beneficial to the clinic as well as Mr. B.

User Acceptance and Compliance
Although the device does not provide the user with the ability to put it on and off by himself, Comfort for Mr. B was one of our main priorities. The device is provides comfort by having no hard, rough materials in contact with his body. We believe that Mr. B would want to wear our device as it is functional, comfortable as well as being aesthetically pleasing. For cosmetic considerations, we have added colour to the device through the use of the sleeve and coloured shoelace. The device also looks very sleek and modern.

Benefits
Our design is beneficial to the user and the client because it satisfies the main objectives and functions such as supporting the elbow, allowing forearm rotation, angling the elbow and providing comfort. Other benefits include ease of adjustability, low cost, and its cosmetic appeal. The design can also be built at and by the clinic.

Backpack Elbow Orthosis

Envision Eng
F 03 - T 05 - 1



Problem Description

Tara Packham in the Hamilton General Hospital Hand Clinic has a patient named Mr. B who has very little working muscles in his shoulder and none in his elbow. His shoulder is also subluxed. Mr. B wants to be able to lock the orthosis at various positons so he can use his hands and also be able to rotate his forearm. The client wants the orthosis to be use-friendly, low cost and safe. Also, it is crucial that it reduces the load on his shoulder as to not damage it further.

Design

The orthosis is a very simple but effective splint-type design. It is lightweight, and most of the load is distributed to the user's back. It is not very big, but does have some bulk to the part on the back. The components attached to the arm, however, are quite limited and are not excessively large with respect to the arm. As seen in the sketch, there are two cuffs and a backpack component.

Functionality

The orthosis supports the weight of the shoulder and elbow, while allowing the elbow to be locked at a range of 30 to 120 degrees of flexion. Also, it allows the user to rotate the forearm freely (if capable) because the forearm cuff is not very tight. The orthosis can do everything that the client asked for.

Materials, Components, and Assembly

The materials required are a backpack, thread, two Velcro straps, and two small sheets of thermoplastic. Most of the materials can be obtained at the hand clinic, excluding the backpack which is easily purchased at any superstore. A needle may be required for sewing pieces in proper positions, such as the tensor bands and on the backpack itself. With the proper equipment, for example a sewing machine, the orthosis can be created within a few hours. Firstly, the cuffs made of thermoplastic must be molded to the user's bicep and forearm. Then the Velcro pieces must be sewed to the cuffs. Afterwards, the last components (hook of bag, adjustable strap and cuffs themselves) must be sewed to the backpack. Refer to annotated sketch for specific design.

Cost

For the clinic, the cost of producing the orthosis can vary from roughly \$20-\$60, depending on the backpack used. As for the user, we foresee the cost being somewhere between \$30-\$75, which also depends on the backpack used.

User Acceptance and Compliance

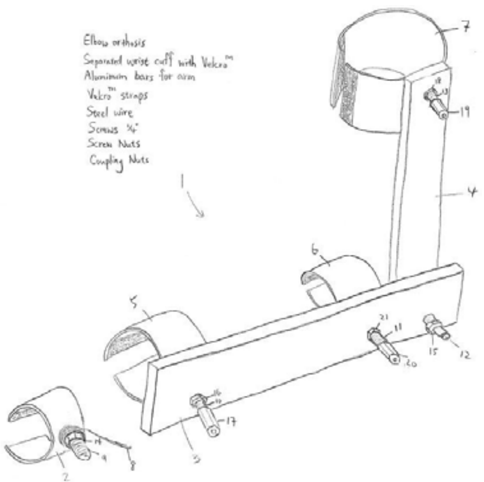
The user can put it on using his one good arm. Because of the backpack style, the orthosis is worn over clothing and he/she doesn't have to deal with the weight on the shoulder. This style also makes the design socially acceptable and not embarrassing to wear in public. The safety of the orthosis was considered. The design presents no hazards to the user or people surrounding.

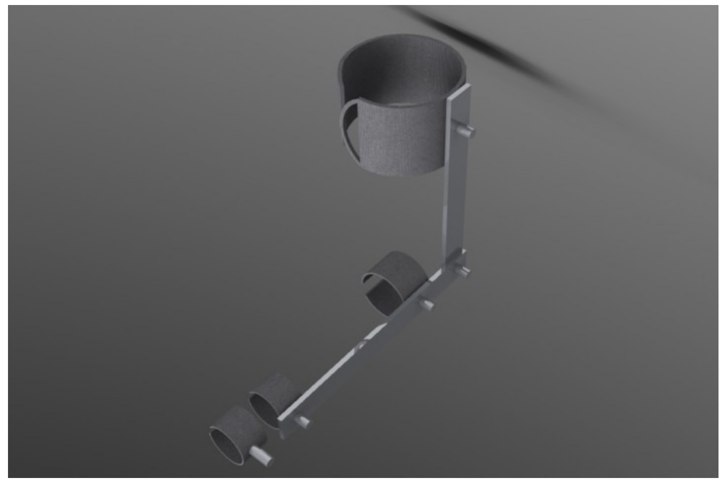
Benefits

This orthosis is very comfortable compared to some of the other's available today and is much less expensive. It also is socially accepted as mentioned above, is easy to adjust and still allows forearm rotation inside the cuff. Having all these characteristics in a design is quite difficult and remarkable. The user will definitely notice these benefits, especially if they have already tried using another orthosis in the same price range.

Elbow Orthosis For Mr. B

Professional Imagination
F 03 - T 05 - 2





Problem Description

Create a dynamic elbow orthosis that will be light-weight and inexpensive. The orthosis should be able to be locked in various positions and provide supination as well as pronation in order to allow Mr. B to move his arm to various positions that he so desires. The adjusting mechanism should be simple to use and the orthosis should not place any additional stress on his injured shoulder. It should be easy to put on/take off and should be constructed from materials that may be worn if he is incarcerated.

Design

The orthosis was designed with simplicity in mind. The result was a simple, lightweight and fully functional device. The cable, as seen in the sketch above, is used to essentially "tie everything together". It is used to lock everything in position. It is wrapped around the posts (reference sketch) and then the coupling nuts can be tightened to fasten it in place. The first prototype was manufactured using aluminium bar, nuts, bolts, Velcro straps, and aircraft wire. The aluminium bar was 1" wide and 1/8" thick. The forearm component runs almost the length of the forearm, starting at the elbow and stopping just before the wrist. The upper arm component goes from the users elbow to the upper bicep region. For actual dimensions, please see the Materials, Components and Assembly section below.

Functionality

The orthosis does not require any additional straps or supports. It is so light that it can be worn on the arm without placing any additional strain on the shoulder. The orthosis features the ability to use four ranges of motion; extension, flexion, pronation and supination. These ranges can be provided in conjunction with one another or used separately. The device can be fixed in various positions allowing the user to maximize use of the injured arm. The easy to use straps allow one to put on and take off the device thus allowing oneself to be independent; no additional assistance is required. The device was designed to be used even if incarcerated. It will feature plastic components, no sharp/jagged edges and will be metal-free. The device is capable of providing all of the functions that Mr. B desires.

Materials, Components, and Assembly

The prototype was made using the following: 24”x1”x1/8” Aluminium bar(x1),1 ½” x ¼”x 20 Bolts (x5), flat washers (x10), coupling nuts(x4), hex nuts(x6), 2” Velcro with D-rings (comes in 1.5m packs), 1” Velcro with D-rings (also sold in 1.5m packs)

Mr. B’s specific device would use plastic parts in place of the aluminium bar, steel washers, nuts and bolts.

All materials were purchased at Home Depot. The tools required to assemble the device are a handheld drill, ¼” drill bit, hacksaw, screwdriver and a nut driver or wrench. It can be built in less than two hours. The device is simple to assemble and does not require any special instructions.

Cost

The total cost of material was $41.00

User Acceptance and Compliance

The user has been considered in many ways throughout the design process. All objectives were met in order to satisfy the user’s needs. This will certainly weigh in to the user’s acceptance of the device. The user is able to take on and off the orthosis with ease. Mr. B can tighten the straps to a level that he feels comfortable. It is discrete in the sense that it is small and very simple; it will not draw any unwanted attention to the user. Although the device can not be worn underneath an article of clothing it can surely be worn on top of one. Cosmetics were not the primary objective however if you user so desires, certain aspects of the components can be changed such as shape or colour.

Benefits

This device provides all four ranges of motion; extension, flexion, pronation, supination. It is also much lighter than existing devices. The design is very simple and can be built by someone that does not have a lot of manufacturing expertise. It requires only a few relatively easy to use tools. If not being used, the device can easily be brought along in a purse or back-pack. It is made from strong materials and as a result it is very strong and durable. Finally, it can be put on, taken off and adjusted with only the use of one hand.

Prime Elbow Orthosis

The Third Option
F03 – T05 - 4

Problem Description

Our goal is to design a dynamic elbow orthotic that extends users arm yet fit comfortably on their arm. The orthotic must be built to easily harness and locked at multiple angles of extension without the assistance of a secondary party. Ideally, the device should not put an extra load on users shoulder to prevent further straining or injury of muscle tissues. The client constrains the design to be easily functional without the use of fingers because finger mobility and dexterity of the user is hugely restricted. In addition to limited mobility, the device must not possess any fine parts and requires larger and simpler parts that would be easier to use. The design must not be costly for the client, Tara Packham and the Clinic, to produce to reduce the cost for the user Mr. F.

Design

After much hard work and the testing of several alternative solutions, we have skillfully created a dynamic elbow orthosis. The design is unique and conforms to the client's wishes, with a simple and effective orthosis that will accommodate the user's needs. As seen in the photograph below, the orthosis runs from the back of the upper arm to just past the elbow and is parallel to the arm when it is fully extended. In terms of size, the orthosis is made with specific dimensions to fit the user and weighs approximately two kilograms. This is held in place by soft, comfortable fabric that will not irritate the user's overly sensitive skin. A cord with a significant degree of elasticity passes through the length of the device, and can be pulled and locked into place to maintain a constant extension at several varying positions. The body of the orthosis is made of a lightweight plastic material that will reduce any strain on the user's shoulder and thus adequately help in the patient's recovery.

Functionality

The Prime Elbow orthosis was designed to fulfill as many of the client's needs while keeping the design as simple as possible. The primary function of the orthosis is to help Mr. F regain the muscle ability to extend his arm 180 degrees. This is achieved in the design with a rope that applies a force on his wrist, pulling it away from his shoulders thus extending his arm. In terms of client requests, some were given up for the benefit of more important objectives. Comfort was kept at the top of the list of client requests since we user satisfaction is valuable to The Third Option. To keep user comfort, we limited all contact of the device on the forearm to only the wrist. The rest of the device is attached to the user's arm, wrapped around by a soft and puffy arm strap that gives maximum comfort during use.

Materials, Components, and Assembly

The wrist belt should be with a buckle, the nylon cord should be tight and coarse, the arm strap is made of nylon with the inside lined with cotton for comfort. The orthotic can be assembled with super glues and multi-
purpose ties. The plastic tube needs to be cut in half (vertically with the tube standing up) so it can be attached to the back of the orthosis (on the tricep).
There are two means to produce this kind of tub e, one is to cut a hollow tube with an ideal radius into halves, and
another is to make the tube out of thermoplastic materials. Holes will need to be put into the tube which will allow the user to adjust the angle by putting the hook from the cord into different holes.
The assembly of the orthosis is simple and needs no special instructions and can easily be built with basic tools such as scissors, x-acto knife, and a screw driver. Be cautious when cutting or drilling the holes with sharp tools.

Cost

The cost of the product to the clinic and user buying will be approximately in the price range of $50-$60. This is due to the circumstances of the labour and cost of materials to manufacture the product.

User Acceptance and Compliance

The compliance of the user has been considered through the Durability, Comfort, and Correct Function and Use of the product. As long as the user follows the instruction correctly the device will function flawlessly in aiding them. You must first open up all the straps and make sure your elbow has direct contact with the device by rolling up any sleeved clothing. Once your arm is in orthosis, close the straps tightly but no tight enough to restrict blood flow in the arm. Adjust the tension band to a desired angle to improve the range of motion to your liking. When you are finished using the device, locate a solid surface to dismantle the orthosis from your arm by opening the straps and slowly removing your arm away from the device. It's shaped to fit your arm as naturally as possible. There are pads to cushion the elbow, forearm and bicep. A tension band is used to change to angle of motion, in the case of prolonged use to prevent any stiffness in the arm. The orthosis has been designed and built to look and feel as small and natural as possible to the human arm. Our objectives have been met with a prototype which anyone with elbow problems can use. The safety of the design has been considered through the durability of the device and with device being shaped to fit the user.

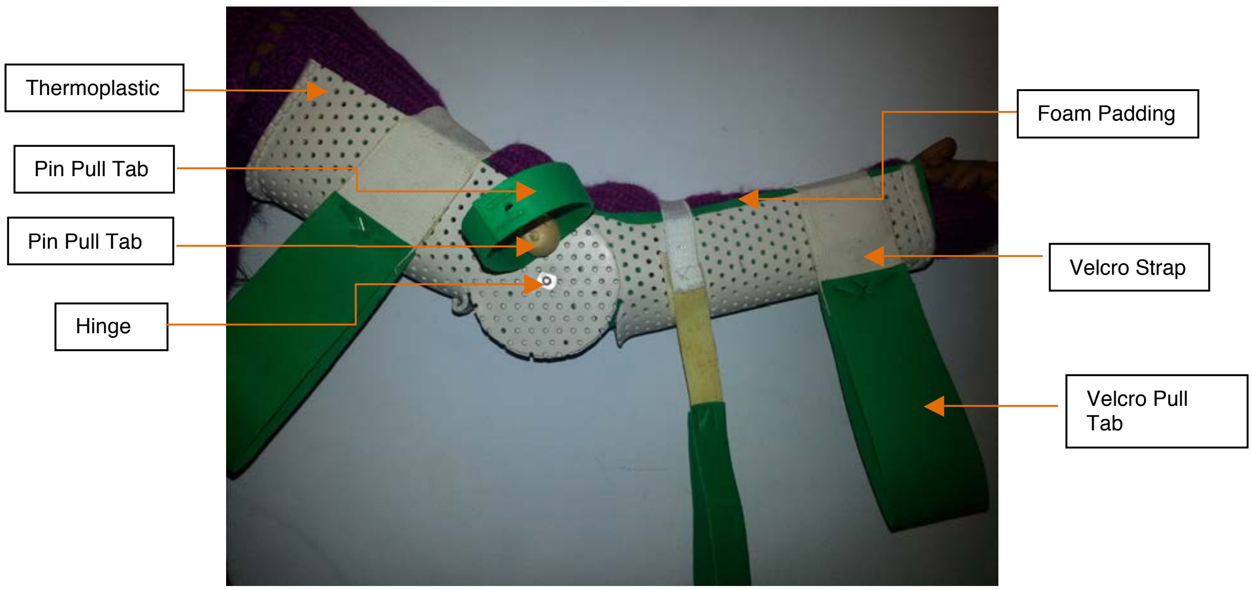
Benefits

Our elbow orthosis design is definitely much simpler and more efficient compared to other elbow othosis designs on the market. The current elbow orthosis products consist of complicated adjustment mechanisms and expensive material whereas the Prime Elbow Orthosis only consists of a comfortable arm strap, plastic tube, heavy duty string and a wrist strap. Although other designs provide more functionality, our design provides simplicity and efficient of materials.

Super Splint 3000

RED

Rehabilitation Engineering Design
F 03 - T 05 – 5



Problem Description

Client is Tara Peckham, an occupational therapist in the hand clinic at Hamilton General Hospital. Ms. Peckham wants an elbow orthosis for Mr. F that will work to improve the range of motion at the elbow as part of the rehabilitation process due to the injuries sustained in a house fire. In addition the orthosis should maintain the elbow at end range, should not promote blisters or infections and should be able to be used independently despite limited hand function.

Design

The Super Splint 3000 is primarily thermoplastic which accounts for most of the weight. The orthosis weighs 1lbs. It is composed of two pieces; a biceps component and a forearm component each molded to the size of the user's arm. At the elbow end of the forearm and biceps components the thermoplastic is shaped into discs. The discs overlap one another and are joined by a screw through the center of each disc that acts as a hinge, and therefore the forearm and biceps components can rotate around the screw. Super Splint 3000 covers the entire arm from wrist to the upper biceps. All edges are rounded or rubbed down. The components are held at the desired angle to each other by aligning the correct holes then pushing the locking pin through. A pull tab is attached to the locking pin. Each component is fit with foam padding that can be removed by separating the Velcro holding it in place. Three Velcro straps (two for forearm and one for biceps) secure the orthosis to the arm. Pull tabs are added to each strap.

Functionality

Super Splint 3000 can hold Mr. F's arm at various angles from full extension to full flexion.

The angles are achieved by a series of holes in the disk of the forearm component. Lining up the hole (corresponding to the desired angle) with the single hole in the biceps component and inserting the locking pin will hold the angle. Therefore it can facilitate in stretching and strengthening the muscles, ligaments and tendons about the elbow which is the requested function of the elbow orthosis.

Materials, Components, and Assembly

The materials required include thermoplastic, foam sheet, dowel, wooden doll heads, Velcro and screws. The OT clinic already has thermoplastic, the specific screws used are from a hockey helmet and the rest of the materials can be obtained from Michaels Arts and Crafts store. The tools used include scissors, X-acto knife, super glue, stapler and a power drill. Time of construction should take no more than 2 hours.

Special Assembly Instructions
Locking Pin:

1. Use dowel with same diameter as the hole that runs through the wooden doll head.
2. Cut desired length of dowel keeping in mind the length that will go into the doll head and leaving enough to penetrate through angle holes.
3. Add glue to side of dowel that will go into dowel head and push dowel through

Thermoplastic Cut Out:

A specialty cut out for the thermoplastic is required because of the discs at the elbow end of each piece. Though it is not a complex shape a provided visual and instruction list will significantly reduce the amount of time required to make the cut out.

Cost

Super Splint 3000 will cost the clinic approximately $20 plus the cost of thermoplastic to make. This figure omits the thermoplastic because the price of the thermoplastic used for the prototype is not the same as what it costs the OT clinic for its thermoplastics.

User Acceptance and Compliance

The factors considered to improve compliance are the level of comfort, ease of use and the aesthetics of the Super Splint 3000. Comfort is improved by providing an orthosis capable of being molded to the size of Mr. F's arm for ideal fit and adding a foam lining and rounding the edges to prevent injury. The pull tabs on the Velcro make it easier for Mr. F to put on and take off the orthosis. The pull tab on the locking pin also makes it easier to remove it. Additionally the locking pins are given enlarged heads making it easier to insert and lock the orthosis. Putting the Super Splint 3000 on can be done independently with the use of a supportive surface. First the desired angle should be set then Mr. F can insert his arm into the Super Splint 3000 and strap it up. Compared to other elbow braces it is just as cosmetically pleasing. Though the brace covers the entire arm and has over sized pull tabs, it is light and has very few parts providing a sleek look. Mr. F should have no problem wearing the Super Splint 3000.

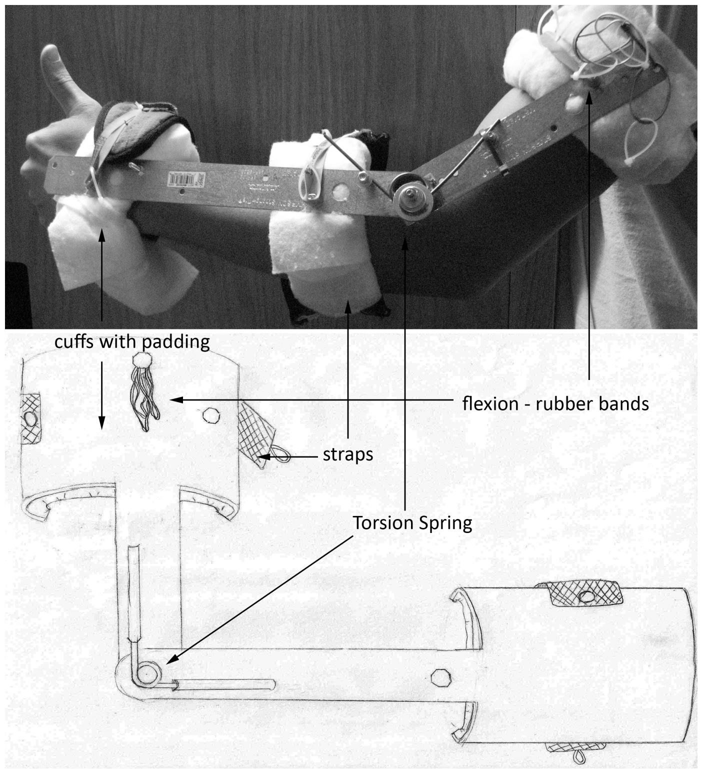
Benefits

The cost of the Super Splint 3000 is much lower than the price of commercial splints. The foam inner padding is removable and washable so it maintains hygiene and prevents infections. It covers a large surface area of the arm (compared to cuffs) which reduces the pressure in one area and spreads it out over the entire arm preventing blisters. The Super Splint 3000 is strong enough to maintain end range even with swelling because of the durability of the thermoplastic and strength of the locking pins. It has large pull tabs and locking pins which makes putting on, taking off and changing the angle of the orthosis easy despite limited hand function.

The biggest benefit of the Super Splint 3000 is its ease for the client to manufacture. It is primarily made out of thermoplastic which the OT clinic already has available and the rest of the materials are available at any arts and crafts store.

Torthosis

Team Something Cool
F03- T05 -6



Problem Description

An Elbow Orthosis device needs to be designed for the Hamilton Hand Therapy Clinic. Mr. F, a burn victim, is having difficulties with the current devices. They are hard to put on and take off without external help and cause blistering and swelling. The device should apply enough force to flex and extend the arm. Mr. F's current range of motion is between 30 and 130 degrees. The device must be designed in such a way that the clinic can build it. It should be inexpensive and visually appealing, while minimizing degree of discomfort.

Design

The Torthosis Device is named after the torsion spring used to accomplish one of the main functions. It weighs an estimated 1.5-2lb and it extends from the forearm (close to the wrist) to the top of the bicep. It is comprised of two Thermoplastic frames attached at the elbow by a bolt. The torsion spring is at the bolt and there are two cuffs, one on each frame so the device can attach firmly to the patient's arm.

Functionality

The device can apply force to keep the arm at end range (flexion or extension). This is accomplished using a torsion spring for extension and rubber bands for flexion. The cuffs cover large surface area and can be moulded to avoid burns on the patient's arm. The cuffs are also covered with padding to minimize discomfort. The Torthosis device is easy to put on and remove, as it does not use Velcro straps but rubber bands fasten to the arm. In addition the device is easy to build and it uses easily accessible materials.

Materials, Components, and Assembly

The required materials for the device are about 12”x8” thermoplastic sheet, 5 sets of small bolts, nuts and washers, Large bolt with a nut and a washer, zip-ties and rubber bands. A torsion spring (180 degrees right hand wound, 0.115” wire diameter, 4” leg length, 1.348” spring outer diameter. Or similar can be bought from Mcmaster-carr or any other industrial supplier.). Padding of choice can be added to the thermoplastic, as the clinic sees fit, to better accommodate Mr.F’s sensitive skin.
Tools required are all available to the clinic. They include: Heater gun (available at clinic), small adjustable wrench ($1 from dollar store), sewing supplies/glue (both available at the clinic).
Construction may take up to 30minutes and assembly instructions are included in the final report.

Cost

~$30 – 12”x8” thermoplastic sheet
~$10 – Torsion spring (including shipping and duty if ordered from Mcmaster-carr)
~$2 – zip-ties and rubber bands (if not found in the clinic)
~$6 – nuts and bolts (found at any hardware store or in the clinic)
~$5-10 – padding (kitchen sponges, foam or anything that the clinic chooses)

Total Cost: under $55
*most likely much less since the clinic can provide a lot of the materials at lower cost than what was available to our team.

User Acceptance and Compliance

Although the main focus of this device is to rehabilitate Mr.F, user compliance has been considered in a number of ways. Torthosis is designed in such a way that it can be taken on and off by the patient (rubber bands instead of Velcro) without external aid. It is made of thermoplastic, so its appearance is less crude compared to devices made out of metal. In addition thermoplastic allows the clinic to mould the device to the shape of Mr. F’s arm, then add the padding which results in a very comfortable fit, effectively reducing the amount of bruising and swelling (as caused by commercial elbow orthosis). Almost all of the objectives have been met, aside from being able to wear the device under clothes, which contradicted with many other objectives.
The device is safe and it poses no harm to the patient or people around him. There are no parts that stick out and it is not possible to alter the device so it can cause injury to the user. Instructions along with visuals are included in the final report.

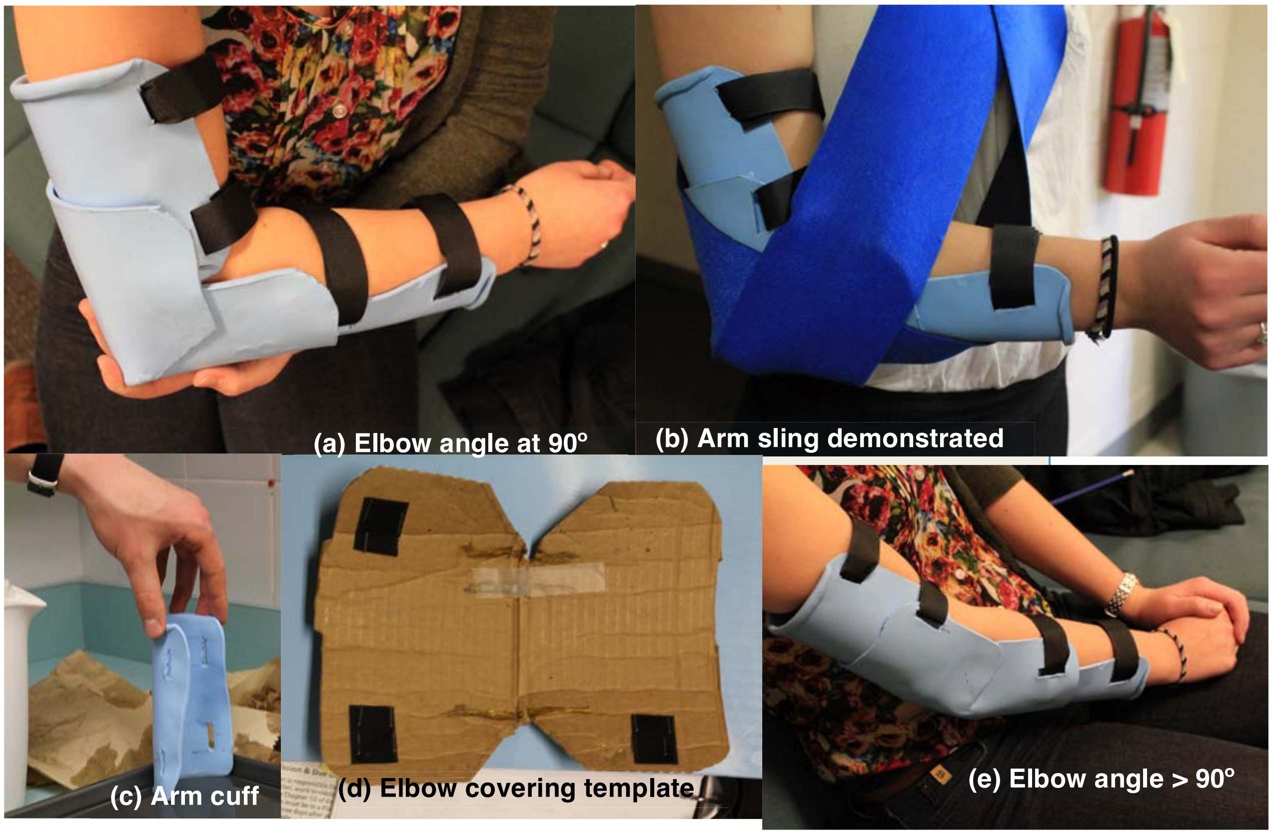
Benefits

Ease of use – as outlined in user compliance, the device uses rubber bands which make it easy to fasten and open the cuffs, therefore the patient can use the device without external help.
Cost – the device costs around $50, which enables most patients to get the treatment that they need (since medical insurance does not cover elbow orthosis).
In addition, many of the parts can be reused (bolts, thermoplastic and spring), which further decreases the cost to the clinic and the patient.
Weight/Degree of discomfort – the device is light and it uses large surface area to make contact with the skin (avoiding burns), which eliminates the problems Mr. F was having with commercial devices. Torthosis is a dynamic elbow orthosis, which doesn’t require the patient to apply a lot of force and lock his arm at a specific position (the constant force applied by the spring keeps his arm at end range throughout the therapy session)
Customization – the clinic can alter the shape of the device and choose the padding in order to better meet a patient’s individual needs.
Different torsion springs can be chosen for different ranges of motion (90 deg, 120 deg, 180 deg or 270 deg) in order to apply the appropriate force.
Assembly – Torthosis was designed with ‘how it will be built’ in mind. The assembly process is simple and it does not require special tools or materials, yet it provides the same rehabilitation strength, durability and reliability as commercial devices.

ELO 5000

SYNERGY

F03 – T06 – 3


(a) Elbow angle at 90°
(b) Arm sling demonstrated
(c) Arm cuff
(d) Elbow covering template
(e) Elbow angle > 90°

Problem Description

Tara Packham introduced Mr. B, one of her patients at Hamilton General Hospital, to the Engineering Class of 2016 in a 1P03 lecture. Mr. B is a 23- year-old single male who recently injured himself in a traumatic motorcycle accident. He suffered from a compound fracture in his right arm and de-gloving of his wrist along with multiple lacerations of his tendons and nerves. Mr. B now seeks a dynamic elbow orthosis to supplement his daily activities. The ELO 5000 should enable sufficient range of motion of the arm through flexion and extension with locking capabilities in various angular positions; be easily adjustable and comfortable; and be inexpensive in its manufacturing and maintenance costs.

Design

ELO 5000 is comprised of two thermoplastic arm cuffs (one on the biceps and the other on the forearm), an elbow covering, and an arm sling. The arm cuffs are attached to the elbow covering with 2 Velcro straps. There are 2 more Velcro straps securing the arm cuffs in place. The arm sling is made from neoprene, which is commonly used in orthopedic braces. The arm sling is strapped around the uninjured shoulder to reduce pain and discomfort. ELO 5000 is approximately 2 lbs and spans from above the wrist to halfway down the biceps.

Functionality

ELO 5000 immobilizes the elbow, reduces the weight of the injured arm, and allows for full pronation but limited supination of the forearm. It also locks the degree of flexion and extension at various angles. It does not limit usage of the hand and fingers. However, it is not fully suitable for the penitentiary because it can be potentially turned into a weapon.

Materials, Components, and Assembly

ELO 5000 is made of thermoplastic, Velcro, and neoprene. Everything can be obtained at the Hand Clinic at Hamilton General Hospital. The thermoplastic is used to create the arm cuffs and the elbow covering, the Velcro is necessary for fastening one component to the other, and the neoprene is used for the arm sling. A substitute material for the neoprene can be used if not readily available, such as a breathable cotton cloth.

To create the thermoplastic components of the ELO 5000, the following tools or equipment should be gathered: a utility knife, a heat-resistant pan, a spatula, a kettle, paper towels, pens, and scissors. It takes approximately one hour to construct the ELO 5000.

1. Use paper towel templates by placing them on the area of the arm to be traced with a pen. Mark where the Velcro straps should go through. Place the thermoplastic sheets in the pan and mold them accordingly to the shape of the biceps and forearm. Cut out the rectangular pieces for the Velcro straps while the thermoplastic is still warm.

2. Repeat step 1 to create the elbow covering using an optional elbow cut-out provided in Figure d.

3. Thread the Velcro straps through the holes in the thermoplastic arm cuffs and elbow covering to attach the components.

4. Position the arm sling by wrapping it around the elbow orthosis and across to the uninjured shoulder and around the back (Figure b). There is another strap in the front that further supports the weight of the arm.

Cost

$64.00 Thermoplastic sheet (18” x 24”)
+ $4.54 Velcro straps
+ $7.98 Arm sling

$76.52 Total Cost

User Acceptance and Compliance

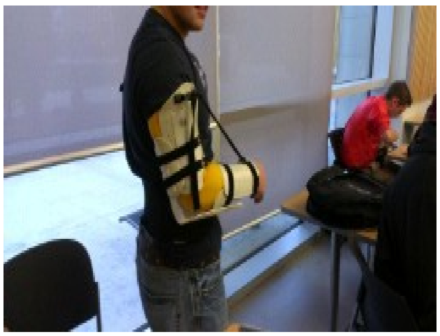
User compliance has been thoroughly investigated. ELO 5000 allows the user to remain independent because it can be put on and removed with one hand. It is quite comfortable to wear because it is lightweight, and the thermoplastic is molded to fit the contours of the arm. If the device is too loose, the user can simply adjust the Velcro straps. The various elbow coverings can be replaced with relative ease by undoing the Velcro straps. ELO 5000 is visually appealing with a smooth texture. There are rounded corners with the edges softly rolled over to minimize skin irritation. The arm sling avoids pressing on the user’s neck and his injured shoulder to further maximize comfort. Thus, ELO 5000 meets most of the objectives. It enables a sufficient range of motion, immobilizes the elbow in various angles, is adjustable and comfortable to wear (due to the reduced weight of the injured arm), and is inexpensive.

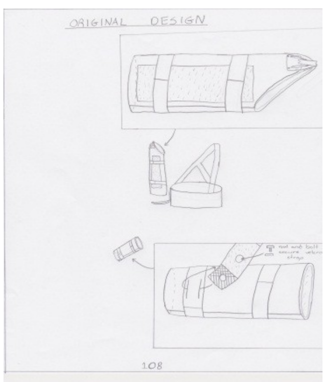
Benefits

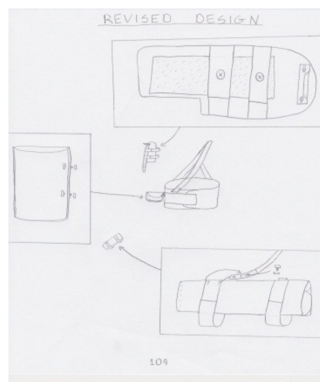
Firstly, ELO 5000 uses simple, industrial-strength Velcro straps for easy attachment. It does not use bolts, screws, or anything else that necessitates fine motor skills or poses a danger to the user. Next, ELO 5000 is lighter and smaller compared to many of the other designs. It is also quite durable and does not require further maintenance. Also, ELO 5000 is made from materials that is readily available at the Hand Clinic in Hamilton General Hospital. Lastly, it does not take a lot of time to construct ELO 5000, and it can be easily modified to suit the needs of future users.

The Pelcro

The CKKPV Engineering Group
F03 - T06 - 4







Problem Description

The Pelcro, a dynamic elbow orthosis, was designed for Mr. B. He was recently in a motor vehicle accident and suffered many injuries including damage to his brachial plexus, degloving of his right hand, a subluxed right shoulder, and a compound fracture of the bones making up his wrist. The Pelcro is a comfortable and stable orthosis that can be reproduced with ease with items that can be easily acquired by the Hamilton Hand Clinic.

Design

The Pelcro consists of three major components including thermoplastic, a back belt, and a milk carton. The thermoplastic allows for flexion and extension of the arm and rotation of the wrist. The velcro straps can be adjusted by pulling it through the pulley wheel which in turn adjusts the angle of his elbow. The milk carton offers support to the user through simply resting their elbow in it. The back belt also offers support and distributes the load from the right arm to the left shoulder with the one strap coming across the left side of his body. It will weight approximately two pounds, which is a desired feature of the design; to be lightweight. The Pelcro is made up of two pieces of thermoplastic; one on the bicep and the other on the forearm. It also has a back belt, which wraps around the user's back and has a strap coming across the left shoulder. The design is quite extensive, but will help Mr. B and other patients with similar conditions.

Functionality

The Pelcro can enable the user to have full rotation of his arm through flexion and extension with full mobility of his wrist. It can provide support to the shoulder and also not cause strain to his shoulder due to its lightweight stature. All of these functions can be accomplished while still being an inexpensive device. The only function that could not be met was the feasibility for prison. It was decided that it was too big of an obstacle to design around given the period of time.

Materials, Components, and Assembly

The Pelcro consists of a variety of different materials including thermoplastic, velcro straps, pulley ring, a milk carton, and a back belt. The mounting hardware used was nuts, washers, and bolts. Most of our materials can be obtained from either a hardware store or a department store. The only tools needed to build our elbow orthosis are an electrical drill, a screwdriver, and pliers. The building of our orthosis from start to completion would take roughly three hours total. To construct our device the first thing you would need to do is shape the thermoplastic to the specific users arm. Once the thermoplastic is shaped you can begin by placing the velcro where needed on the upper arm and forearm and securing it with nuts, washers and bolts. The final step involves securing the milk carton to the back belt also with nuts, washers, and bolts.

Cost

The items used in the construction of our device consist of thermoplastic, a back belt, a milk carton, velcro, and mounting hardware (such as nuts, washers, and bolts). The total cost of our device came to roughly $110. With each material costing approximately the following:
Thermoplastic – $50
Back Belt – $30
Milk Carton – $5
Mounting Hardware - $10
Velcro - $35

User Acceptance and Compliance

The users condition was taken into careful consideration with respect to his injuries. The Pelcro is designed to be taken off and put on by one person, although it may be with slight difficulty depending on the strength in his injured arm. Since The Pelcro utilizes nuts, bolts, and washers the inside of the orthosis is padded so that these mounting materials do not make direct contact with his skin. A second consideration was to make the device not come in contact with the hand since the skin is tender due to his hand being degloved. One final main consideration that was taken was to include a back belt with an arm rest that would assist in taking the load off of his subluxed shoulder. The design works via a pulley type system that allows the user to change the angle of the orthosis without using his injured arm.

Benefits

Mr. B will be able to have full range of motion, from flexion to extension along with the ability to have free rotation in his wrist. The milk carton and the back belt each combine to provide Mr. B with support in his shoulder and arm. Additionally, given his conditions and the circumstances, The Pelcro is a relatively inexpensive device and can be easily afforded by the Hamilton Hand Clinic. The last, and possibly most important to Mr. B, is that it allows him to perform everyday activities such as typing, writing, and eating.

DE Orthotics

DE Orthotics
F 0 3 - T 0 6 - 7

Problem Description

Tara Packhman, with the Hamilton General Hospital, has asked us to design an elbow orthotic for the user Mr. B. He was in a motorcycle accident which shattered his elbow and dislocated his shoulder. Mr.B. needs his elbow to be immobilized while being able to adjust the angle because he cannot hold it up himself. He would also like to rotate his forearm while wearing the orthotic. Because of his shoulder injury it is not possible for him support much weight on his arm. As well, Mr. B. wishes the orthotic to be safe enough to meet minimum prison requirements. The Hospital has asked for the orthotic to be comfortable, low cost, safe and durable enough to withstand everyday activities.

Design

The design is simple enough so the hospital can recreate the orthotic in a few hours. The completed orthotic weighs less than three pounds to not create much additional load on the arm. The orthotic can be created to fit any user's arm, while covering from just below the wrist to the bicep.

Functionality

The orthotic was created to fulfill all of Mr. B's requirements. It is lightweight, flexible, allows Mr. B. to use his full range of motion and is safe enough to meet minimum prison requirements.

Materials, Components, and Assembly

The orthotic can be made from many household materials as well as some easily found in a local hardware store. These materials include; paper, glue, wing nuts and bolts, metal wire, Velcro, tape, and nylon string. The total assembly takes less than two hours but can easily take one hour with a heat source to dry the glue. The tools we used included, scissors, an oven, glue gun, a heat gun and wire cutters.

To assemble the orthotic, first shape the paper maché to the user's arm size. In between layers wrap a length of metal wire to provide extra support. Use an oven or a heat gun to completely dry the glue until the paper hardens. Then cut out the appropriate length and cut it in half at the pivot point. Where the orthotic pivots cut two holes and insert the wing nuts and bolts. Attach the Velcro straps at desired positions. Finally tie down the nylon strap around the wing nuts allowing the strap to wrap around the opposite shoulder for support. To provide extra comfort, the bolts on the inside should be covered with a soft material or they can be shaved down to allow more space for the elbow. The picture above shows the completed assembly without the attached nylon strap.

Cost

For all the materials used, the orthotic costs less than $10 to build.

User Acceptance and Compliance

The orthotic was built to be comfortable to the user, so Mr. B. can wear it for extended periods of time to aid in his rehabilitation. The orthotic does not have any sharp edges or parts sticking out to hurt the user while wearing it. The design is simple enough to remove and put on using his good arm, the wing bolts and Velcro are used because of their simplicity to adjust the orthotic. To adjust the angle, one simply loosens the wing nuts and moves the orthotic to the desired position and then tightens the nuts to hold the angle.

Benefits

Our orthotic is lighter than other designs, which lessens the load on Mr. B's shoulder. This leads to a more comfortable design that can be worn over extended periods of time. Also our design allows for easy adjusting of position. The wing nuts used do not require much force to tighten and can be turned with only one hand. All the materials used were from home and this leads to a very cost efficient and affordable product.

Original Content Inc. Type Master $1.0x10^4$

Team Name
F 0 3 - T 0 6 - 8

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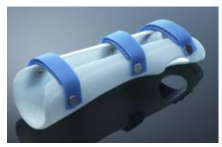
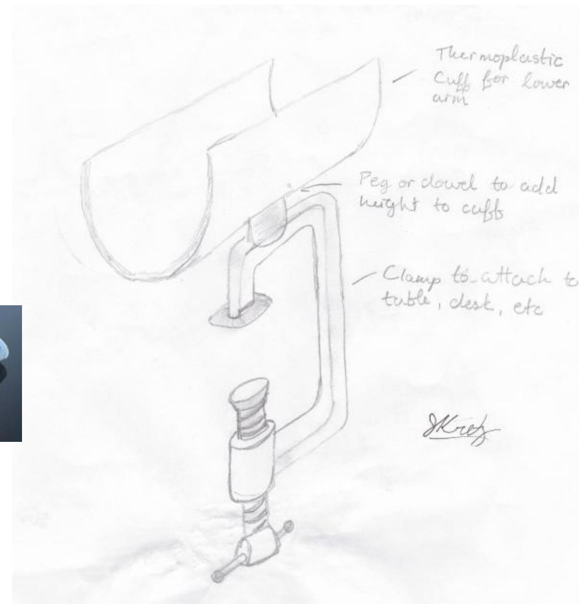




Problem Description

The Hand Clinic has a patient that does not have the ability to move his arm. He can move his fingers, and he wants to be able to do some easy desk work. He hates asking for help, so he wants a device that he can use on his own. The Hand Clinic has very few resources available to construct an orthosis. The Hand Clinic wants any solution to be very cheap, and easy to make. The user doesn't have very much money to spend.

Design

The orthosis is composed of a large cuff to hold your arm, a clamp to attach it to a desk top. There is a short rod connecting the cuff to the clamp, to provide additional height. The device weights approximately 1 pound, however its weight is negligible to the user and his arm. The weight of the orthosis rests on the table, as well as lifting the weight of the user's arm of the shoulder. The cuff is about the length of the user's forearm, from wrist to elbow. Its height is adjustable based on table height and construction decisions.

Functionality

The orthosis supports the weight of the user's arm, to deduct the weight of his injured shoulder. It holds his hand in a static position where he can perform simple desk work, such as typing. The orthosis would be very difficult to use as a weapon. The client requested that we make an elbow static-progressive splint for the user's long term recovery. This function would not be possible with our design.

Materials, Components, and Assembly

Our orthosis consists of a thermoplastic cuff, a short wooden/metal dowel, and a C- clamp. The Hand Clinic has many pieces of thermoplastic. The dowel and C-clamp can be purchased at any hardware store. To construct the orthosis, you will require hot water, or a heat gun, for the thermoplastic. Glue of any type, a screw can be used to connect the thermoplastic to the dowel. The dowel can be attached to the C-clamp by either welding it (if materials are available), or gluing them together. Construction takes no longer than 30 minutes. This time can change depending on the construction methods chosen. A simple flow chart could help the Hand Clinic to properly construct the orthosis. To use the device, simply clamp it onto a table top and tighten the C-clamp. Be sure to orient it to the right spot to allow you to work. Place your arm in the cuff.

Cost

The total cost of the orthosis is less than twenty-five dollars. Most of this cost comes from the thermoplastic cuff. The cuff costs around fifteen dollars. A C-clamp purchased at a hardware store is about five dollars. The cost of the peg can change depending on material choice, and costs no more than four dollars. There are very few materials used and consumed to construct the orthosis, so cost of construction is almost negligible. The cost to the user will be at the discrepancy of the Hand Clinic, based on materials and construction time.

User Acceptance and Compliance

We considered user compliance by creating a device that does not have to be worn at certain time intervals. The use of the device is based off how often the user must do desk work. Our orthosis was created to assist the user in desk work, and not to solve medical problems. If the user does not want to use the device, it simply makes it more difficult for him to do desk work. The user gets the orthosis on and off simply by placing his arm in the cuff. There are no straps or complicated procedures. The user can attach the orthosis to a desk, and never needs to ask for assistance. To maximize comfort, we have used a personalized thermoplastic mold to comfortably fit the users arm. The only time the orthosis is used is when the user is at his desk. Often, when you are doing desk work there are few other people around, so cosmetics are not very important. The device still looks very simple, and is not embarrassing to use. Our most important objectives were to make the construction of the device very simple, and keep the cost as low as possible while maintaining functionality. These objectives were met by using common materials that can be easily obtained by the Hand Clinic, to minimize material cost and make the device simple to construct. The design is very safe for both the user, and the people around him. There are no sharp edges, it is not very heavy, and has no hard parts. You cannot easily use it as a weapon, and you cannot hurt yourself with it.

Benefits

Our design is much cheaper than existing devices. Most orthosis’ cost hundreds of dollars, but ours only costs around twenty five dollars. Our device has a very simple construction that can be done with common household materials. It can be created by hand in less than thirty minutes, whereas some elbow orthosis’ take hours to construct. Our device is very simple to put on and take off. The user does not need any assistance to set up and use the device. The device is only used in the workplace or at home, so cosmetics do not matter. Very few people will see you using the device, making it more likely that the user will want to use it.

Dynamic Elbow Orthosis Proposal for Mr.F

Mr. PSY
F 0 3 - T 0 6 - 9

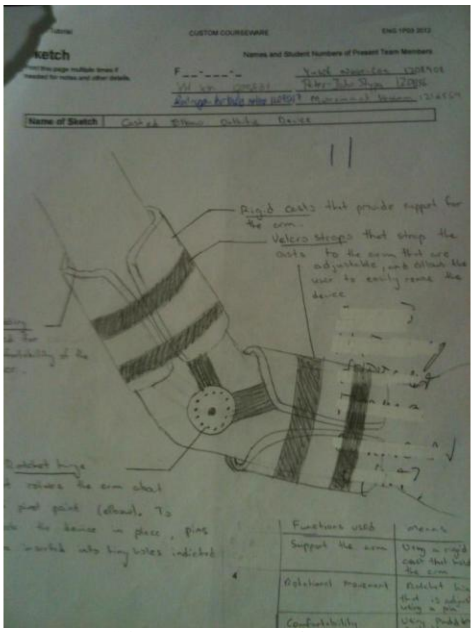


Figure 1. “Casted Elbow Orthotic Device”
First Alternative Design Sketch.

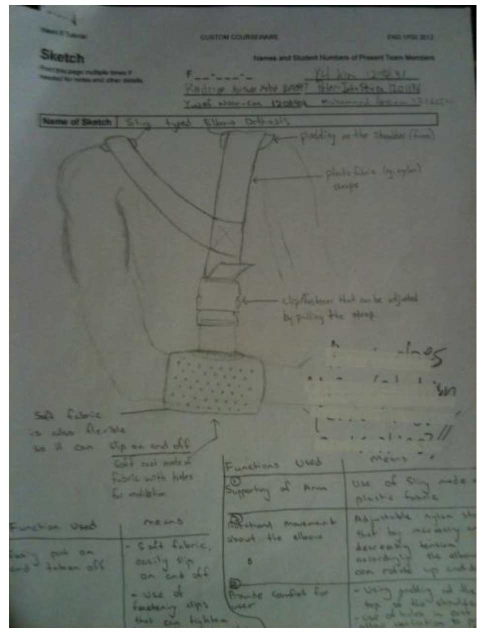


Figure 2. “Sling Typed Elbow Orthosis”
Second Alternative Design Sketch.

Problem Description

To design a dynamic elbow orthosis for Mr. F that will allow him to rehabilitate the rotational movement in his arm. We have chosen to address the burns of Mr. F with the design. We have also chosen to address the problem of cost efficiency, and simplicity.

Design

The design is very light, and provides low weight on the shoulder. It also is also very adjustable, allows maximum comfort for the user, and it is put into a small and compact design.

Functionality

The design can be easily adjusted, and is easily removable. The design does not require much effort from the user to put on and take off. The design does perform everything that the client has requested including addressing the burns, being easily constructed at the hospital, and it can be made at a low cost.

Materials, Components, and Assembly

Materials and components included in the design are: a gym bag strap, thermoplastic, and cotton. These materials can be purchased at a local sports shop or superstore, and the thermoplastic can be purchased at the hospital. The tools needed to construct this design are all located in your kitchen. This includes knives, and hot water. It will take at least 30-45 minutes to build. To build the design, we must first mold thermoplastic by boiling it in hot water, and wrapping it around the patients arm. The thermoplastic is the attached to the gym bag strap with cotton. The design does require special instruction on what temperatures to heat the thermoplastic.

Cost

It will cost $21.00 for the client to make, and $30.00 minimum for the user to buy.

User Acceptance and Compliance

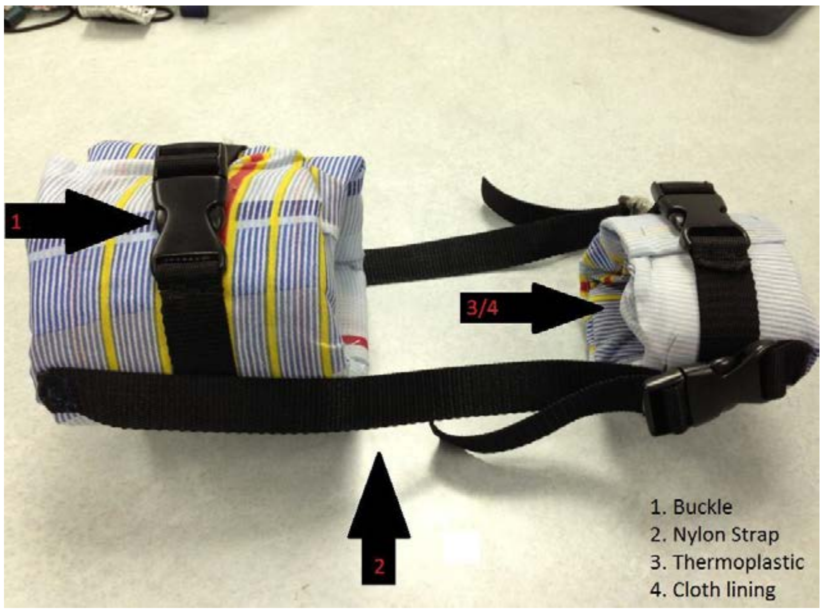
User compliance has been considered through the ease-of-use of the design, adjustability, and comfort. The user simply clips the cast on and off using the gym bag strap. The design is made comfortable through use of padding. The user will simply strap the design around them, and place their hand in a cast that will support the arm. The user will want to wear it because it is comfortable. We have coloured the design to make it aesthetically pleasing. We have met our objectives of being easily adjustable, comfortable, aesthetically pleasing, cost efficient, and simplistic. The safety is defined through minimal use of light parts.

Benefits

Our design is innovative, comfortable, cost efficient, simplistic, and easy to use compared to other designs.

Static Progressive Elbow Orthosis

Biomechanical Solutions Inc.
F 0 3 - T 0 7 - 1



Problem Description

We at Biomedical Solutions Inc. wish to create an elbow orthosis for Tara Packham (from the Hamilton General Hospital) that addresses the presented issues of her patient, Mr. B. Mr. B was involved in a unique motorcycle accident in which he degloved his hand and destroyed all the muscles joining his elbow. He also, sublexed his shoulder during the accident and is currently awaiting drug charges. The client, requested that an orthosis be created for Mr. B which would be lightweight (so as not to put added pressure/stress on his injured shoulder and elbow), easily put on and taken off (so that the user would be able to use it alone without the aid of another individual), provide range of motion(so that the user isn't restricted in any movements and can complete daily tasks), as well as provide rehabilitation (by providing extension and flexion capabilities) to Mr. B's elbow. In addition to this, the orthosis must not contain any components/materials that would be considered a weapon if Mr. B were to go to jail. However, the needs of the client must also be met. To this end, the final design must also be inexpensive and be fairly easy to replicate at the clinic.

Design

The final design consists of 2 main components (the 2 cuffs and the flexion/extension straps), which can be broken down into 4 secondary components (the buckles, nylon straps, thermoplastic shell, and cloth lining) that are outlined on the visual above. The buckles are used to attach the cuff together and tighten and loosen the cuffs using the nylon straps. The buckle is user friendly as it is easy to clip on and off. It also enables the nylon straps (flexion and extension) to be adjusted with minimal force required by the user. The thermoplastic (lined with sponges) is the core of the cuffs and the orthosis and is surrounded by a cloth material that adds a personal feel to the cuffs. With all its components, the final design is lightweight (less than a pound), and very small in respect to the arm, making the design uniquely graceful to use.

Functionality

This design is able to provide everything that the client wishes and requires. It provides range of motion to the user, by using adjustable straps that provides the user the ability to flex and extend their elbow joint. It is also lightweight, and as a result, does not put stress on the user's shoulder. Also, due to its lightweight, it cannot be used as a weapon to cause harm if the user does go to jail. Lastly, the orthosis was designed to be user-friendly. This means that the user is easily able to put on and take off the orthosis alone and without touching his degloved hand.

Materials, Components, and Assembly

There were few materials and components used in the creation of our design. The final design consists of two cuffs (each made using thermoplastic, padded with sponges and a cloth slipover to make the cuff look appealing), attached together by two straps (one on either side) attached to adjustable buckles. The cuffs can be closed (and adjusted for needed tightness) with buckles attached to the cuffs. All these materials (excluding the thermoplastic which is already found in the clinic) can be found in a hardware store (such as Canadian Tire). The only tools required to build the design is a needle and thread and a hot glue gun and if the maker is efficient, building the design should take no more than 2 hours. Building the orthosis design is a simple process and requires no special instruction. To start, cut the thermoplastic into two strips, one 5 x20 cm (for the lower cuff) and one 8 x 30 cm (for the upper cuff). Place the two strips in hot water for approximately five minutes and then fit the corresponding piece to the patient's upper and lower arm. Then cut the 2 sponges in half and hot glue the sponge along the inside of a cuff (repeat this for the second cuff). When the glue has dried, wrap the cloth slip around the cuffs and sew the cloth shut. Then, to create the closing mechanism of the cuffs, sew on straps around the cuff and attach the buckles at the end of the strap. Lastly, to create the adjustable range of motion straps, sew on the two sets of straps that connect the two cuffs together (one set to be sewn along the inner arm part of the cuff, and one set to be sew along the outer arm part of the cuff).

Cost

The materials used for our final design are easily accessible and inexpensive. As a result, the cost of the creation of the design is $64.00. The cost can be broken down as follows: $45.00 for the thermoplastic, $6.00 for the buckles, $3.00 for a meter of the polyester fibre straps, $8.00 for the sponge pads, and $2.00 for the cloth that encloses the cuffs.

User Acceptance and Compliance

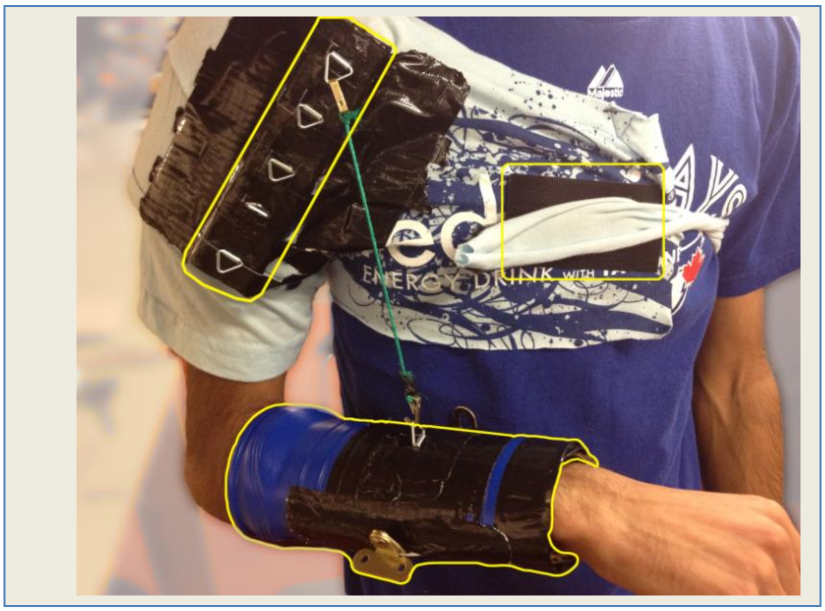
While designing the orthosis, the user compliance was a top priority, and for this reason the design is exceedingly safe, user-friendly and stylish. The cuffs are very comfortable as they have been padded with sponges and then covered with a soft cloth material. This cloth also adds flare to the cuff as it is customizable (different colours/patterns of cloth can be used) almost making the orthosis appear as an accessory. To get the device on, the user clasps the buckles together and to get the device off squeezes the buckles to release the cuffs. For the use of the orthosis, the user just needs to pull/release the straps to extend and flex his elbow. This provides him with a range of motion that otherwise might be difficult for him to produce on his own. Overall, the design is very safe as it is very light weight, and no component can be used as a weapon or be hazardous to the user.

Benefits

In comparison to other solutions, our design can be considered top-of-the-line for a variety of reasons, the most important being its simplicity. It's simple and uncomplicated design allows it to b easily replicated for low costs. Its simplicity also gives it aesthetic appeal, as it can be worn with a variety of clothing without clashing with any one style. The user-friendly feature is also a great benefit as the user will not require outside help to accomplish chores of daily life. All these benefits combine in making our design exceptionally beneficial compared to all other solutions.

Dynamic Elbow Orthosis

5 Guys One Fix
F 03 - T 07 - 2



Problem Description

The team will create a device that allows Mr.B to support his elbow and shoulder so that he may go about his daily life activities. Mr.B has no control in his shoulder so he not able to support the weight of his arm. Also his elbow has no motor skills and so needs constant support allowing for small range of motion, rehabilitation and healing. Tara, who is an occupational therapist, works at the Hamilton General Hospital. She needs to be able to create the device in her clinic keeping in mind that the cost should be very minimal and the device should be able to be used with simplicity.

Design

The elbow orthosis was engineered to be compact and lightweight while still giving support and flexibility. The lightweight materials chosen will reduce the load on the shoulder without compromising support of the arm. After several design stages it was chosen that a system of hooks and a rotational forearm piece would be used as the main components. It was designed so that the arm would sit naturally at a 90 degree angle. Comfort was not overlooked as the device would be shaped and molded to the users arm and shoulder allowing for a secure fit with no loose ends. User compliance was a key part of the design.

Functionality

The orthosis was designed so that it would perform a set list of functions set out by the client. The device is easy for the user to put on with one hand. It is also easy for the user to change the position of his arm to several different degrees of motion depending on the task they wish to complete. It gives the user a range of forearm rotation as well and everything is capable of being manipulated with one hand. The device can also be fitted with different tension devices, such as springs, to provide different levels of extension or flexion.

Materials, Components, and Assembly

-Thermoplastic -Springs -String/Cord
-Hooks -Straps
-Velcro -Shoulder brace (typically fabric)

All of the materials can be obtained at a local hardware store or they are already in the possession of the clinic. All that will be needed to make the device is basic workmanship skills and simple tools. It should take approximately 3 hours to work up the basic device. Besides the basic assembly there is only one special instruction. The friction lid bearing which is the piece that provides the forearm rotation needs to be bent in the circular shape that fits to the clients arm and device. This would be done either with a rough circular mold or from the piece that was molded on the clients arm.

Cost

The cost of the device includes the cost of the materials used, which is about 100 dollars, as well as a rough estimate of labour and other charges, totaling to around 300 dollars. But for the just the device itself 100 dollars is an ideal price.

User Acceptance and Compliance

The device had to be designed with user compliance in mind, after all there's no point in making a device if the user is unwilling to wear it or use it. The elbow orthosis was designed to be molded to arm for a tight yet comfortable fit. It can be worn with clothing on and it can be taken off, put on or adjusted with one hand. The device is a little bulky but the user should have no problem wearing it. The design is also very safe it has no sharp edges or removable parts that would cause harm.

Benefits

The benefits of our orthosis are that it is able to perform more than one of the clients requests. We have a unique and rather genius way of providing and locking in forearm rotation.

Elbow Orthosis Design Project

Functional Designs Inc.
Biomedical Technology

Team Name
F 0 3 - T 0 7 – 3

Problem Description

The team has been asked by Tara Packham at the Hamilton General Hospital Hand Clinic to design a dynamic elbow orthosis for a patient, Mr. B.

- A motorcycle accident has caused extensive damage to his shoulder and elbow.
- The load on the shoulder from the orthosis and arm must not cause further injury.
- The orthosis must extend the elbow out to regain range of motion

- The design should be comfortable as to not irritate the skin or cause further discomfort to the user.
- The design should be cost effective so that it is available to a wide variety of users
- The device should be user friendly and independently operated

Tara and the hand clinic desire a device that fits all of the previously stated objectives and for the design can be implemented for those with a similar injury to Mr. B, not just him alone.

Design

The new designed elbow orthosis is engineered to be light weight (less than 200g) and highly portable (easy to fold and put it into a container) device. The orthosis uses simple ideas like sliding stop knots to adjust the length of the string to support the weight and adjust the degree of freedom and tension on the arm.

Functionality

This orthosis can provide flexion and tension to the arm and supports the weight of the arm to relieve the shoulder pressure. This design addresses almost everything the client had asked for including flexion, extension and support. The orthosis could possibly be manufactured into a weapon making it unsafe for General Population in prison. In that aspect the design did fall shot in client expectation.

Materials, Components, and Assembly

The materials used in this design are Velcro straps, bungee cords, thermoplastic, metal loops, screws, cloth, thread, foam padding and buttons. The cloth, buttons, thread and foam padding can easily be found at second hand clothing stores or purchased at Fabric Land. As well thermoplastic can be obtained from the hand clinic. There rest of the materials can be found at almost any craft store or dollar store. Required tools include a heating device to shape the thermoplastic, a screwdriver to attach the loops and a sewing machine to make the sling. The sling could easily be manufactured in a garment assembly line and wouldn't take long to be made. The thermo plastic part of the orthosis would have to be made for each client and once set it would take only a few minutes to attach the hooks with a screwdriver. This would have to be done on physician on personal basis.

Requirements for this design would be to make sure the hooks are placed on the side of the cuffs so that the bungee cords are straight.

Cost

Thermoplastic: $67.50
Bungee cords: $4
Screws: $ 1.50
Loops: $2.80
Bungee cords: $3.69
Velcro: $2.00
Foam padding: $3.98

User Acceptance and Compliance

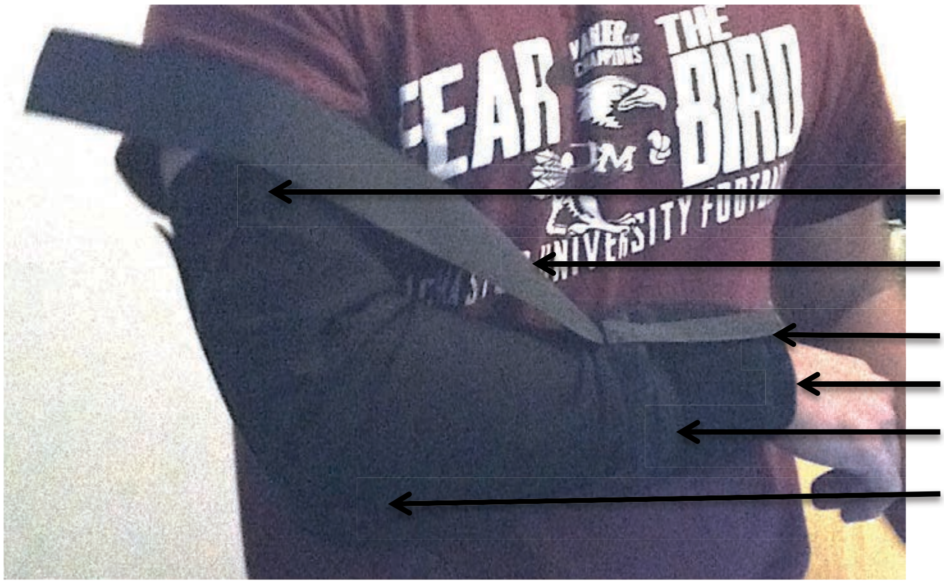
The orthosis has been designed to be comfortable and easy for user compliance. Foam padding between the cuff and the arm provides a snug fit and relives any discomfort due to rubbing or chaffing. Since the device uses fabric it can be made in a variety of colours to suit the user. The device is to be worn on top of clothing making it easy to lip on and off. The user can take off the device by removing the sling and undoing the bungee cords and Velcro. In order to put the device on the user will have to be sitting down but can put the device on with one hand.
The user will use this device to help extend the elbow and help stretch out the bicep and triceps. The user can also use a different arrangement of the cords of the device to lock their arm at an angle for assistance in daily activities.

Benefits

The benefits of this device is that it is lightweight and comfortable, it is functional, provides tension, extension and it can go over clothing as well as meeting its objectives of providing support, flexion, and helping with extension.

The Vincenzo Dynamic Elbow Orthosis

Saverio Inc.
F03 – T07 - 4



Problem Description

Create a dynamic elbow orthosis for Mr.B, which meets the objectives within the given constraints provided by the Hamilton General Hospital Hand Clinic that will provide the most feasible solution for future patients.

Due to severe injuries, Mr. B has requested specific design requirements for his elbow orthosis. His finger and wrist muscles work, but he has very few working muscles at his shoulder and none at his elbow. He wants to be able to lock his elbow at various degrees of rotation to let him use his hands. His right, dominant, injured arm is currently in a sling.

Mr. B would like the splint to be very lightweight due to his sublexed shoulder. He wants to be able to work on active assisted range of motion with a brace on. Finally, he is awaiting trial on drug charges and would like a splint that would be permitted in general population if he is incarcerated. These requirements have to include a relatively low cost budget.

Design

The Vincenzo consists of one sleeve of fabric which extends from the forearm to the upper arm, and one cuff of fabric that fits to the wrist. These two components are secured to the arm through the use of hand-made, double-sided Velcro. There are three securing points for the device, which are located at the wrist, forearm and upper arm.

Two sets of Velcro straps extend from the forearm. The primary set of straps is the longest and extends from the forearm to the upper arm Velcro. The desired degree of flexion or extension is achieved when the Velcro meets and is then fastened by a plastic clip to ensure there is no slippage. The secondary set of Velcro straps extend downward from the forearm to the wrist cuff. The rotation of the wrist is locked into any position desired by the user when the straps are secured to the Velcro surrounding the wrist cuff.

The clothing-like design results in a compact, lightweight, user-friendly device.

Functionality

The device is fully capable of meeting every requirement as set forth by the client. The client can use the device to work on active assisted range of motion. The device can be adjusted to any range of flexion or extension. The device does not put strain on the shoulder and does not require any support straps due to the lightweight nature of the product. The device can also be permitted in a prison, as the device has no sharp edges and does not pose a threat to other inmates.

Materials, Components, and Assembly

The Vincenzo consists of two materials, fabric and Velcro; these materials can be purchased at Fabric Land, or any other fabric supplier. The Vincenzo consists of the additional component of a plastic clip that can be purchased at any grocery store or Staples Business Depot. The tools required to produce this device include scissors, sewing thread and a sewing machine or sewing needle. The device can be fully constructed in a half hour using a sewing machine, or in less than two hours by hand stitching. Only a diagram of the existing model and a description of the device are required to have a full understanding of how to construct the product.

Cost

The total cost to the user including the cost of building materials and tools is $20.05, taxes included. Due to the fact that the Hamilton General Hospital Hand Clinic is already in possession of fabric and Velcro, the only component they would need to purchase is the clip. The plastic clip costs $1.95, which is an extremely low cost for the Hand Clinic to pay to manufacture one device.

User Acceptance and Compliance

User comfort and compliance has been considered throughout the entire design process. The simplistic, clothing-like design of the Vincenzo provides a high level of comfort to the user, while blending in with clothing. The cosmetic decision of keeping the device one solid dark colour for an adult male will encourage frequent use. In the case of younger patients, the clinic can offer the Vincenzo in a variety of colours to encourage user compliance. The device can be easily put on over clothing as the fabric stretches and can be secured in place by the double sided Velcro.

Benefits

The Vincenzo should be used over existing products due to its simplistic approach to meeting all of the users' requirements. The primary straps allow the user to achieve any degree of flexion or extension. The device is lightweight; therefore it does not cause strain on the sublexed shoulder. The device is very cost effective and accessible to anyone regardless of his or her budget. Finally, this device should be chosen because the clinic has all but one of the materials necessary to build it and therefore the Vincenzo is the most practical design.

ElbowDox

Biomechanical Engineering Solutions
F03 - T08 - 2

Problem Description

Biomechanical Engineering Solutions was approached by Ms. Tara Pacham, who works in the Hand Clinic of the Hamilton General Hospital. The Hand Clinic receives many patients that have damaged their arms/hands in various ways. Their goal is to help patients recover quickly while minimizing pain and discomfort. Ms. Tara Pacham has asked the team to design a dynamic elbow orthosis for a patient, Mr. B, who was in a motorcycle accident. Mr. B has little to no muscle left in his arm and shoulder. With this in mind, the firm believes the team is capable of designing a product that will meet the user's needs and be appealing to a wide user base. The team must design an effective device that holds a user's arm in place and locks his/her elbow at set angles, all while remaining mobile, safe to use, and marketable to individuals with arm injuries.

Design

Because the device is made up of mostly PVC, and there is relatively little metal in the design, it is not a heavy device. Furthermore, the functionality of the sling guarantees that the device will not create a large load on the user's arm, and will even support the weight of the arm itself. In regards to size, this device conforms rather tightly to the user's arm. It is possible to wear the device inconspicuously underneath clothing.

Functionality

This device is capable of locking the user's arm at different, user-set angles; it allows forearm rotation; it protects the user's arm from further damage; and finally, it reduces the load on the user's shoulder.

Materials, Components, and Assembly

Required Material:
-1” copper tubing
-1/2” copper tubing
-double sided tape
-3” PVC pipe extension
-foam padding
-steel bolts & nuts
-steel pins & nuts
-Velcro strips

Assembly can be completed by any individual or group of individuals that have knowledge of power tool operation and safety. Tools needed are: a table saw, a vice, a drill press, a hand sander, and necessary safety gear. It will take one person 90 minutes to assemble one unit.

Cost

The estimated cost of materials required to assemble one orthosis is $16.54. These materials are also very easy to purchase, and are available at virtually any hardware store.

User Acceptance and Compliance

This device was designed with user compliance in mind. A user will be able to quickly put on and take off this device without the aid of another if a surface such as a table is used to hold the device. The foam padding was chosen to maximize user comfort, increasing the chance that the user will want to wear this device. Cosmetically, this orthosis is not very large, and has dark, neutral colours. The two telescoping metal rods joining the shells have been described as “badass” by onlookers during test runs. The engineering team has met the majority of our stated objectives. The exception to this is our objective of the orthosis being non-weaponizable. A suitable alternative to metal tubing was not found for the telescoping rods. User safety has been thoroughly considered. Hazards have been reduced as much as possible through the sanding of materials during assembly, the usage of nuts to secure fasteners, and the combination of the outer shell and the foam protects the user's arm very well.

Benefits

This device reduces the load on a user's shoulder, ensuring long term comfort for individuals with arm injuries. It is also easily adjustable by the user, without the need for others to interfere and help with adjustment. Finally the product has a very low cost of production, and is made out of common materials. This will aid the Hand Clinic by making sure that the manufacturing is quick, simple, and economical.

The **ARM**ada

Elbow Grease
F 0 3 - T 0 8 - 3

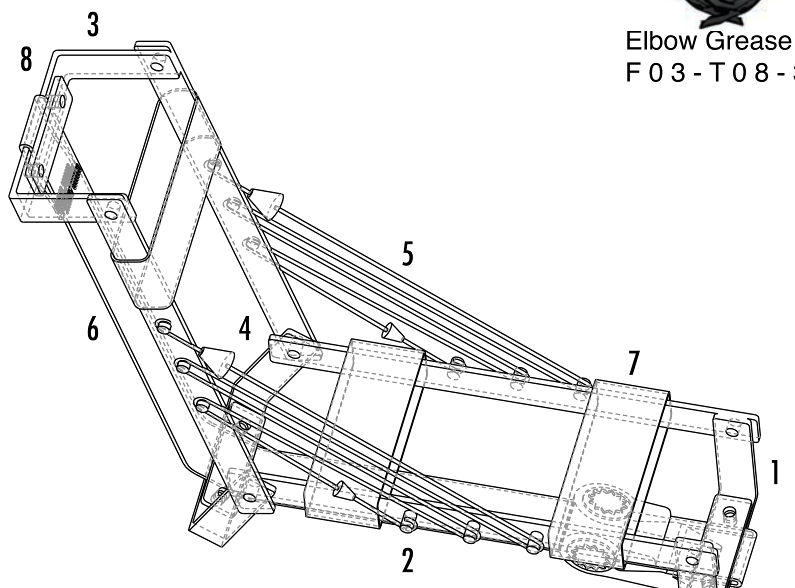


Fig. 1 - The ARMada orthosis orthographic view

Problem Description

Design and prototype a dynamic elbow orthosis to support the rehabilitation process of a client suffering from a brachial plexus injury and de-gloving of the wrist. The orthosis is meant to support anatomical joints and attached members to return mobility and function through dynamic rehabilitation and mobilization techniques. Consequently, the device is expected to utilize singular or multiple points/forms of adjustability in addition to customizable comfort and fit.

Design

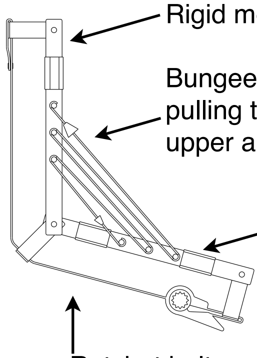


Fig. 2 - Orthosis side view

Functionality

The design satisfies all pre-determined functions for the orthosis with the exception of weight and acceptance into the general population.

The metal, zinc alloy is relatively heavy, however the primary support strapping mechanism redistributes the weight to minimize stress, and primarily centralizes the force on the upper back (i.e. along the upper vertebrae of the thoracic spine). The second exception was made with the approval of our TA, to disregard the orthosis's acceptability amongst the general population (i.e. if client is incarcerated). The final design can be weaponized indefinitely, however most of our design alternatives could be weaponized to some degree.

Materials, Components, and Assembly

Materials

- 4 rust-proof metal alloy rectangular plates
- 4 heavy-duty bungee cords
- 6 rust-proof metal alloy L-brackets
- 12 sets of nuts, bolts, and washers (fasteners)
- 1 approx. 2” ratchet belt

- 1 approx. 1.5” nylon strap
- self-adhesive foam padding
- heavy-duty duct-tape or similar adhesive
- 3 sets of approx. 3” velcro straps

Components and Assembly
Refer to *Fig. 1*.

1. Attach 2 L-brackets to form 3 U-shaped components.
2. Attach top of 2 U-brackets to corners of two plates, one on each side.
3. Repeat with remaining U-brackets and plates.
4. Attach non-U-bracket to other components so it rotates freely.
5. Attach bungee cords to skeletal frame.
6. Attach ratchet to the underside.
7. Attach velcro securing straps.
8. Attach the nylon shoulder belt *(the figure demonstrates the placement of the belt on the upper U-bracket)*

Cost

MATERIALS	COST ($)
Zinc plated steel bars	14.93
Washers, screws, and bolts	7.85
Ratchet (belt)	2.95
Bungee cords	3.50
Adjustable nylon belt (strap)	1.25
Velcro straps (and glove)	6.75
Total Cost	37.23

User Acceptance and Compliance

The ARMada is designed to make the orthosis and its user self-sufficient; the design allows the user to wear and remove the device without external assistance and with minimal effort.

To secure the orthosis properly, the user must strap his forearm and upper arm into the device using the velcro straps, and slip the nylon shoulder/back strap over his opposite (good) shoulder.

The back strap is easily adjustable for a comfortable and snug fit. It redistributes the weight and stress of the orthosis away from the brachial plexus injury and centralizes maximum weight along the upper thoracic spine.

The wrist has no rotational restrictions as the lower velcro straps simply secure the lower forearm and allows for considerable movement of the wrist.

The device is designed to be visually appealing, clean, and sturdy. Meeting the design objectives primarily relied on material selection. The skeletal frame is comprised of metal alloy plates, which stabilize the entire structure and make the device sturdy, rigid, and usable under all weather conditions. The placement and the minimal but critical stretchability of the nylon and velcro straps keep the device securely in place without compromising comfort.

Benefits

The dynamic elbow orthosis, ARMada is well built, sturdy, rigid, weather-proof, and will not easily break. The design allows for a high strength and durability threshold to compensate for daily usage and normal wear-and-tear.

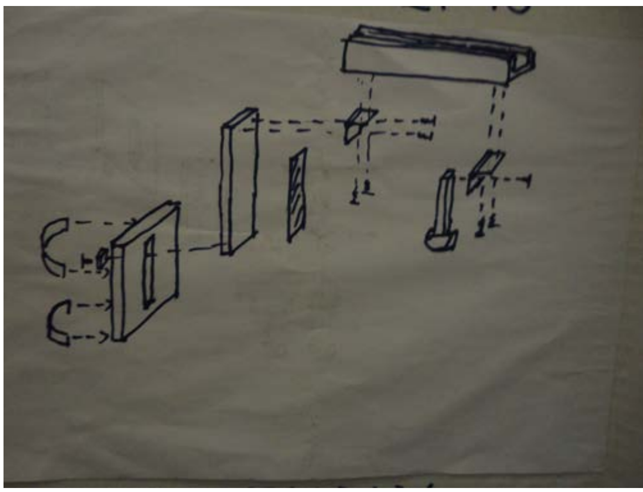
The ratchet strap is an adjustment system that allows for small degrees of adjustments over a wide range of motion. It employs a simple tightening mechanism and a quick release button to loosen the strap.

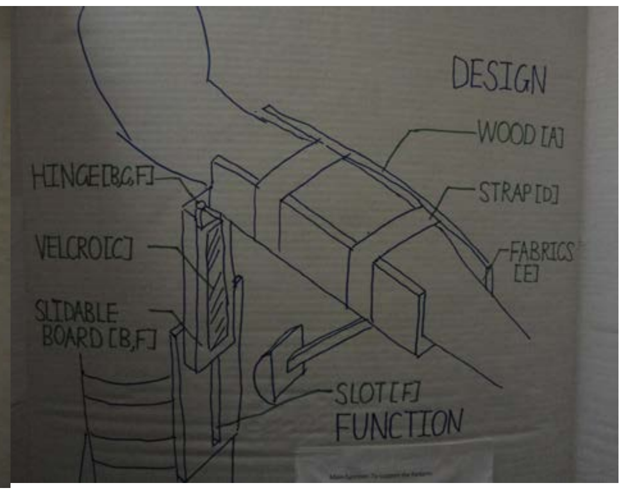
The back strap redistributes the weight evenly and away from the brachial plexus injury, with a maximum force centralized along the upper back.

Overall the techniques used in the design are simple and highly effective, allowing for a wide range of motion, a great level of adjustability, comfort, and fit, with completely safe and secure supports.

Sav 2.0

Team Sav
F03-T08-4





Problem Description

The problem introduced to the team involves Mr. B a 23 year old single male that enjoys riding his motorcycle. He had a tragic motorcycle incident, and injured his dominant right arm severely. He currently uses a sling to hold up his right arm. He was diagnosed with a compound fracture and degloving of the wrist with tendon/nerve lacerations. He also has a brachial plexus injury and nerve grafting that occurred 6 months post injury. The brachial plexus is that controls the shoulder and elbow. This injury has created very little movement in his shoulder and no movement in his elbow. His wrist and fingers can move. The client has asked the team to create a very light splint due to his dislocation of his shoulder. Also, the user would like to be able to work, so the splint should allow full range of motion. Furthermore, the user is awaiting trial on drug charges, and would like a splint that would not be considered as a weapon.

Design

The design has three main parts. The leg piece (piece C), the bottom piece (piece B) and the arm piece (piece A). The leg piece has a slit down the middle, and a bolt that slides through it. This is so you can adjust the height of the main part. The bottom piece is used to adjust the range of motion, its just a flat piece of wood hinged to the top piece, with Velcro along the surface. The top piece is shaped like a U, for your arm to sit in. It is hinged to the bottom piece, and hinged to a stick (piece D) that has

Velcro attached to the end of it. The stick attaches to the Velcro on the bottom piece, and this is how you change the range of motion. It is about 8 pounds, but would be much lighter had we used a better type of wood. It is about a foot by 8 inches, and can fold up. The arm sits in the top piece (piece A), and it goes from the elbow to the wrist

Functionality

Our elbow orthosis meets all the functions the user would want. It has assisted range of motion, and a large range of motion. It supports his shoulder very well, and is very comfortable for the user. It can do everything the client has requested, except it would possibly be considered a "weapon".

Materials, Components, and Assembly

The elbow orthosis requires wood, velcro, screws, hinges and a comfortable material. The materials can be purchased at any hardware store, and can be purchased at a reasonable price. The only necessary tools are a wood saw of sorts, and a power drill. It would take about an or two to build, if the proper tools are used. The instructions are as follows:

- Attach two boards to the top of flat pieces to make a U shape (part A)

- Attach the bottom piece (part B) to the top piece (part A) using a hinge.

- Attach the stick (part D) to the bottom of the top piece (part A) using a hinge.

- Add Velcro to the end of the stick and to the flat piece

- Attach a bolt through the slit of the leg piece (part C) and into the bottom piece (part B) in order to connect them

Cost

Depending on where supplies are purchased, the orthosis would cost about 25-30$ as well as two hours of building time.

User Acceptance and Compliance

We have met the needs and desires of the user by giving him assisted range of motion, as well as a comfortable elbow splint that reduces the stress on his shoulder. The user can put it on and off on his own, he just attaches the leg piece to his leg with straps, and his arm in the top piece with straps as well. It been made comfortable by attaching pieces of really comfortable cloth. The user just puts his arm in the top piece, and adjusts the orthosis to his desired range of motion. The orthosis is comfortable enough that the user wouldn't mind wearing it. We attached the cloth using Velcro, so it can be removed and washed. The design is a safe as we could make it, with no sharp piece or anything sticking out.

Benefits

Our design is better than other models because it supports the shoulder in a very good and comfortable manner. It is also very unique, and visually appealing. It also is very easy to adjust the range of motion, where as some designs are harder to do by one self.

The "Double Function" Elbow Orthosis

EffectiveYes
F03-T08-5

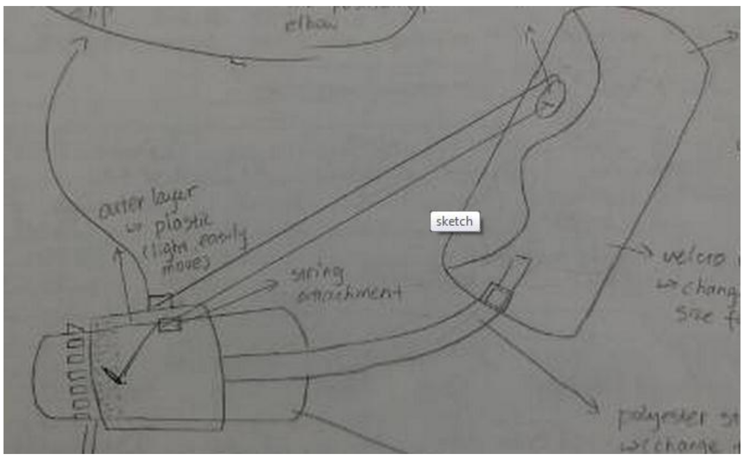


Figure 1: Technical Hand-Made Sketch

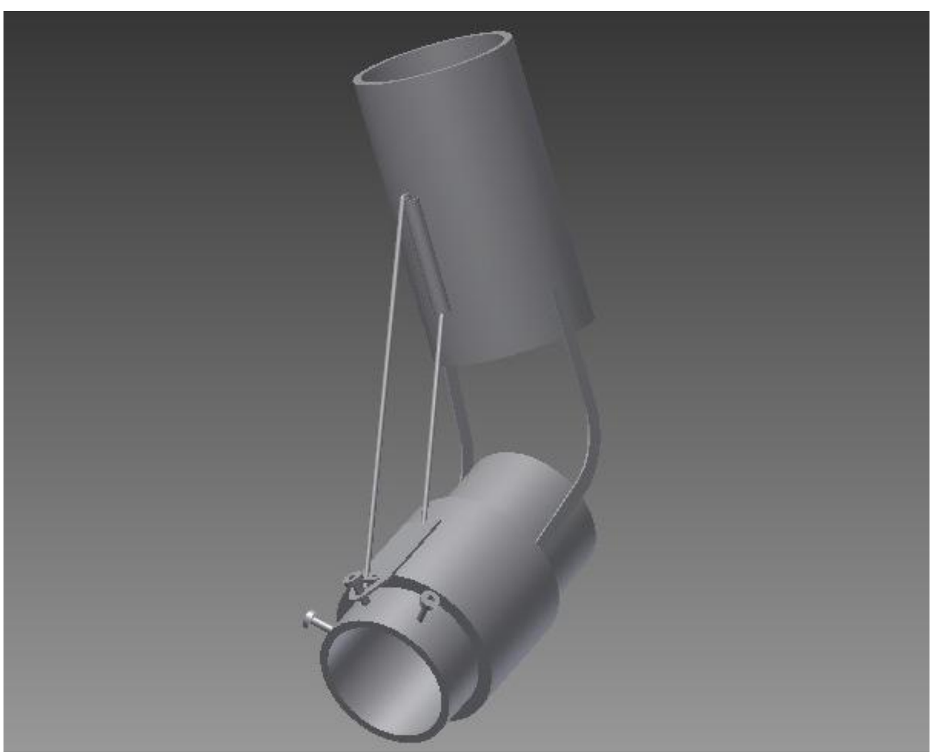


Figure 2: AutoCAD model (Autodesk)

Problem Description
Adjusting and locking the elbow at the joint. Minimizing the weight and minimizing this support on the right shoulder. Facilitating forearm rotation. Make sure the elbow orthosis is cost-efficient.

Design
Two cuffs made of PVC plastic with soft insulation inside. Both cuffs are placed on the upper arm and lower arm. They are connected by two strings. It will be quite lightweight, around 300g. It’s not very big, because we minimized the surface of contact. The string is adjustable and can interlock the inner and outer layer of the forearm piece..

Functionality
It can change the angle of abduction of the forearm. It can rotate the forearm and lock it into place. It can minimize the weight of the brace by supporting itself on the left shoulder. It does not respect the rules and regulation of medical devices, while being incarcerated.

Materials, Components, and Assembly
Our design requires PVC plastic, soft kitchen mats, construction string, shoulder pads, some common plastic (binder) and some tape. They can be obtained at almost any general materials and hardware store. It took around one week of constructive assembly. A simple sketch and CAD model would be enough to build it. There are no special instructions, because the design is fairly simple.

Cost
It will cost the clinic 100$ and it will cost the user 200$. This is low compared to other commercial elbow orthosis that cost hundreds to rent.

User Acceptance and Compliance
The user acceptance has been considered, our elbow orthosis is lightweight, minimizes support on the right shoulder, it is easy to adjusts and it is very sturdy. Our design takes into account user compliance. The point of an elbow orthosis is for it to favour more good and help the healing process. That is why our elbow orthosis is lightweight and very easy to adjust. It favours healing at many aspects (Double function).
User compliance is excellent because the elbow brace is very easy to put on and to adjust.

Benefits
Our elbow brace is ultra-light, very cost efficient and it is mindful of the problems that the user has.
It is the fact that our design fulfills two functions that distinguishes it from all the other design. It does not require a lot of materials, and it can be easily built from recycled items. The design itself is very unique and innovative.

Dynamo Elbow Orthosis Proposal

Flexar
F03 - T08 – 6

Problem Description

Tara Packham, an occupational therapist from the Hamilton General Hand Clinic, presented the user Mr. F, who is a victim of burn injury. Due to this injury, much of his skin suffers second and third degree burns, and his elbow joint has become fused together. We were asked to design an elbow orthosis that would allow Mr. F to gradually rehabilitate his elbow, to a point where he would no longer need an external device to move his arm. While doing this the design would also have to allow Mr. F to be as independent as possible, allowing him to perform everyday duties. Finally the design would have to offer as little discomfort as possible, considering the severe burns Mr. F suffered as a result of his injury.

Design

Our design includes two thermoplastic cuffs that offer enough leeway to slide onto the arm very easily. They are lined with neoprene a material that will cushion his arm, and prevent any damage to the burns on the skin. A turnbuckle attached to two long 't-shaped' pieces on either side, slides onto the slot each of the two cuffs includes for these pieces. Once the turnbuckle slides on, it attaches each cuff together and it tightens them against the arm. After the turnbuckle has been attached it can be twisted to adjust range of motion in the arm. The whole design is very lightweight, and it minimizes discomfort. The cuffs cover a large surface area of the arm in order to distribute the force out, but overall the design is fairly small and would not interfere with daily tasks.

Functionality
Our elbow orthosis can be put on easily with only one hand, and easily adjusted without much force. This allows the user to be independent and use the orthosis without any outside help, which was something that was very important to him. Our design provides a large range of motion for the user, and allows substantial flexion and extension. This plays a large role in his recovery, and through occupational rehab accompanying the orthosis, the user will be able to regain motion of his arm. The design is also lightweight, and the neoprene lining the cuffs minimizes the discomfort caused by the orthosis. A goal of the design was to make the orthosis comfortable, however due to the severe burns suffered by the patient, this was impossible. Instead our design simply minimizes the discomfort caused. The device also cannot provide a locking system that would restrict the motion of the orthosis to the clinic, as recommended by the representative. This however was not one of the most important requirements, so providing the user with independence was focused on instead.

Materials, Components, and Assembly
The materials used in this design were: thermoplastic sheets; neoprene; a turnbuckle; and nuts and bolts. Much of the materials can be purchased at any hardware store for less than 5 dollars, and the thermoplastic and neoprene can be ordered directly from providers. The only tools required to construct this design are a drill to drill holes in the thermoplastic and connect the turnbuckle with the nuts and bolts, and hot water to mold the thermoplastic. If the builder has a lot of experience molding thermoplastic, as the client at the Hand Clinic does, the design itself is fairly easy to build, and should take only about an hour or less to build.

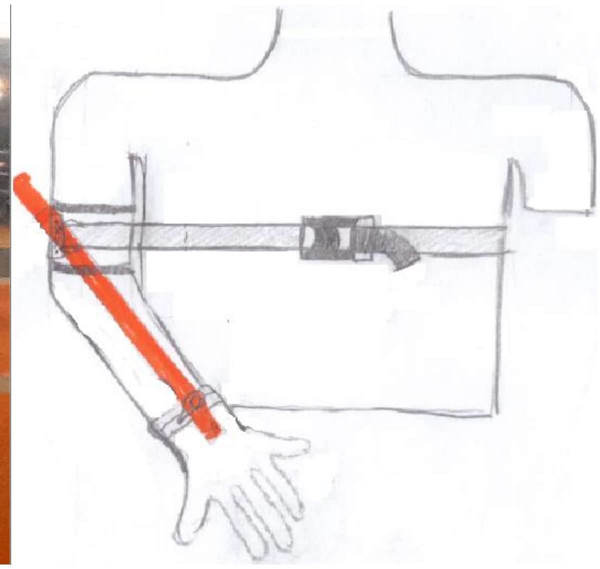
Cost
The cost for building our orthosis would be around $60, with the majority of the cost going to thermoplastic, which the Hand Clinic already has a large supply of. The cost to the user would be the same or a little bit more, depending on how much profit the hand clinic was attempting to make.

User Acceptance and Compliance
Our orthosis has been designed primarily with user compliance in mind: it minimizes discomfort, so Mr. F should not have a big problem wearing it. It also allows him to be independent, and put the orthosis on by himself. Assistance from other people like his parents is not required at all when using this device. This was something which was something he did not like, and our design exterminates this problem. The device slides easily on and off, and all the parts can be slid together simply using one hand. The user can wear the orthosis for as long as the Hand Clinic feels is necessary, and for whatever period of time they decide. The orthosis can be worn by itself, or in conjunction with another orthosis. Our design itself is very simple and clean looking, with respect to cosmetics. It is not too large or bulky, and it can be made out of many different colours of thermoplastic depending on the user's preference. The design contains no sharp edges that could hurt the user, and is very safe.

Benefits
Our design is the best choice for our client Mr. F because it provides him with the independence he needs to go about his daily life. Other orthoses on the market are very difficult to put on, take off, and adjust without assistance; even for someone who is healthy. Our design allows all of these things to be done easily, without assistance. The design is much simpler than many of the existing designs on the market, and is very user friendly.

Dyn-Arm

For Life's Design
F 04 - T 03 - 1



Problem Description

The client, Tara Packham came to us on behalf of the Hand Clinic at the Hamilton General Hospital because she wanted a device engineered specifically for a client of her own, Mr. B. This device needed to enable him to carryout daily activities which he could have done prior to his accident. The result of the injury was: a severely damaged brachial plexus including severed muscle and nerve groupings in the shoulder, a compound fracture in the elbow, as well as degloved skin and tendon and nerve damage to the right forearm.

Due to the extent of Mr. B's injuries, Tara needed a device that could solve a few problems. For starters, it absolutely had to minimize the force exerted on the shoulder. As well, it needed to have an adjustable range of flexion and extension that would lock the elbow. The device needed to constrain the movement of the shoulder to zero degrees of freedom.

Our client, wanted to be able to construct the device at the Hand Clinic. Therefore, it had to be made of the most cost effective material as possible. Overall, the design should satisfy Tara's needs but also help as many people as possible.

Design

In this design, the shoulder is secured to the body by using a thick material belt. As a result, our prototype restricted the movement of the subluxed shoulder and also reduced the stress on it. The arm achieved flexion and extension when a rigid ruler that had a Velcro strip backing was adjusted along the arm band. There were two points of contact on the right arm; the hand glove with attachment clip and upper arm supporting band. The user would simply peel the ruler off of the upper arm band either letting the arm into extension using gravity or pulling the arm into flexion. After adjustment, the user reattached the backside of the ruler onto the Velcro arm band on the humerus and clipped the hole in the ruler to the hand glove. This secured the arm in any desired position.

Our design was lightweight and compact; it comfortably fixed the entire arm in any position and the straps that ran across the body evenly distributed the weight of the arm across the chest and along the back. Another design advantage our prototype had was it did not prohibit the user's mobility of the left arm or left upper torso while wearing the device.

Functionality

This device was able to achieve most of the requirements outlined by Tara Packham and it was fully functional. It supported the users shoulder and it allowed the user to flex and extend their arm. In addition, it would aid in the rehabilitation process. The flexion and extension of the arm was an important function since the user would want to be able to do as many tasks as they could have done before the accident. One of the requests we could not meet was assisted supination and pronation, however the design allowed the user to freely supinate and pronate independent of the device.

Materials, Components, and Assembly

The materials used in this device are, foam padding, a glove, a rigid flat metal ruler, a climbers clip, a belts and Velcro.

To build this device, the clinic would not need many tools. The builder would need scissors, and depending on the manufacturing preference, a sewing kit. The time required to build this device is fairly low. It would take 45 minutes to 90 minutes with some instruction.

Cost

The materials cost of this device was very inexpensive. All the parts were purchased locally making the cost roughly around $30.00, but this excluded labour rates. It is estimated to cost $40-$90 when built by the hand clinic. We predict that our design would have a maximum cost of $100 for the user.

User Acceptance and Compliance

We have taken the users compliance into consideration and this is why the device is lightweight and comfortable. The user may require some assistance when putting it on and taking it off, but once it is on, it will be easy for the person to use. The Velcro will make it simple for the user to move the arm from flexion to extension without any assistance. The padding made the device comfortable in all the areas where it was in contact with the body. As well, at first glance of our prototype, one might ask, "is that all?" which clearly demonstrates the designs simplicity. Lastly, the user would want wear this in public since it helps to carryout daily tasks, i.e. open doors or shake hands.

The user will want to wear this device because it will decrease their dependence on others as well as aid in the recovery period of the injured arm. The Dyn-Arm is any colour you would like it to be and more importantly it is universal for any user.

Benefits

Our design is better than pre-existing solutions based upon its simplicity, the designs low weight and high functionality. Dyn-Arm is a feasible design which could be produced using household materials if needed. Once it is on the user, the device is operated independently. The user would feel comfortable wearing the device in public and the device would be acceptable for Mr. B to use in jail, if he simply replaced the metal ruler with a plastic one.

Furthermore, it would be inexpensive to produce for the hand clinic which results in a lower purchase cost for the user.

Torsion Spring Orthosis

McMasters of Engineering (MME) Firm
F 04 - T 03 - 2

This is the space for your visual. Do not change its size. Your visual may contain any combination of well-done sketches, photographs and CAD models. All visuals must be original. Use annotations.

1.

Problem Description

The actual problem was to design a dynamic elbow orthosis for a user who suffered a subluxed shoulder, a Branchial plexus and degloving of the hand. Furthermore, the design allows the weight of his arm to be removed from his shoulder, provide a range of motions and adjustments.

Design

The prototype, in terms of size will encompass the entire arm, and in terms of weight, the prototype will weigh roughly less than 0.5kg.

Functionality

Functionally speaking, the prototype cannot perform everything the client requested. Generally speaking, the prototype can: 1) lock the arm into pace, 2)allow for supination and pronation, 3)secure the upper arm to the body to take weight of the shoulder. However, the prototype does not fulfill the user's entire need as it will not be allowed in prison due to the materials used.

Materials, Components, and Assembly

The materials required for the construction of the prototype include: a spring, a belt, wrist and elbow pads, wood, chain, bowl-shaped elbow support, and some fabric. The materials can be obtained quite easily from the hardware store (Home Hardware) and Shoppers Drug Mart. Furthermore the tools required to construct the prototype include: a drill, glue, and thread. The time required to build the prototype will be approximately 20 minutes. Lastly, there are no special instructions required as it is self-explanatory.

Cost

The entire cost to purchase all the material is approximately $80. Furthermore in terms of labor costs (time), it will cost the client approximately 20 minutes of labor per constructed prototype.

User Acceptance and Compliance

The user's compliance has been considered as the dynamic elbow orthosis created is comfortable and provides orthotic therapy. Generally, the user will get it on and off by unstrapping the belt and pulling it off by himself. Furthermore, the device has been made comfortable through the use of padding and fabric. The user will use the device by putting the device on his arm and adjusting it to his liking before locking it in place. Lastly, with respect to cosmetic considerations, the device has been made to look simple and inconspicuous.

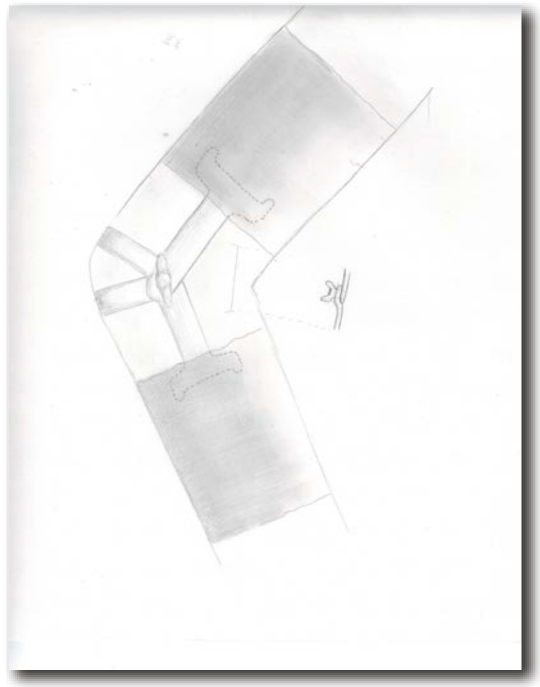
Benefits

Our design is better than existing solutions because our prototype is simple and not as complex as other designs. Furthermore, the cost of our design relative to existing solutions are much cheaper than existing solutions. Existing solutions cost approximately $200- a few thousand dollars, whereas our orthosis costs only $80.

Our design provides many benefits to the user, including but not limited to: comfort, usability, simplicity, support for the damaged shoulder and stability with the spring. While other current orthosis do not provide stability, our elbow orthosis provides stability through the use of a spring, as the spring applies constant pressure to the arm, holding the arm in place, at a desired position. Furthermore, other existing elbow orthosis do not provide adjustability, whereas, our dynamics elbow orthosis provides adjustability through the use of a chain, as the chain can be easily taken off the screw attached on the wooden plank, thereby allowing the users arm to be easily adjusted.

Simple Elbow Splint

Dynamic Engineering Inc.
F04 - T03-3



Problem Description

An occupational therapist, Tara Packham, from the hand clinic at Hamilton General Hospital has a client, Mr. B, who is on trial for drug charges and was involved in a motorcycle accident. The result of the accident was a compound fracture, dislocation and degloving of his right wrist with tendon and nerve damage. He also suffered from a brachial plexus injury that left him without muscle control in his right shoulder and elbow. However, he still does have functioning finger muscles. Mr. B now has difficulty performing everyday tasks such as typing and other activities relying upon holder and arm movements especially since the injury occurred to his dominant are. The user needs a device that can be locked into a position that allows him to make use of the functioning muscles in his fingers. the device must minimize pressure placed on the shoulder so it does not cause further damage to his shoulder. Due to his circumstances that device should be permitted to be worn in the case that he is incarcerated. The client (Tara Packham) requested an inexpensive device that has the potential to be reused in the future for similar cases.

Design

As seen in the sketches and the picture above, the device is consist of two fabric pieces placed in and upper and lower arm and plastic pieces attached together with a screw that acts like a splint. The device's weight is around 1.4 lb and would not lay pressure on the injured shoulder causing further damage. With respect to the arm, the spandex fabric sixe depends on the actual arm size so the user is able to slide it along the arm easily. The two plastic pieces on both sides of the hand performs the function of a hinge. The T-shaped end would be sawed to the fabric to secure and lock the movement of the arm. To attach the plastic pieces, a plastic screw is used. It would not be pushed against the skin and would be leveled with the plastic pieces. The end part of the plastic screw would be melted and structured in a way to secure the plastic handle from falling or getting lost. The plastic handle allows the two pieces to be loosen or tight in order to lock a certain required angle. Finally, fabric ribbons to support the elbow and secure the position of the plastic pieces.

Functionality

The weight of the fabric applies a small amount of weight on the shoulder, preventing any further damage to the brachial plexus injury. It allows the device to be worn without applying pressure on the shoulder. The two pairs of plastic pieces that go on either side of the elbow are rigid, but lightweight. They allow a screw and a turning knob to work to set the device at the angle that the patient would like. The device allowed the arm to be locked in positions where menial tasks, like typing, important to many jobs could be accomplished easily with minimum discomfort to users. This device characteristic is put in place to give the user the opportunity for active assisted range of motion as much as possible. The ability of the angle between the plastic pieces to be altered allows for effective flexion and extension of the arm according to the activity the user would like to complete. Furthermore, the device allows the device to be worn in general population in prisons. It is soft and has no sharp edges. The device is easily made with the limited resources of the client. On the other hand, the device is to be made using cheap production methods.

Materials, Components, and Assembly

In order to make this device, first, measure the circumference of the patients forearm and upper arm and use the corresponding amount of spandex fabric. Sew the ends together to form a sleeve. Next, measure from 1/3 of the way down each sleeve from the elbow joint. Create 4 rod-like pieces by molding thermoplastic into a flat rod with a T at the end. Drill a hole in the end opposite to the T. Then, sew the T-shaped end of the plastic piece to the sleeve using a small piece of fabric to cover. The screw will fit into the hole drilled into the plastic pieces with the flat head of the screw on the inner side of the arm on both sides of the elbow. Finally, the plastic knob can then be screwed on to the screw and tightened to allow the desired angle between the plastic pieces to be achieved to hold the arm at the various angles. These materials can be found at a Hard store and shoppers drug mart. This process will take around 45 minutes as long as all the required materials are available.

Cost

The cost of the device is very cheap for the client. The prototype cost was $10.00. The plastic pieces supporting the arm were a dollar each and the elastic arm band was $1.00 dollar. The two plastic screws and knobs that lock the elbow at various angles were $5.00 total for both**.** The Velcro piece that crossed the elbow crease was free. When the actual orthosis is designed, the plastic pieces would be substituted with thermoplastic that would increase the cost of the device based on the small amount required.

User Acceptance and Compliance

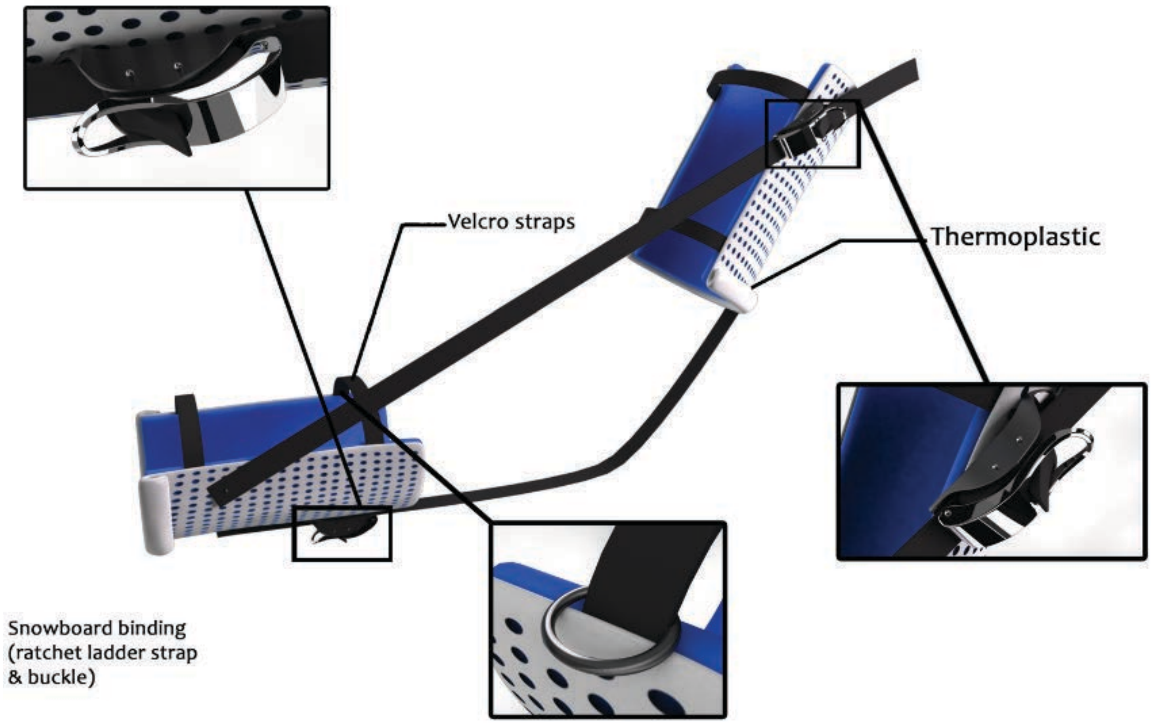
The device was made to be as simple and easy as possible. The user is going to slide the device into his/her arm. Since the parts contacting the skin is fabric, the user would feel more comfortable wearing it than a solid, rigid plastic part. Also, the fabric can have any colour with different designs on it. The device is safe to use where it does not have sharp edges or chemicals that might irritate the user skin.

Benefits

A side from allowing flexion and extension motion, the device is very simple to understand and construct. Also, the device can be easily cleaned by putting it in a laundry bag and washing it with the other clothes since it does not have sharp edges. Furthermore, the device is very cheap and can be reached by many users. The plastic pieces can be made out of recycled plastic which would make the device green and good for the environment. Lastly, the user can be completely independent when using this device where he/she can adjusting by himself/herself without relying on others for help.

KineFlexor 2.0

Kinema
F 0 4 - T 0 3 - 4



Problem Description

The problem statement presented to the team involves the user, Mr. F, who is a 29-year-old male that was involved in a house fire accident. He suffered second and third degree burns on 20 percent of his body surface area. Due to change in body chemistry, calcium build up in his elbow has rendered his arm immobile. He has very limited hand function bilaterally and very sensitive skin. Hamilton Hand Clinic and Tara Packham, the client, wants the team to design a device that would allow Mr. F to regain a certain range of motion in his elbow, while providing maximum comfort. Mr. F requires an orthosis that can allow him to maintain any desired position without his own effort, while providing maximum comfort given his condition. Mr. F is very independent so he wants to be able to adjust the device by himself.

Design

The design consists of two base pieces of thermoplastic that go half way up the forearm and triceps. Each piece has a soft material on the inside. Both pieces attach to Mr. F's arm by means of Velcro straps. Both pieces are attached to each other by snowboard binding straps and buckles. This design is very lightweight and reasonably sized with respect to the user's arm.

Functionality

The device allows the user to achieve flexion and extension in any desired position in a simple way. The user accomplishes this by using the buckles, which guides the elbow through its desired range of motion.

Materials, Components, and Assembly

To build the device, one will require a pop rivet gun, power drill, sewing kit, and a large pot that can hold hot water. These tools can be found at a local hardware store and craft shop. One will also need the following materials: nuts, bolts, rivets, Velcro straps, plastic rings, yoga mat (or like material), snowboard binding straps (ratchet ladder strap), snowboard binding buckles, and a thermoplastic sheet (9in x 12in). These items can be obtained from a hardware store, craft store, sports store, or could be ordered online. This device will take approximately 1.5 hours to construct and can be completed by following the above design.

Cost

This device will cost the clinic approximately $65 to construct and will cost the user whatever the clinic sees as an appropriate price.

User Acceptance and Compliance

Compliance for the user focuses mainly on ease of use and comfort. Mr. F can take the device on and off completely independently. He can take it off by easily pulling 4 rings and put it on by fastening the Velcro straps and inserting the binding straps into the buckles. Mr. F can easily adjust the range of motion desired by lifting the buckle. With Mr. F's skin condition in mind, there is a perforated yoga mat material inside the thermoplastic to maximize comfort while allowing airflow so that his fragile skin can heal. The device looks very professional and is not very obtrusive so Mr. F should not mind wearing the device. The device is safe because there are no sharp edges or pieces and there is no way for the device to cause injury to Mr. F while it is in operation.

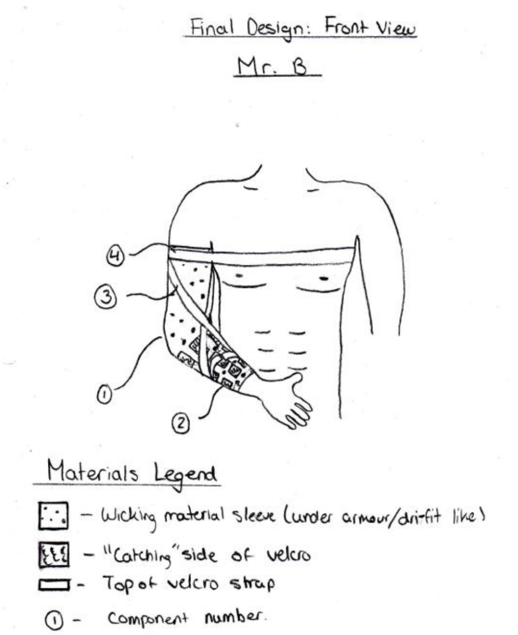
Benefits

There are many benefits associated with this design that put it above many of the current commercial products on the market. Firstly, the parts required to construct the device are low cost and can be easily obtained from local stores or can be ordered online. Furthermore, the device is relatively easy to construct with little direction or instruction needed. Benefits for Mr. F include ease of use with respect to taking the device on and off and adjusting to the desired angle. Another benefit for Mr. F is comfort of the device while minimizing skin contact so that the device does not harm his skin.

Arm Sleeve Orthosis

EGHS Inc.
F 0 4 - T 0 3 - 5

[1] Working Prototype of Design



[2] Final Design Alternative with Materials

Problem Description

The goal is to provide Mr. B with a means to complete every day basic tasks with his dominant right arm. The user requires an orthosis that is lockable at different positions, allowing him to utilize his hand at different arm angles. Due to a sublimed shoulder, Mr. B needs a brace that puts very little stress on his injured shoulder. The orthosis should allow the user to position the arm in the full range of motion that a normal person would have. Finally, Mr. B has requested the ability to vary forearm rotation while wearing the elbow orthosis.

Design

Our design consists of a soft fabric sleeve and two Velcro straps, which when adjusted by the user, determine how much flexion and extension, as well as pronation and supination, the impaired arm is set at. Visually, the orthosis is very inconspicuous, utilizing neutral colours such as black and white as to not draw attention to itself. Its shape is such that it holds very close to the skin, allowing for the user to not be limited by large devices, and even allow clothing to be worn over the orthosis. Its size depends on the user but the sleeve is generally smaller than the user's arm to allow a snug fit. The Velcro straps also depend on the length of the user's arm. The relatively small size of the orthosis coupled with its fabric materials means the orthosis is very light. Due to its negligible weight, users' are not restricted in their daily activities allowing them to perform a range of functions uninhibited.

Functionality

The team at EGHS Incorporated is happy to say that The Arm Sleeve Orthosis completes each required function of the client and user thoroughly. By varying the lengths of the Velcro straps, the user is able to adjust and lock the arm in a full range of motion. Supination and pronation of the forearm is also achieved. By producing a greater tension on one side of the forearm using the Velcro straps this orthosis is able to force a desired supination or pronation in the forearm. Finally, due to external circumstances, the user needed an orthosis that is legally usable in a general public or in this case a jail. Due to the light and gentle nature of The Arm Sleeve Orthosis' materials, the client will definitely be able to legal utilize this device if convicted.

Materials, Components, and Assembly

The device is constructed from simple, easy to obtain materials. The device consists of a wicking material sleeve, such that as an athletic dry-fit sleeve which can be obtained at SportChek. Velcro Straps and elastic straps can be obtained at virtually any fabric or crafts store such as Michael's. In order to construct the device, only a sewing kit is required and measuring tape in order to get the correct size. The device is very quick and easy to make having a total construction time of 1 hour 15 minutes. The assembly does not require any special instructions. The assembly is kept very simple by first measuring the user's arm to obtain the correct measurements then cutting the elastic straps accordingly and sewing them onto the sleeve in the triceps region. Velcro pads are sewn around the forearm onto the sleeve.

Cost

Cost was closely monitored and kept to a minimum. For the athletic sleeve, Velcro straps, and elastic straps the total cost was $28.

User Acceptance and Compliance

The objectives of the design were not only to create a fully functional elbow orthosis but to also make it appealing, safe, and practical. The device is a simple arm sleeve that the user can just slide on with minimal effort and time. It is very quick and easy to put on, adjust, and remove. It is also a safe material to put into a washing machine to keep the device clean. To adjust the device the user would just have to stretch the straps accordingly to the tension they wish to use and stick the strap to a piece of Velcro accordingly on the wrist of the device. The user will definitely want to wear this device. It satisfies all of the functions the user would like it to perform as well as satisfying all of the user acceptance and compliance objectives. It is very light, comfortable, easy to use, and can be worn under clothing therefore it is unnoticeable. The device's appearance is no different to the equipment professional athletes wear in their respected environments; therefore, it is a very appealing device and customizable options are available to the user. Safety was a primary objective of the design since it had to be accepted into a prison. The device definitely meets the safety objective since it contains no dangerous parts that could be used as a weapon and it itself is very impervious. In order to create the safest design possible, the design was kept very simple by utilizing strap tension technology with safe, easy-to-use materials.

Benefits

After viewing the design and functionality of The Arm Sleeve Orthosis it is clear that this orthosis holds a great overall benefit to the user. The design is lightweight, comfortable, ambidextrous and visually pleasing boosting user compliance. Not only is The Arm Sleeve Orthosis a compliable mechanism, but it is also meets all of the desired functional needs stressed by the user. Where this orthosis exceeds compared to other products is that the simplicity of the product does not hinder its functions. Even though this orthosis is easy to make, has a low cost and is extremely comfortable the functionality of the device is not compromised. In essence the team at EGHS Inc. has found a way to produce one of the most comfortable, lightweight braces on the market while meeting and surpassing the functional needs of the user.

Elbow Orthosis Proposal

S.P.L.I.N.T.
F 0 4 - T 0 4 – 1

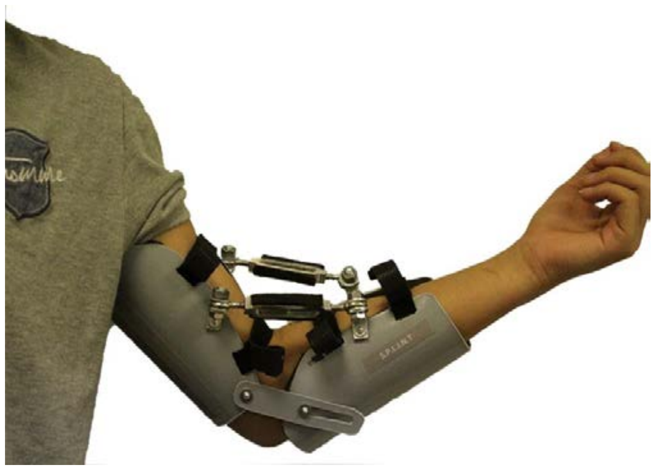


Figure 1: The final design.

Figure 2.1: The orthosis achieving extension on the patient's arm.

Figure 2.2: The orthosis achi-eving flexion on the patients arm.

Problem Description

The user has multiple burns and has had an ossification surgery, and needs forced extension and flexion in the arm and range of motion while keeping it comfortable.

Design

Lock/unlock mechanism which uses turnbuckles to allow for positional settings while making it easy to change angle mechanism. Since the user, Mr. F, suffered 3rd degree burns on the arm, the splint provides superior comfort through the use of felt padding which is mounted inside the splint where it comes in contact with the patients arm. Two turn buckles on the side divide the tension force between the upper and lower arm allowing it to be easier to maintain the force at end range. Turnbuckles are used to facilitate the extension and flexion of the arm. If the user wants to gain extension, the turnbuckles need to be turned away from the users arm. If the user wants to gain flexion, the turnbuckles need to be turned towards the arm. The turnbuckles are connected to the plastic on the upper and lower arm which provides stability of the splint. The plastics on the lower and upper arm are connected together by an adjustable pivot. (See Figure 1). The device weighs approximately 2kg and fits on an arm over clothing.

Functionality

The final design performs functions such as provide extension and flexion of the arm at various degrees achieving full extension to full flexion. A rectangular piece of plastic padding at the point where the turnbuckles exerts force on the radius or ulna. This is used to increase the surface area and decrease the pressure on the burnt skin. The device is fully covered with padding to insure no skin surface area is exposed to the plastic or uncomfortable material. The mobile elbow joint leaves room for extensive flexion and extension. These functions were all requested by the patient and are fulfilled through the design.

Materials, Components, and Assembly

All the materials and components that are required to build the device are easily found and can be purchased at a local hardware store. The materials required are a plastic bucket, two turnbuckles, four bolts, four L-Brackets, eight washers, eight pop-rivets, four nuts, 8 ft of velcro and four pieces of felt padding. The assembly process for the orthosis is relatively simple and should only take the client three hours to complete. This is done by first tracing out the design of the users arm on parchment paper and then transferring this design to a piece of plastic and cutting it out. The next step is to heat the plastic in boiling water for around 20-30 minutes to make it malleable. Once the plastic is taken out, the client needs to work with it quickly so that it does not solidify. The piece of plastic will be pressed against the arm so as to get the proper shape and then left to harden for around 20 minutes. While waiting for the plastic to re-harden cut out the two adjustable pivots that will be used to attach the top and bottom halves of the orthosis together. Using a drill, drill holes into the appropriate spots on both sides of the top and bottom half of the orthosis, and on both sides of the adjustable pivots. Using pop rivets and a rivet gun, attach the top and bottom half of the orthosis to the adjustable pivots using the predrilled holes. Now mark out the areas on the orthosis that will be cut out for the insertion of the Velcro straps. Now using a flame (preferably a blow torch), apply the flame for a very short period of time to the areas of plastic that are sharp so as to melt them into a smooth piece. Now drill the hole on the top and bottom half of the orthosis for where the turn buckle mechanism will be inserted. Using pop rivets, fasten the four L-brackets into the predrilled holes. Now for each L-bracket, insert a bolt into the hole followed by a washer, turnbuckle attachment hole, washer, and bolt onto the actual bolt in that order. Insert the velcro strap into the pre-cut holes and sew it permanently to the orthosis. Finally insert the felt padding making sure to cover any protruding parts of the pop rivet.

Cost

The orthosis will cost $40 tax included + labour costs.

User Acceptance and Compliance

The user’s needs have been considered in the following ways, its light, doesn’t give any rashes on the skin area in contact with the device, it is comfortable, it is easy to operate, to put or take off without the help of another person. The orthosis is designed so the user can simply slide his arm in and out of the device easily. The device is fairly easy to use. For achieving extension and flexion the user turns the turnbuckles. If the user wants to gain extension, the turnbuckles need to be turned away from the users arm. If the user wants to gain flexion, the turnbuckles need to be turned towards the arm. One objective was that the splint should be safe for people around the user and for the user himself, and it was measured in the amount of times the splint dismembers or injures user or surroundings while in operation. This objective was met with 100 points with a result of 0 times injured or dismembered users while in operation.

Benefits

The benefits in the design are that it is really light weight, cost-effective and provides force at different angles due to having two turnbuckles.

Dynamic Progressive Elbow Orthosis

Limitless Engineering
F04 - T04 - 2

Figure 1: Adjusting for flexion

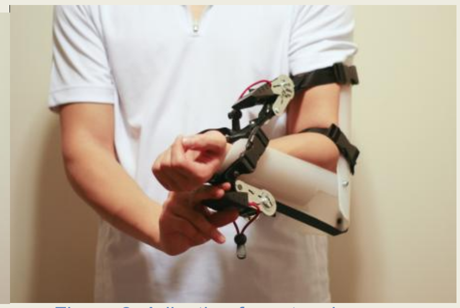


Figure 2: Adjusting for extension

Problem Description

The objective of our firm was to design an orthosis for Mr. F. This device will help him regain his full range of motion in his left arm. The device should also be lightweight and not irritate his skin grafts. In addition, this device should be able to be used without the need of assistance. The device should not only be applicable to Mr. F but should be able to be implemented for a variety of users. Finally, the cost of construction should be minimized and must be able to be constructed within the clinic. Our firm has designed an orthosis that promotes both full flexion and full extension. Mr. F's skin grafts will not be irritated as our design uses an appropriate material that can be in contact with his skin with minimized irritation. By testing the prototype we determined that Mr. F will be able to use the device without any assistance. The device can be adjusted to be worn by a variety of different arm sizes. All the materials used in the construction of the device are inexpensive and are easily accessible.

Design

Figure 1 shows the orthosis being adjusted to promote flexion. The ratchet strap pulls the cast on the forearm and forces the arm into a flexed position. Figure 2 shows the opposite adjustment. The ratchet strap pulls the cast and forces the arm into an extended position. The device covers roughly half of the surface area of the upper and lower arm. The cast weighs a little less than half a kilogram. The ratchet straps are the heaviest portion, weighing a little less than a kilogram each.

Functionality

This design promotes a full range of motion. It can be adjusted at any given angle between the upper and lower arm between 60 degrees (full flexion) to 180 degrees (full extension). The orthosis is adjusted through ratchet straps. These have large grips on them and can be still used despite Mr. F's lack of finger dexterity. The material of the cast will not irritate Mr. F's sensitive skin grafts. The device is held to the arm with nylon straps. These straps can be adjusted to any arm size and can therefore be used by different users of varying arm sizes.

Materials, Components, and Assembly

The device is made up of a cast and a ratchet strap “pulley” system. The cast is made from a polypropylene sheet (similar to thermoplastic).The cast is created by heating the polypropylene sheet and moulding it to the shape of the arm. The sheet can be heated by use of an oven or hot water bath. The cast is attached to the arm by nylon straps and buckles. These are all screwed on to the cast with nuts, bolts, and washers. A drill with a set of drill bits is required. The ratchet system is attached to the straps on the top of the arm (flexion ratchet) and directly to the cast on the bottom (extension ratchet). These are attached by nuts, bolts, and washers. The attachment of the nylon strap to the ratchet strap itself may differ from different ratchet straps. All materials can be ordered through

Cost

The cost to make one device is approximately $64.00. The most expensive component of the device is the polypropylene sheet. The construction of one device however only uses a quarter of a full polypropylene sheet. If the device were to be made in larger quantities, the full sheet could be used and the cost per device would be reduced to approximately $34.00.

User Acceptance and Compliance

User compliance has been considered by closely fulfilling original objectives that are favourable to Mr. F. Our device provides comfort for the user. The material of the cast has a minimal coefficient of friction between the skin and the plastic. This ensures minimalized irritation. The cast is moulded to the shape of the arm as well. This ensures the use of the device to be a comfortable experience. The device can also be taken on and off by itself. This objective was specifically set out my Mr. F, as he does not want to have to ask for assistance while using the device. The device is very similar in appearance to many commercial elbow splints. Compliance has been considered through the design of the cast, the materials used, the ease of functioning the device, and its visual attractiveness.

Benefits

Our device is superior to existing elbow therapy products as it is a multifunctional, inexpensive elbow orthosis. All the materials that are required in the construction are easily accessible and inexpensive. The device is ideal most specifically to Mr. F, but can also be used by a wide variety of users. The device can be adjusted to different arm sizes and flexion/extension settings. It can be used not only by Mr. F, but can be used by others of similar injury. The device can be used even with minimal functionality of the other side of the body. Unlike commercial elbow splints, this device is constructed of a material specifically to ensure minimized irritation of sensitive skin regions. User compliance of the device is high as it is visually appealing and can be worn at all times (indoors, outdoors, workplace). Our device is superior to existing elbow therapy products, and is the ideal elbow orthosis for Mr. F.

Telescopic Elbow and Shoulder Support

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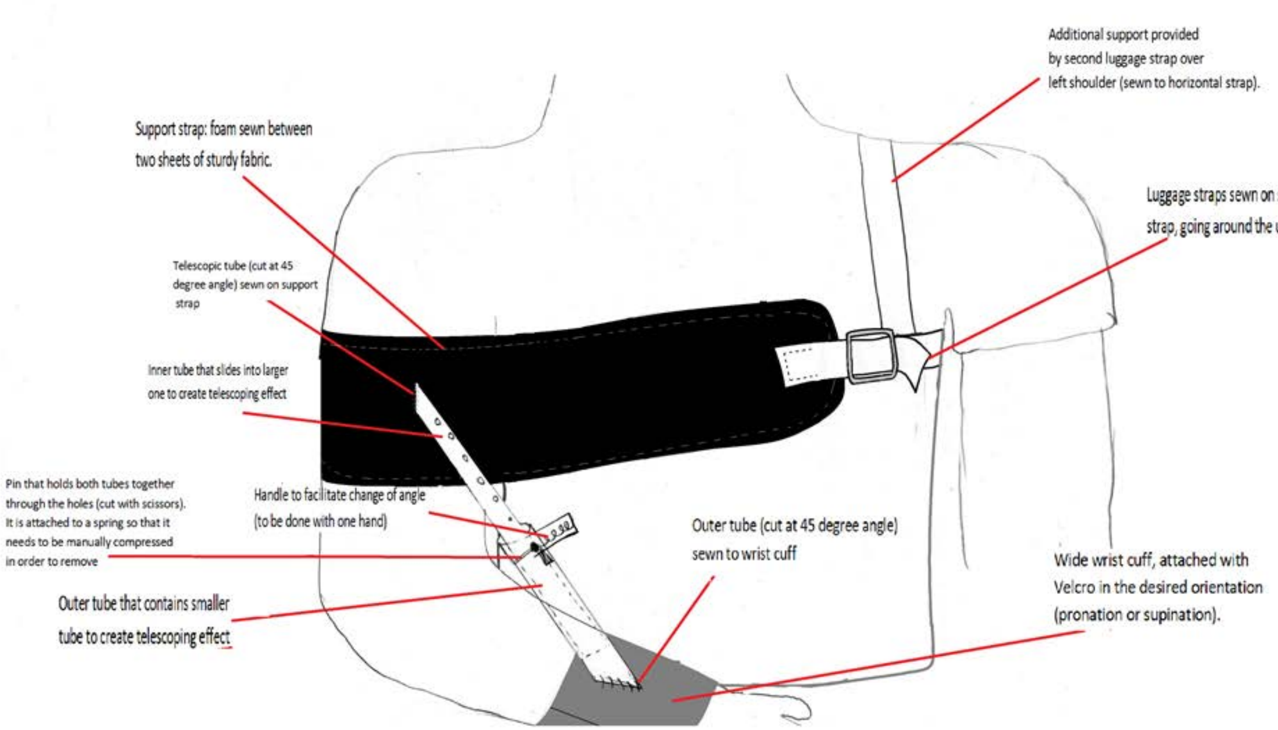
Team Name
F 04 - T 04 - 3



Problem Description

Tara Packham, from the Hamilton General Hospital, wants a device for her Client Mr. B, who suffers from a shoulder subluxation, an injured brachial plexus (nerve damage in right arm) and a compound fracture in the wrist. Both she and the client want a device that can facilitate the use of his functional hand despite the total loss of use of his arm, shoulder and elbow. This includes locking the elbow at many angles, control of pronation and supination as well as active assisted range of motion. They are also looking for a device light enough to prevent further subluxation, and that can be easily made in the clinic without the need for elaborate tools.

Design

As seen in the sketch above, the Telescopic Elbow and Shoulder Support is simple and light. The elbow locking mechanism consists of two tubes perfectly sliding into each other that can be extended or contracted to the user's preference. The holes are then aligned and a spring-loaded pin keeps them in place, as seen in the sketch. As this tube is connected to the wrist cuff and the cross-chest-strap, the angle of the elbow is relative to the adjustable length of this tube. For the control of pronation and supination, seen in the smaller sketch, a tensor band is wrapped and fixed at the wrist to provide rotational pressure to keep it at the desired position. In addition to providing extended range of motion, this device weighs less than ___ and provides additional support to the shoulder with the cross chest shoulder strap, seen as the large black strap in the sketch. The straps are also all adjustable to the user's size.

Functionality

As described above, this device controls the elbow angle and pronation/supination of the arm, all while supporting the shoulder. As the telescoping tubes are easily adjustable, the client can quickly change the desired position of his arm to adjust his daily activities such as tying a shoe, typing, or writing. He can also choose the level of pronation or supination, weather it is for active assisted range of motion or just for the different positions he needs to complete daily tasks. This being said, the Telescoping Elbow and Shoulder Support can to everything that was requested, actually surpassing the needed level of shoulder support.

Materials, Components, and Assembly

All materials used for this device can be obtained at a general hardware store for a relatively low price (see chart, below). The construction time ranges from 1-2 hours but can be improved if done on a regular basis. The tools needed are scissors, a sewing kit and adhesive glue at minimum, and certain simple instructions would be necessary to build the device: Cut tubes to desired length, make aligning holes with scissors, and attach a 3 inch section tube perpendicular to telescopic tubes (with adhesive glue). Attach spring and pin to end of perpendicular tube so that it can be compressed to remove the pin from the holes. When decompressed, the pin is force inside a new hole and is therefore the basis of our telescoping system. See telescopic tubes sketch for a visual idea of the construction. The harness is easy to build and everything is attached with a needle and thread (can be done quicker with sewing machine).

Cost

The average cost is 24$ per device, but the price will go drastically down if materials are bought in bulk (probably the case for the clinic). See chart for specific cost:

Material	Cost per unit	Total cost
Luggage straps	$2.87/2ft	$5.74
Foam padding	$6.82/50 ft	$1.36
Cotton fabric	$22.50/sq meter	$5.63
UVC tubes	$16.50/20ft	$0.83
Spring	$1.59 ea	$1.59
Pin	$2.29 ea	$2.29
Velcro	$33.59/5ft	$6.72
Total		$24.16

User Acceptance and Compliance

As the device itself will help the user complete his daily activities, we are already one step closer for the client to like the design. Additionally, our device provides him with comfort, as the design has adjustable straps to his size and is padded with soft foam throughout the chest strap. It is easy to use and can be put on with one hand, and can be fully adjusted with one hand as well. The client can be totally independent with this device and will enjoy the extra movement he can do. On the cosmetic side, any device will be visible but this one comes in discreet colors that can be disguised with his clothes. The device is relatively safe as the telescopic tubes are made of UVC mouldable plastic, and are malleable in case of a fall. No sharp edges or other risks are present, and the user can trust the device.
How has user compliance been considered? How will the user get it on and off? How has it been designed to be comfortable? How does the user use it? Will they want to wear it? What have you done with respect to cosmetic considerations? You should be discussing how you met your objectives. How have you considered safety of the design?

Benefits

The difference with this device compared to others is that there is added shoulder support in addition to the locking of the elbow. It is much easier to use with the spring loaded pin and the sturdy but malleable materials are quasi fail-proof. It can be constructed quickly in an inexpensive manner, and all the objectives are met (even if incarcerated, the spring loaded aspect must be removed but the rest of the device is acceptable). Additionally, when the client no longer needs it, all materials can be recycled and reused for other similar devices, adding a sustainable component to this project.

Boltflexor

Joint Industries
F04 - T04 - 4

Figure 1

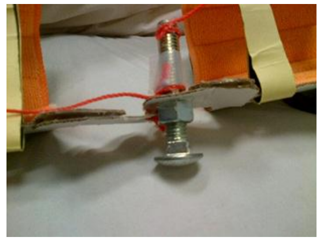


Figure 2

Figure 3

Figure 4

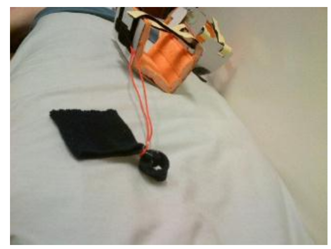


Figure 5

Problem Description

The problem revolves around Mr. B, a 23 year old single male who sustained extensive injuries when he crashed his motorcycle at high speed. His injuries include a degloved right wrist, a dislocated shoulder as well as tendon and nerve lacerations. Due to these injuries, Mr. B has no movement or rotation in his right arm. The task is to design a device that will aid Mr. B in regaining range of motion in his right arm. Since Mr. B lives alone, the device should allow for easy adjustability without assistance, allowing him to change the ROM at will. This will also allow him to maintain his independence. In addition, Mr. B should have the ability to perform normal functions while wearing the device, giving him the freedom to leave his home and have mobility. Since his right shoulder is dislocated and cannot support much weight beyond that of the arm itself, the device should minimize the strain put on the shoulder to prevent any further injury. Also, Mr. B has the possibility of being incarcerated, so the device should not be able to be easily weaponized. Finally, the client's needs must be taken into account. The client is Tara Packham and Hamilton General Hospital. Materials and tools used to construct the device should be easily accessible and it should require a short amount of build time. The following design meets all of the above criteria, making it an effective tool in Mr. B's rehabilitation.

Design

With primary concern given Mr. B's weakened shoulder, the design is lightweight; weighing just 0.27 kg, with as little direct pressure on the shoulder as possible. It uses a belt attached to the device that goes around the waist (figure 1). This keeps the upper arm firmly pressed against the chest, taking strain off the shoulder. Mr. B wanted to perform simple tasks, so the pronation and supination of the wrist is important. The device's compact form (figure 4) does not inhibit movement of the lower arm, while the glove device that provides the rotation (figure 5) is as minimally invasive as possible.

Functionality

The functions that this device focuses on are considered to be the most important for Mr. B. First, the range of motion can be changed and also fixed in place due to the nut and bolt mechanism (figure 2). By tightening and loosening the bolt, the attached string can pull the arm from full extension at 0 degrees to flexion with a maximum possible angle of 120 degrees. In addition, the glove mechanism provides the desired rotation of the wrist, allowing for different hand positions for different tasks. The Velcro strap can be set in two positions, one for pronation and the other for supination. The problem of Mr. B's possible incarceration was addressed, with an emphasis on using soft, blunt materials to prevent the device being weaponized. However, the nut and bolt, being made out of metal, could cause bodily harm. The range of motion was deemed to be a more pressing issue so it took precedence. The bolt would ideally be made of a different material to avoid this problem.

Materials, Components, and Assembly

The prototype is constructed using foam liner, cardboard, a nut and bolt, string, T-shirt fabric and Velcro straps. As for tools, a glue gun, duct tape, scissors and a stapler are used. All of these are found at Dollarama and Home Hardware. The construction process was very simple and time effective. Cut two pieces of cardboard and liner to a length of 12cm with a height according to the user's arm. Glue the liner inside the cardboard. Attach two Velcro straps to each arm component using the sticky tabs provided. Attach the two components with a small piece of cardboard (figure 2). Cut a hole in it large enough for the bolt then glue the nut so that it is surrounding the hole. Keep in mind, when the bolt is fed through the hole it should not rub on the skin, so adjust the height of the piece of cardboard accordingly (figure 4). 2 pieces of string are glued to the bolt and to the arm components.The belt should easily reach around the lower chest and be able to fold back on itself using Velcro straps. The strap is glued at one end to the upper arm component and fed through a slit cut into the same component. Construction time is one hour, depending on number of people involved.

Cost

The following costs will be based on the materials and tools used in the building of the prototype. For the clinic, the cost will be roughly 20 dollars for the materials, which include foam liner, cardboard, nut and bolt, string and Velcro. However, the durability may be a concern, so thermoplastic could be substituted for cardboard at an added cost of 30 dollars, depending on the size of the arm. As for tools, the total cost was 30 dollars for a glue gun, duct tape, scissors and a stapler. The cost to the user would be slightly more than that of the client.

User Acceptance and Compliance

To put on the device, the user slips his arm through it like a sleeve, keeping the arm fully extended. The bolt should rest above the inside of the elbow (figure 4). Tighten the Velcro straps so the device is securely fixed to the arm. Put the belt strap around the waist and put through the slit provided, pulling it tight so the upper arm cannot move abductionally. Then, adjust the device by tightening the bolt. This will put tension on the string and force the arm into flexion (figure 3). The opposite can be done to return the arm to extension. The device must be comfortable, flexible and compact to aid with user compliance. The foam liners prevent from rubbing and help keep the arm securely in place while remaining comfortable. The lightweight design means the user can be mobile while wearing the device and perform many essential daily tasks such as typing and writing.

Benefits

The Boltfexor is an ideal device for Mr. B because it was designed specifically for this user. It has a very lightweight design while providing the required range of motion of both the arm and wrist. It is incredibly cost effective for both the client and the user, using readily available supplies. This device would be the ideal addition to Mr. B's rehabilitation process.

DYNAMIC ELBOW ORTHOSIS PROPOSAL

C.O.E.A
F 0 4 - T 0 5

Problem Description

Mr. F was a victim of a house fire, leading to heterotropic ossification in his elbow, and severely limiting the range of motion in his arm, as well as his hand function bilaterally. Tara Packham of Hamilton Health Sciences would like a specialized splint to induce flexion and extension in Mr.F's arm, and regain full range of motion. Furthermore, Mr. F has skin grafts, which are prone to blisters and infections, and he would also like to be independent in applying and removing the splint.

Design

The design of the orthosis is simple, which allows for it to be easily recreated. As shown, the knob on the clamp lock can easily adjust the angle of the orthosis. Also, the surface area of the orthosis has been minimized, to minimize contact with skin. In doing this, the size of the orthosis has been restricted to a moderate size, covering from the wrist to the bicep, as displayed. The main structure of the orthosis is built out of thin aluminum plates, which minimizes mass in the overall orthosis. The brass clamp makes up a majority of the weight of the splint, which is 1.6 pounds.

Functionality

The orthosis allows for a range of angles in which flexion and/or extension can be induced in the arm of the user. The locking mechanism will put the sufficient pressure on the user, Mr. F's arm so that he may achieve a full range of motion over time, as the angles of the device can be adjusted along with his improvement until his end goal is achieved. Furthermore, the client had request specifics about the device, as mentioned in problem description. Small surface area of the orthosis, and its changeable bandages accommodate for skin sensitivity, and the large knob will allow for independence.

Materials, Components, and Assembly

The elbow orthosis is made of common and inexpensive tools and materials. The materials include 6 pieces of thin aluminum plates for the overall structure of the orthosis, rivets to attach the plates, a screw and bolt (to attach at the elbow joint whilst allowing movement), a window clamp, Velcro straps, as well as bandages and padding.

Tools included a tin snip (for cutting light metal), a hand drill, rivet gun to attach rivets, as well as a glue gun and sewing kit.

Materials and tools are commonplace items that can be obtained at local hardware stores. The assembly of the orthosis, like the design, is fairly straightforward, thus elaborate instructions are not needed to assemble this elbow orthosis, as basic assembly can be deduced by looking at a pre-existing orthosis. However, basic instructions for assembly are required for someone who is assembly the device for the first time. For example, the aluminum plates can be bent by hand around a round surface, and holes are drilled at joints and at places where two pieces are attached. Procedures such as sewing on the Velcro straps and applying padding and bandages do not need to be done in a specific way, but should be done to maximize the potential of the device to the user.

Cost

All the materials used in the making of the orthosis are inexpensive. All aluminum plates totalled to $ 13.99. Velcro straps required were $ 5.00. The cost of a box of 20 rivets was $2.00. The window clamp was for $ 16.99 and the bandages and the padding amounted to $ 5.00. Therefore, the overall cost of materials was approximately for $ 43.00. The cost for the clinic will be less than $43.00 if they were to buy supplies in bulk. The cost of the device for the user will be slightly more, depending on how the clinic wishes to charge.

User Acceptance and Compliance

User compliance is an integral part of the design space. Mr. F will be able to get the device on by placing his arm into the frame and adjusting the Velcro straps along the device. Taking it off is efficient, as once the Velcro straps have been detached the device will just slide off of the user's arm. The design team feels as though we have succeeded in designing a device which will allow for independence.

Minimal contact from the device is the most vital feature in terms of comfort. This will minimize discomfort and injuries, as well as maximize mobility. Bandages have also been placed on the device to address his cosmetic concerns, which he can change himself. Finally, all bolts, screws and sharp edges on the device have been eliminated to ensure minimal risk of injury. This as a splint, will be one of the clients top choices, on his road to regain full range of motion. This device will perform its function, and is specialized to address the specific needs of the client himself. All objectives deduced from the problem statement have been met, to a considerable extent. With instructed wearing, the device will allow for the client to regain full extension and flexion of his arm.

Benefits

There exists considerable benefits in the design of this orthosis. The orthosis performs the fundamentally needed function of an elbow splint, which in this particular case is to allow for eventual full range of flexion and extension in the right arm, through developing increments. The clamp allows for flexion and extension of any angle, and are not limited to increments as other splints are. Furthermore, the minimized surface area, padding and changeable bandages ensures the protection and hygiene of Mr. F's skin. It is lightweight, as well as accommodating to apply, remove and adjust with ease, thus allowing for independence. The price of materials needed for the orthosis is also considerably low, in stark contrast to many others on the market.

Consilient Orthosis

Consilient Orthosis
F 0 4 - T 0 5 - 2

Final Design

Final Design: Flexion

Final Design: Extension

Problem Description

Mr. F was afflicted by *Heterotrophic Ossification*, a build up of additional bone around his elbow. This was a result of chemical changes that occurred in his body while healing from second and third degree burns covering 20% of his body surface. The excess bone was removed in surgery, but the experience severely reduced the range of motion in his elbow. As a result of the burns, his dexterity was significantly reduced, therefore reducing his independence. The Hamilton General Hospital Hand Clinic is looking for a device that will increase his range of motion, specifically a static progressive orthosis, holding his arm at maximum extension and/or flexion. Due to his burns, he has had extensive skin grafts making his skin extremely fragile, which means any irritation caused by the orthosis can cause blisters and bleeding.

Furthermore, Mr. F seeks to be independent, so the orthosis should be designed so that he can control it using his damaged hand. His range of motion should be improved to the extent that he can live and work independently. The Clinic itself is looking for a design that can be fabricated mostly from materials that are readily available in their shop, and at a relatively low cost.

Design

Refer to Appendix

The design has few moving parts, other than the turnbuckles, which will increase the overall strength of the device. The forearm and upper arm portions cover about half the length of each section of the arm and wrap around a little over half the circumference of the arm. There are six hooks on each component (a total of 12), 3 on each side. The hooks extend about a half-inch from the device and the thermoplastic and memory foam are about a three quarter inch thick in total.

Functionality

The device can provide both an extension and flexion force by means of the turnbuckles. The turnbuckles provide an adequate flexion force through the shortening of the turnbuckle, which is simply done by turning the middle section. The turnbuckles can provide an extension force, but not as well as they can a flexion force. The turnbuckles are easy to lengthen and shorten, and require minimal dexterity. The turnbuckles can be attached to hooks at different locations to provide the desired amount of flexion or extension. If a large flexion force is required for example, the user may want to attach the turnbuckle to hooks on opposite sides of the device. If a large extension force is required, the turnbuckle should be attached to hooks closer to the elbow.

Materials, Components, and Assembly

The materials required for the device are easily found within the shop or at a local hardware store, such as Home Hardware. The device requires the use of thermoplastic, memory foam, small hooks (preferably ones with screws), duct tape, glue/adhesive, Velcro straps, and turnbuckles. If memory foam is not an option, any sort of foam material can be used. The tools required for construction are: one hand held drill, one utility knife, 1/16 inch drill bits, wire cutters, and a hot plate. The design takes approximately one hour to build, or less depending on the skill level of the builder. To assemble:

1) Heat up a pan of water on a hot plate and heat up the thermoplastic until it has the desired flexibility
2) Mould the thermoplastic around the arm, leaving room for foam inserts. Cut the plastic to half the length of each portion of the arm and to half the circumference of each portion of the arm.
3) Drill three pilot holes on either side of each component (for a total of six on each component), and screw in the hooks.
4) Cut off the sharp ends of the hooks with the wire cutters and cover the cut ends with duct tape.
5) Glue the foam inserts onto the inside of each component with the adhesive.

Cost

The cost breakdown is as follows: $5 for the turnbuckles ($2.50 each), $3.00 for the memory foam, $15 for the thermoplastic, $24 for two packs of Velcro, $3 for the glue, and $6 for three packs of hooks (5 in each pack), $0.06 for duct tape

Total Cost: About $47.00

User Acceptance and Compliance

User compliance was considered thoroughly throughout the design process. The user can easily put it on and take it off due to the use of Velcro straps, which require little dexterity. The user should be able to use it without assistance, which is what the user wants. The memory foam provides extra support and padding, increasing the comfort of the device, and the device is lightweight so it will not tire Mr. F's arm. The device is simply adjusted by turning the middle portion of the turnbuckles and placing them at different positions (hooks). The device is durable, and at a low cost, which will benefit the user. The design is safe, but there may be a problem with the hooks rubbing against the body, which would cause irritation.

Benefits

There are several benefits to our design that make it better than other design alternatives available. Our design represents several advantages. It is simple, easy to use, and this is extremely important to the user. It is affordable, well within the client's budget, and even though the price tag is low, the durability of the design would make you think different. It is comfortable and lightweight which will certainly please anyone who uses the orthosis.

The Buckler

Team Name: Breaks and Burns
F 0 4 - T 0 5 – 3

The user changes the angle of the Buckler by using the turnbuckle.

Bungee cord supports and prevents rotation of arm.

The device enables the user to hold light objects while wearing it

The Buckler when not being worn is lightweight and easy to transport.

Stretch utility straps are used to secure the device onto the arm.

The foam sponges cover small metal parts that could be a potential danger.

Problem Description

Tara Packham, an occupational therapist from the Hand Clinic at Hamilton Health Sciences, has a 23 year old male patient, Mr. B, who was involved in a motorcycle accident that resulted in no working muscle in his right shoulder and elbow. He has a compound fracture at the radial bone in his forearm and suffers from a brachial plexus injury that prevents him from using his arm. However, his fingers still function and he desires a device that will position his hand in such a way that it is possible for him to do everyday tasks such as writing, typing, holding, and pressing things (i.e.- flexion and extension). The device must not interfere with any part of the Hand Clinic's rehabilitation process and must be easy to construct using materials available to the clinic.

Design

The design consists of two cuffs of thermoplastic that go around most of the forearm and bicep. A turnbuckle is attached to the outer sides of the cuffs, and a bungee cord is attached to the inner sides. The thermoplastic is flared out in the areas where the turnbuckle and bungee are connected to prevent skin irritation. An elastic strap is attached to the top and bottom of each cuff. A body strap that is made of two backpack straps connected together goes between the bungee cord and arm, around the body to hold the arm in place. The Buckler weighs 575 grams and is meant to be worn over clothing.

Functionality

The Buckler has a body strap that relieves the shoulder from carrying the weight of the arm by redistributing the weight across the body. This body strap also prevents the arm from drifting. The design provides flexion and extension in the right arm via the turnbuckle, and the bungee provides additional support to the arm. The Buckler does not, however, provide any adduction or abduction. It does not actively allow for supination or pronation of the arm although it is possible for Mr. B to wear the device while his arm is either supinated or pronated.

Materials, Components, and Assembly

The Buckler is made of easily available and inexpensive parts. Firstly, it requires thermoplastic which is already accessible to the clinic and can also be purchased online. It also needs a turnbuckle, nuts, bolts, and washers, all of which are available at Canadian Tire. Finally, the foam sponges, stretch utility straps and bungee cord are found at the dollar store. The device takes approximately one hour to fabricate and is simple to make. No special tools are required other than a drill or awl to make holes in the thermoplastic, and scissors to cut the thermoplastic.

Cost

The device will cost the user $50.29 based on the cost of materials listed below:

Materials	Cost ($)
3.87 inch Turnbuckle	2.29
Thermoplastic	35.00
Misc. Nuts, Bolts, Washers	4.00
Bungee Cord and Foam Sponge	2.00
Stretch Utility Strap	2.00
Body Strap	5.00
Total Cost :	$50.29

However, since thermoplastic is already available at the hand clinic, the device will cost the clinic $15.29.

User Acceptance and Compliance

Our product addresses user compliance by being very easy to adjust. If Mr. B. wants to change the angle, he simply has to twist the turnbuckle clockwise to achieve flexion, and counter-clockwise to achieve extension. If he wants to adjust tension, he just has to hook the bungee cord at a different location. He can do both of these things without having to rest his arm on a flat surface.

It's comfortable because the thermoplastic is moulded to his arm, and the straps are elastic so they're less abrasive than Velcro. The body strap is also very soft so he can wear it for long amounts of time and the whole product is lightweight.

Regarding safety, the edges of the thermoplastic have been made blunt and foam sponges have been added to the ends of the turnbuckle to cover the washers, nuts and bolts.

Benefits

The design of our product is very simple making it easy to construct at the Hand Clinic. It is made of easily available parts that are inexpensive and reusable. Because of this, in case of breakage, it is easy to fix or replace.

Linsongity Elbow Orthosis

W.E.L.L.R. Solutions
F 04 - T 05 - 4

Figure 1: Device showing highest flexion setting

Figure 2: Linsongity Elbow Orthosis

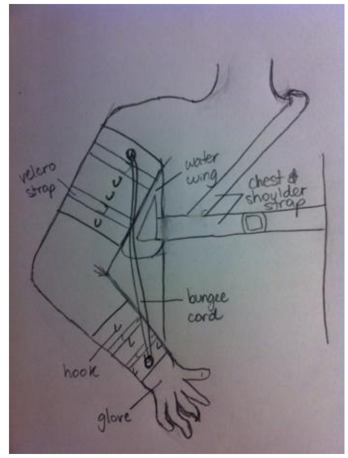


Figure 3: Final design sketch

Problem Description

The user Mr. B lacks full motion in his right arm, although is able to slightly move his wrist and fingers. A severe right shoulder injury also constrains the movement of his right arm, as the muscles around the joint are damaged and weak, therefore the shoulder cannot provide the arm with strength and support. Furthermore, Mr.B also suffers from de-gloving on certain parts of his arm, consequently making his skin very sensitive. Due to these injuries, Mr.B requires a device that provides him with full range of motion about his elbow. In addition, the client Tara Peckham, from the Hamilton General Hospital Hand Clinic, requires a simple, inexpensive, but functional design in order to address Mr. B's injuries and aid his recovery.

Design

The design is lightweight, approximately 1 to 2 pounds in weight. In addition, it covers most of the arm, that being about 60 to 70 percent. The design has three parts, a part that attaches to the bicep, one to the forearm, and a wrist/hand part. In terms of size and in relation to each other, the bicep part is the biggest out of the three, with the forearm part being the next largest in size, and the hand part being the smallest.

Functionality

Functionally speaking, the device can provide the user with an optimal range of flexion, extension, supination, pronation, adduction, and abduction. This range varies per function, and consequently some functions work better than others. For instance, the user can achieve a flexion and extension range that is greater than

90 degrees. The device can perform all of the required functions by the client, although it cannot perform all functions at the same level of functionality.

Materials, Components, and Assembly

In terms of the materials used for the construction of the device, velcro straps, adhesives such as super glue and tape, fasteners, a shin pad, a water wing, foam and padding, 7 small hooks, a bungee cord, a winter glove, and 2 backpack straps were used. The materials for construction can be obtained at a local hardware store such as Canadian Tire, Home Depot, or Rona. In order to assemble the device, tools such as scissors, a needle, and thread were used. With this in mind, if further assemblies are desired, the person building the device must have minimal knowledge in sewing in order to attach the glove to the wrist brace. The design was assembled in approximately two hours, and minor modifications were made at a later date which took about half an hour, thus bringing the total assembly time to a number close to two and a half hours. Instructions on how to put on the orthosis are definitely needed, but the process of putting it on is not difficult. Instructions are just needed to assure that the user is putting on the device in such a way that will maximize the functionality of the device and therefore speed up his recovery. For instance, the different ways that extension and flexion can be achieved, as well as supination and pronation of the wrist with the use of the bungee cord.

Cost

A single Linsongity Elbow Orthosis device can be constructed with a variety of materials that will cost the clinic an amount in the range of 20 to 30 dollars.

User Acceptance and Compliance

The user's compliance was considered in the design of the device and can be noted in the simplicity of the design. This means that the user can easily put on the device by himself by using his undamaged arm and can therefore successfully follow his treatment. The time required to put on the device can vary and will not exceed the 5 minute mark. This time can be optimized and can approximately take up a couple of minutes, depending on the user's experience of putting it on. Due to the user's injuries, the device was designed to provide comfort and aid recovery. In terms of comfort, any part of the device that comes in contact with the user's skin was covered in foam and padding in order to minimize irritation. Furthermore, a chest and shoulder strap designed to wrap around the elbow opposite to the damaged one were attached to the device. This accordingly helps reduce strain on the shoulder and allows the torso to provide support for the weight of the orthosis. The user would typically use the device while he is active during the day and while he is sleeping. Moreover, the device is not aesthetically appealing, thus there is the chance that the user will not feel comfortable using it in public. Furthermore, the safety of the device was considered during the design process and effectively implemented on the design. There is no possibility that the device can cause self-harm to the user, but it may be harmful to others. As a result, the device may not be acceptable in prisons.

Benefits

The Linsongity Elbow Orthosis design makes the device better than other existing devices because it can perform 6 different functions to some extent. As well, the device has been designed to provide comfort to the user, keeping in mind that the skin on his arm is in poor conditions, and thus can be easily irritated and further damaged.

FlexRod Elbow Orthosis

Switchback Engineering
F 0 5 - T 0 2 - 1

FlexRod Elbow Orthosis Locking the User's Arm In A Typing Posistion

Problem Description

The problem presented by the client was to build an elbow orthosis to assist a user with a brachial plexus injury, and partially subluxed shoulder, with daily activities. The proposed design allows the user to lock their arm into various positions, such as writing, typing or eating positions. The orthosis assists the user in daily activities that they would struggle with otherwise.

Design

The *FlexRod* elbow orthosis consists of four main parts: the thermoplastic U-shaped cups, the support strap, the flexible rods connecting the thermoplastic and the locking mechanism. The device is very simple, user friendly, and lightweight. The orthosis only weighs 400 g, and the load on the shoulder can be reduced further with the optional support strap. The maximum width the device adds to the radius of the arm is 1.1 cm, making it very low profile.

Functionality

The device can effectively lock the users arm at multiple positions useful for daily activities. Typing, writing and carrying positions can all be implemented with the device. The orthosis can also put on by just the user, allowing independence. The client wanted a device that would help the user perform daily activities, and FlexRod elbow orthosis does just that.

Materials, Components, and Assembly

Materials required are: approximately 1/4 of an 18”x24” sheet of thermoplastic (depending on arm size), elastic Velcro straps, 9 snap buttons, a 7 ft. luggage strap with plastic buckle, 8 zip ties, a roundhead threaded bolt, a corresponding sized nut, a foam bathmat, and 2 flexible rods (with foam coating). All materials can be obtained at a local dollar or hardware store, with the exception of the thermoplastic (which needs to be specially ordered). The only tools required are a boxcutter knife, a hot glue gun, scissors, a sewing kit, and a power drill with a drill bit. The orthosis can be built quickly (1 hour build time) and easily, and only requires a few tools and a small set of instructions.

Cost

The approximate cost of our orthosis is $40.00. The entire device was constructed with materials that are easily available and low in cost. The thermoplastic was the most expensive material used. The exact costs of the materials are as follows: thermoplastic ($17.00), Velcro straps ($2.00), buttons ($2.00), luggage strap ($7.00), zipties ($2.00), bolt and nut ($1.00), bathmat ($2.00), and the flexible rods ($2.00). This results in a cost of $35.00. It takes roughly an hour to build the device, which is a small additional expense. The cost for the entire orthosis is $35.00, there are no extra costs or rental fees. This is a very low price compared to other devices on the market, which can cost hundreds of dollars.

User Acceptance and Compliance

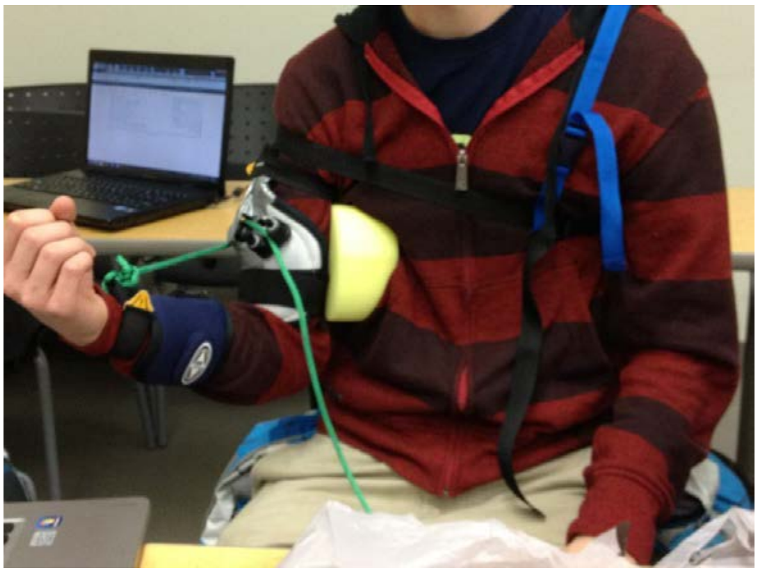
The device is comfortable to wear, low profile, and lightweight, which promotes high user compliance. The user can take the device on and off with one hand, enabling independence. Comfort is achieved through the use of bathmat padding on the inside of the U-shaped cups. The user will use the device during activities like typing, writing and dining. The orthosis can be adjusted to the desired position, and will stay in place until changed by the user. The user will want to wear the device because it is low profile, and will allow them to put their arm where they want. The majority of the orthosis can be worn under clothing (the exception being the support strap), and is hardly noticeable under most clothes. Cosmetically speaking, the device is fairly plain and inconspicuous. Our device met the objectives of being user friendly, comfortable, and assisting in daily activities. Safety has been considered during the design process by minimizing sharp edges and making it easy to remove if necessary.

Benefits

Our device is superior to others because of its low cost, low weight, simple yet effective design, and overall ease of use. Through the use of easily available and inexpensive materials, we reduced costs to a minimum. Compared to commercially available products, our orthosis is a fraction of competitor’s prices. Another way we reduced costs was by ensuring a fast build time. This results in lower labour and manufacturing costs. By using lightweight materials (plastic, fabric) over conventional ones (metal, wood), we were able to reduce the overall heaviness of the device. This also reduces the extra load put on the user’s injured shoulder. During the intial design phase, our team explored the simplest solutions to the problem. This resulted in a final design with simple, low cost and easily replaceable parts. Our device is so easy to use that it can be put on with one hand. It can also be adjusted into position with very little effort from the user. To adjust the orthosis, there are no complex tensioning mechanisms, or finicky screws that are difficult to adjust. It’s as easy as moving the arm into the desired position, and locking it there. Additional benefits are the device’s durability and low profile design. The orthosis is made from rugged materials like plastic, which is light and strong. The orthosis can be worn under clothing, meaning that the user could go out into cold conditions without any issues. Many other existing solutions do not have all of these benefits, and if the do, they cost a lot more.

Cam Cleat Lock

Biopticon
F05 -T02 -2



Problem Description

Mr.B, a 23 year old patient of Tara Packnam at the hand clinic, has suffered sufficient damages to his right arm during a motorcycle accident. His injuries include a compound fracture and dislocation and degloving on his right wrist with tendon and nerve lacerations. He also suffered a brachial plexus injury on his right arm. Mr.B is unable to move his right arm, but has functional use of his right hand. A solution for Mr.B's problem would be a device that allows him to use his right arm for day to day tasks, while still providing support. This device should also reduce the load on the right shoulder.

Design

This design is composed of a wrist and a shoulder mould. Both of the moulds are made out of thermoplastic to increase the durability of the splint. The thermoplastic also provides a comfortable mould for the injured arm. A cam cleat and pulley is attached to the shoulder mould. This design is also composed of a rope that attaches to the wrist mould and goes through the pulley. The pulley provides a means to reduce the force required to flex and extend the arm by pulling on the rope. The cam cleat allows the arm to be locked at specific angles for daily activities such as typing and writing. There is also a chest strap that attaches to a shoulder strap for extra support. This design top of the line because it is very small, the moulds only covers a portion of the deltoid and the wrist.

Functionality

This design is exceptionally functional because it can switch the arm between pronation and supination. It can also lock the arm at various angles in extension and flexion which allows the user to participate in daily activities. This design is also super innovative; it reduces the load on the shoulder by having a chest and shoulder strap, to redistribute the load.

Materials, Components, and Assembly

Materials:

- Velcro
- Super glue
- Rope
- Sponge for padding
- Strap and buckle
- Thermoplastic

Components:

- Cam cleat

Tools:

- Exacto knife
- Needle and thread
- Scissors

Where they can be found:

- Boat shop (cam cleat, pulley and rope)
- Hardware store (strap and buckle)
- Dollar store (sponge)

Instructions:

1. Mold thermoplastic to the users deltoid and wrist
2. Attach Velcro straps to the thermoplastic molds, and sew straps to form a loop
3. Attach cam cleat and pulley to shoulder mold. Feed the rope through the pulley and attach it to the wrist mold.
4. Attach chest strap with buckle to the deltoid arm mold by piercing a hole through the thermoplastic and feeding the strap through
5. Attach chest strap and shoulder strap by feeding the chest strap through the loop in the shoulder strap, so that they are perpendicular to each other.

The construction of this splint takes around an hour.

Cost

- Thermoplastic- $17.50
- Rope-$10.00
- Pulley and clamp-$10.00
- Sponge- $3.00
- Chest and shoulder strap- $8.00
- Velcro(x4)-$8.00
- Thread- $1.00
- Glue and miscellaneous costs- $2.50
- Labour cost- 1 hour of labour

Total cost: 60.00$

User Acceptance and Compliance

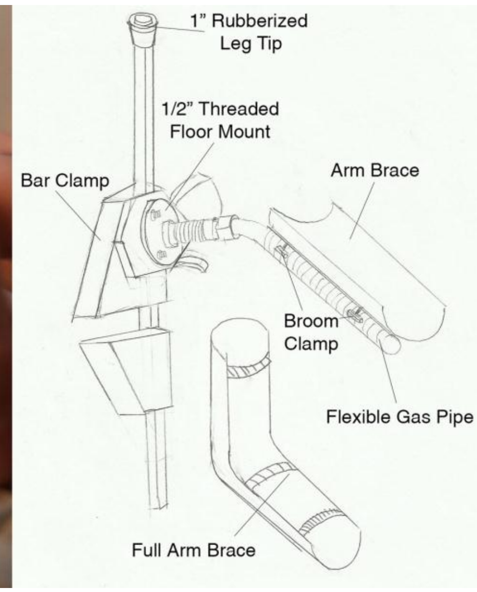
This splint can be easily put on and taken off by Velcro straps. The user simply has to put their arm through the Velcro straps at the wrist and the shoulder and tighten. Then the user simply has to attach the chest strap around their chest to the outside of the arm mould. This splint was designed to be as comfortable as possible with the aid of a sponge as a pad between the users arm and chest. The user can easily adjust the angle of flexion by pulling on the rope through the cam cleat. The cam cleat will then lock the arm in place. This design is exceptional because it is super lightweight and it is esthetically pleasing. This design is also extremely innovative because it meets all of the main objectives of the client and the potential user. This design is also extremely safe for both the user and the people they could come into contact with.

Benefits

This design is the best on the market because it can lock the arm at multiple angles in flexion and extension. It also allows to user to do an assortment of daily activities from lifting objects, to typing and writing. This design is also extremely lightweight, and it includes a shoulder and chest strap that transfers the load to the unharmed shoulder and across the body. The chest strap also ensures that the injured arm does rotate about the transverse plane. This design is also one of the best on the market because it is very cost effective; the user gets a durable innovative design for a very low cost. This design can also be built almost anywhere with simple parts, and it takes very little labour to build. This design can also be adapted to many different types of users with completely different arm injuries.

Workstation Orthosis (WSO)

SE7EN
F05 – T02 - 3



Problem Description

Mr. B, the user described by the client, has suffered a serious injury and lost all muscle control in his right arm as a result. His shoulder has come out of its socket, and he cannot support any weight on it. However, he does have some muscle function in his hand and he would like to be able to use his dominant right hand for day to day activities. This device should provide as many possible positions for him, as well as put minimal to no strain on the shoulder. Lastly, the user wants to be independent; and does not want to ask for help putting on the orthosis.

Design

The design of the orthosis is extremely simple compared to other orthosis' that are currently available on the market. As shown in the image above, there is no load on the shoulder. All the weight of the user's arm is transferred directly to the surface to which it is attached. The clamp itself can be connected to a surface with one hand. Mr. B will be able to attach the support onto any surface with his other hand without difficulty. The flexible yellow gas pipe shown above is to support the arm brace, the part that the arm sits in. The gas pipe is made of metal, it is strong enough to support the weight of the arm, but flexible enough that the user can manipulate it to their desired position. Lastly the thermoplastic brace is removable, the user will be able to remove the brace segment of the orthosis and use it as a simple support while not at the work station. This enables him to do tasks away from the workstation, such as using the restroom.

Functionality

The orthosis has a full range of motion that can be adjusted to any position by the user. It will support and immobilize the user's arm. Current orthosis' on the market do not allow as much freedom at a work station as the WSO does. With the orthosis, he will be able to use his dominant right hand for many tasks, for example, writing, and typing on the computer. Most importantly it removes the load of the arm from the shoulder, which will increase the rate of healing.

Materials, Components, and Assembly

Materials required for the orthosis are: 12” Bar Clamp, 24” Flexible Gas Pipe, 1/2” Pipe Floor Mount, 1/2”x2.5” Bulk Threaded Pipe, and a 6”x9” piece of Thermoplastic. All of these items (with the exclusion of thermoplastic) can be obtained at a local hardware store. Tools required to construct the device include a drill, a screw driver set, a jig saw, a wrench, a utility knife and clamps. The approximate time for an experienced therapist to construct the WSO should be approximately 2 hours. The construction of the design is simple; open the clamp’s plastic cover and drill holes in the clamp so they will line up with the floor mounts’ holes. Attach the threaded mounting plate via screws to the plastic cover. Reattach the plastic cover. Attach the Gas Pipe to the threaded mounting plate by screwing it on. Mould the Thermoplastic to the users arm and then attach the Thermoplastic to the gas pipe connector using the Broom Clips. The clips are attached to the thermoplastic using glue.

Cost

6”x9” Thermoplastic	$4.71
12” Flexible Gas Pipe	$22.00
12” Bar Clamp	$29.99
1/2” Pipe Floor Mount	$3.54
1/2” x 2.5” Bulk Threaded Pipe	$0.74
2 PC Broom Clip	$2.49
6 Small Hardware Pieces	$0.24
4” of Peel and Stick Foam	$0.10
1” Rubberized Leg Tip	$0.88
Sub-Total	$64.69
+13% HST	$73.10
+ 2 Hours of Labour @ $30/hour	$60.00
Estimated Total Cost	$133.10

User Acceptance and Compliance

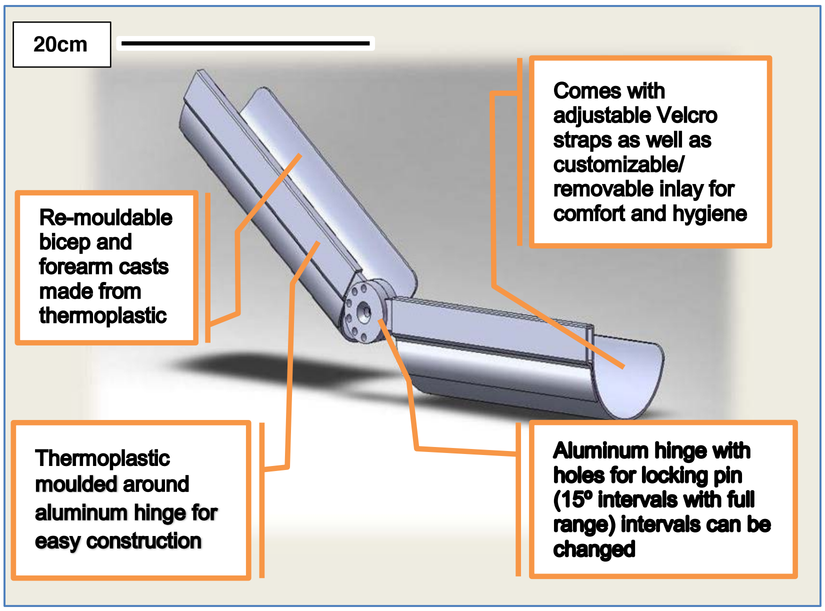
To use the device, the user will attach the clamp to a desk or other mountable surface. Next, the Gas Pipe should be manipulated to the desired position. The user will then attach the arm brace to the Gas Pipe by pushing the Gas Pipe into the broom clips on the bottom of the arm brace. Next, the user has to simply put their arm into the arm brace. The orthosis will assist the user with the main objectives he has requested. The user will want to use this device because it re-enables them to perform the functions they have lost ability to do. It will allow the user to type on a keyboard, sign their name or simply remove load from their shoulder while they are resting. The arm brace is made out of a comfortable material, and because it is formed to the arm it will not irritate the skin. The user will not require assistance to put on or remove the orthosis. The WSO is also less expensive than commercially available devices. Safety has been taken into account by covering potentially sharp edges with tape. The Rubberized Leg Tip has been added to the end of the Bar Clamp’s rod to cover up potentially sharp edges.

Benefits

The design is simple, easy to use, made of readily available parts, and is comfortable for the user. More importantly it is more economical than commercially available devices and it will help the user in day to day activities without adding any strain to the users shoulder. It will give the user a large set of positions at a work station, more than most orthosis currently available in the market. It can also be worn for an extended period of time, and can even be used for the entire day. Additionally, once a user no longer requires the device it can be returned to the clinic and reassigned to another user. A custom fitting arm brace must be remade for the new user. The total cost of making another arm brace would be less than $10 plus the cost of labour.

Dynamic Elbow Orthosis

Limitless Engineering
F05 - T04 - 1



Problem Description

In designing and building for Mr. F the various problems addressed his ability to increase his range of motion to that of a normal person. This problem was tackled by having lots of holes placed at 15 degrees apart for minimal increments to be an option. The second was the ease of building of the elbow orthosis, only needing hot water and scissors is a minimal amount of tools needed for construction. After that there was a need for comfort due to the burns which were approached using Velcro straps on the inside of the cast which could have any material most comforting attached to it by the user. Lastly the thermoplastic frame and aluminum hinge allowed for the conquering of the weight issue using some of the lightest materials available although still structural sturdy.

Design

The design was made keeping in mind the simplicity that was needed for operating the device. This led the design in direction of having minimal parts. As seen in the CAD model above the upper and lower arm pieces are roughly 20 centimeters long (8 inches), which can be varied depending upon the user's size. Regardless of how big the user may be the sleek design and close forming fit allows for discreteness to maintain from user to user. The moulding will have just enough contact with the arm to distribute pressure evenly, starting after the wrist to relieve pressure points and continuing to just before the elbow allowing for the device to change angles. The upper section will start briefly after the elbow and continue up to the arm pit, again being trimmed to user specifications and to reduce weight weighing only one and a half pounds which could be reduced further with more trimming.

Functionality
The elbow orthosis designed by Limitless Engineering covers many of the requirements requested by the client. It has the ability to increase range of motion and is comfortable for the user's sensitive skin with the cotton underlay which can be changed to meet his needs. The hinge is designed to have a spring loaded push button instead of locking pin due to the users limited hand function but with time constraints this was not able to be ordered or manufactured. With more time this part can easily be obtained and implemented into the existing device and allow for complete ease of use of this product. The user will be able to simply press the button using his body and extend the device using his arm, which once in the position required will automatically lock.

Materials, Components, and Assembly
Due to the revolutionary design the materials and assembly of the orthosis have been minimized as construction utilizes the forming of materials to assemble the final product. Thermoplastic, Velcro, fabric and an aluminum hinge are all that are needed for the assembly of a complete product. Thermoplastic can obtained from previously known distributers as well as Velcro and fabric from any hardware store of your choice. The aluminum hinge can either be purchased online in many different forms or order from Innodyne Manufacturing located in Exeter, Ont. The construction takes nothing more than hot water for moulding of the plastic and scissors to trim to size and safety regulations. With a mill and lathe the aluminum hinge could be manufactured to save cost with a total construction period of just over 2 hours if hinge is purchased.

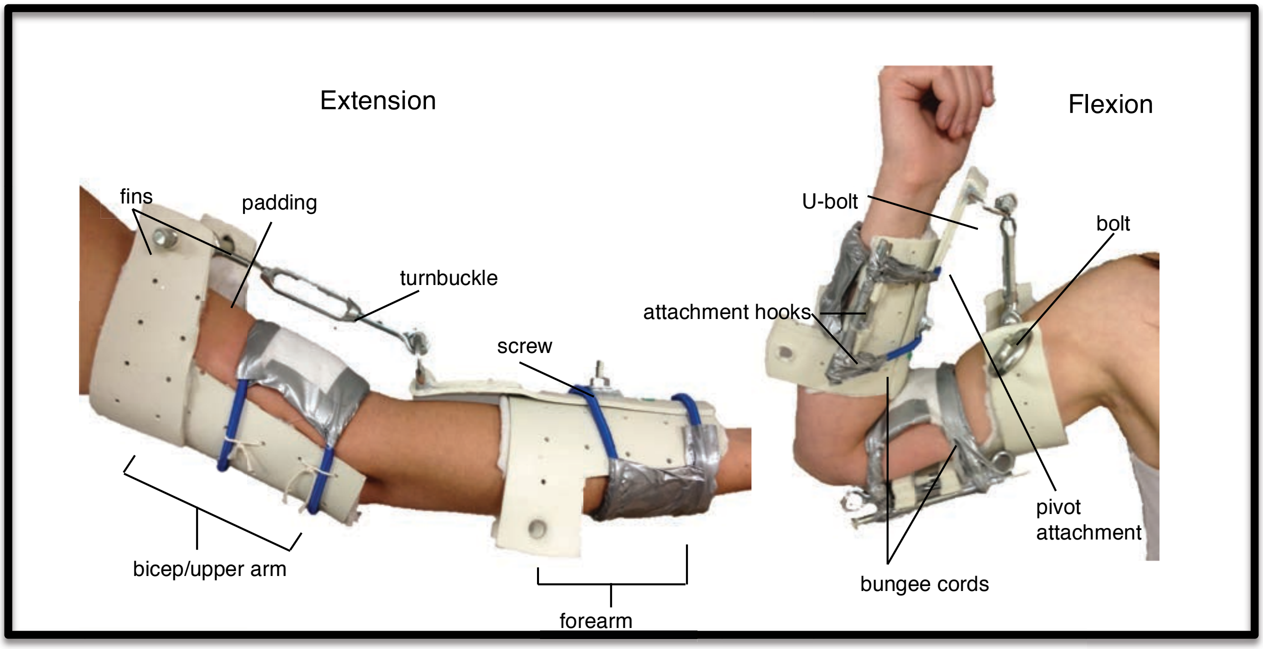
Cost
The Dynamic Elbow Orthosis designed and build by Limitless Engineering will cost a fraction of the price of existing models available on the market today. The device has minimal cost to manufacture as it consists of only thermoplastic, an aluminum hinge, fabric and Velcro. The thermoplastic costs can be cut through the clinics resources in the range of $25 per orthosis while the Velcro and fabric is at minimal cost of several dollars per orthosis. The hinge will be the most expensive part of the orthosis which can be purchased by the clinic starting at just $30. This product is a bargain compared to the many other orthosis' starting from near $200.

User Acceptance and Compliance
The design of this orthosis was based around ease of use. The simplicity of the hinge allows the user to merely insert and retract a customizable pin at the angle they need. The Velcro straps have extended fabric at the end which allows the user to take the device on and off without ever having to touch the coarse Velcro strapping. The inside of the orthosis has been fitted with Velcro underlay so that the user may choose what underlay they would like to apply, this allows for maximum comfort in the recovery process as well as being able to remove it for washing at their convenience. The user will want to wear Limitless Engineering's orthosis due to its discreteness in size and plain outside which can be customized easily with person stickers if necessary. The objectives of a worthy design for our client have been met and implemented through this orthosis. All edges have been rounded and covered with safety in mind leaving no hazards for the client just ease of use.

Benefits
The advantages of the orthosis developed by Limitless Engineering as compared to other orthosis are easily seen through simply using the product. The thermoplastic allows for it to be easily remoulded as well as the Velcro strips allow for the orthosis to be washed and reused through many clients. The light weight cast of the thermoplastic and aluminum hinge allow for minimal strain on other parts of the body while healing takes place on the arm. The orthosis is small and discrete which means it is able to be worn underneath clothing such as sweaters and coats while it is not very bulky to allow for cosmetic appeal. The tight forming of the thermoplastic to the aluminum hinge allows for a high coefficient of friction while in use however can be easily broken down for storage by sliding the aluminum connecting hinges out when not in use. Coming in at under 1/3 of the price of other orthosis on the market make it a clear choice in recovering quickly and stress free.

The Godiva Splint

Godiva's Engineering Firm
F05 - T04 - 1



Problem Description

For this project, the team was approached by Tara Packham, an Occupational Therapist from the Hamilton Hand Clinic, who proposed to Godiva Engineering Firm the task of designing an elbow orthosis for one of her two patients. The team decided to create a splint for Mr. F, a twenty-nine-year-old male burn victim, who experienced heterotrophic ossification in his elbow as a result of his injuries. Due to this, he is now required to wear an elbow splint. The orthosis should be easy to put on and adjust, cause minimal irritation, hold and support his arm in flexion and extension, be relatively cheap, and not limit the user's natural movements. He wants to accomplish all of this independently.

Design

The design of the Godiva Splint conforms to the users arm. Two separate thermoplastic casts will rest on the users forearm and bicep; each custom fitted, and will be joined by the turnbuckle adjusting mechanism. The two casts will also have moderately large screws that extend beyond the width of the arm. The turn buckle adjusting mechanism will slide into the two screws to lock the patients arm into position. The overall design of the Godiva Splint is slightly larger than the users arm. With the use of light metal and thermoplastic the Godiva Splint is at a moderate weight.

Functionality

The main functions of the design were that it would hold the user's arm in specific angles, and be easy to adjust and put on. The turnbuckle mechanism provides for a fine tuning adjustment that is slow, essentially making it as painless as possible for the user. When adjusted to a certain angle, it prevents the arm from moving past that specific point and provides support to the user's arm. Overall, putting on the orthosis and adjusting it is relatively simple, however, since Mr. F does have very limited finger dexterity, strapping himself in and turning the turnbuckle, even with a lever arm, could pose a problem. Despite this, the device has been made to be as basic as possible to limit any difficulty he may or may not have. When he starts to get some motion back in his fingers and begins to redevelop his fine motor skills, he will easily be able to work with this orthosis. Overall, the design does meet all functions well.

Materials, Components, and Assembly

All the materials for the Godiva Splint can be found in hardware stores such as Home Depot and Rona. The following materials are necessary for the design: thermoplastic, turnbuckles, super glue, bolts, bungee cords, duct tape, screws, washers and nuts. The tools required to create the splint are just basic things that could be found in the shop. These include a pair of scissors, a hot glue gun and a heater for working with the thermoplastic. Overall the construction took just under two hours however with a trained professional it could easily be done in less time.

Cost

Since all materials are available at local retail stores, the finished splint is very inexpensive. The total cost was $35.97 not including tax, but if the materials were bought in bulk the marginal cost for each splint would be drastically lower. Also, the cost of thermoplastic takes up around 52% of the final price. Thermoplastic would be much cheaper for the hand clinic as it would be bought in bulk.

User Acceptance and Compliance

As this orthosis is custom-made for the user, it allows for maximum comfort for the user, and is specifically designed to limit the amount of pain Mr. F will feel while wearing and using the device. While the turnbuckle is a slow process, it doesn't push his arm into various positions, but allows it to adjust to the new bend to minimize discomfort. The padding also provides more comfort for his arm while allowing breathability, and helps to reduce the friction on his skin, effectively lowering the risk of infection. Adjustment is also fairly easy, even for a person with low finger dexterity. While the design is not exactly the most aesthetically pleasing, the user can customize its design in anyway. They have the option of changing the colours, and adding any extra pieces to the orthosis that they may desire.

Benefits

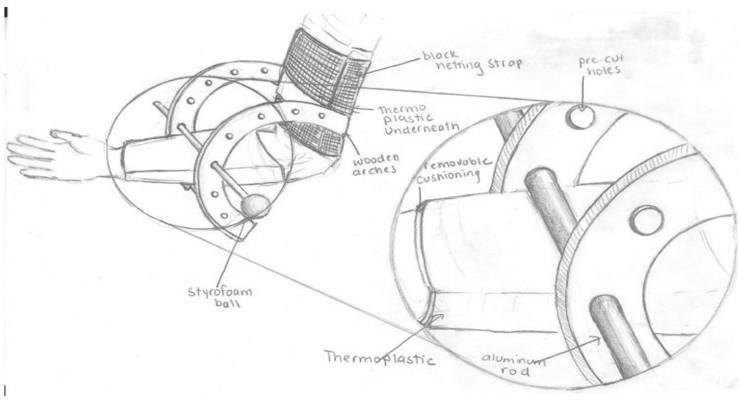
There are already many existing orthoses on the market; however, none of these truly fit the needs of Mr. F. The Godiva Splint is a cheap product that accomplishes its functions well: costing around $35, it is well under the price of its competitors, which stand at hundreds of dollars more. Many of these 'higher end' models tend to be extremely limited in their functionality as well. Dynasplint's braces can only accomplish flexion or extension, not both, requiring the user to purchase two splints for their full recovery. The Deroyal DeROM dynamic elbow splint has a unique strap system, which would be extremely difficult for Mr. F to use with low finger dexterity. The Pro-Glide's pin system also would be unfeasible for a user with limited fine motor skills like Mr. F. The Godiva Spint, however, works well for the user as it is custom-made, and can easily accomplish a full range of motion. It is easy to strap in and easy to adjust, making it a desirable solution for Mr. F's recovery process.

RRAKE ARCHES

Team Name
F 0 5 - T 0 4 - 2

Picture of arm in Flexion

Picture of arm in Extension



Sketch of the Final Design

Problem Description

Tara Packham, from the Hamilton general hand clinic, has a patient - Mr. F - who has suffered from heterotrophic ossification – stiffening the joint in his left elbow. He suffers from limited bilateral hand function requiring a device that can provide therapy to increase this range of motion. The device must be able to both extend and flex the arm through the widest range of angles while providing maximum comfort to the patient who suffers from multiple extremely sensitive third degree burns on his arms. Mr. F must be able to independently and easily put the device on and take it off. The device must be inexpensive to make and within the means of the hand clinic requiring the utilization of simple mechanisms and readily available material to attain functionality.

Design

The design we had developed is composed of two solid plastic moldings formed to the patient’s forearm, and bicep. The braces are attached by pieces of Velcro stuck on lined fabric material, to provide convenient strapping of the orthosis. Each brace is lined with a shock absorbing material which is removable, adjustable, and washable. The two wooden brackets on both sides of the brace allow for the angle to be easily adjusted with a metal dowel. The metal dowel is fixed with an easily grasped handle and detachable ball providing an easily handled component. The device is estimated to weight approximately 3 lbs. with the majority of the load being between the elbow and shoulder. The device is very close to the size of the arm with exceptions for the wooden brackets and metal dowel which will occupy the space within the bend of the elbow.

Functionality

Our design will allow Mr. F to adjust his arm between flection and extension independently. Our design enables him to adjust the Velcro straps, and the angle in which his arm is being supported in, with very little finger dexterity. Our design also disperses the pressure being placed on his arm in flection or extension over a large surface area, to reduce high pressure on any parts of his sensitive skin. All the components of this orthosis are removable and washable. This allows Mr. F to have possibly three different linings that he can cycle thought as they are being washed or even changed throughout the day.

Materials, Components, and Assembly

Our orthosis will require thermoplastic, plywood, Velcro, a metal dowel, lined fabric and foam material. Thermoplastic can be ordered from various thermoplastic sellers. The plywood, Velcro straps, wooden dowel, lined fabric and foam material can all be found at any local hardware store. Tools such as scissors and X-Acto knives will be needed to cut materials and fabric. Tape and Hot glue will be needed to attach the components and materials of our orthosis together. The wooden arc is to be made at a machine shop. Instructions will be needed to explain what materials and components will be needed, as well as a thorough step by step guide in building the design. Our orthosis will approximately take an hour and a half to two hours to build if set with all the materials and components at hand. The construction of the two wooden arches may need a specific set of instructions to build because of their dimensions.

Cost

The total cost of materials for the orthosis adds up to $30.00 in materials plus 1.5 hours of labour costs to build the device. Even if the device is not covered by the client's insurance, it is very inexpensive and easily affordable seeing as most commercial orthoses do not start below $150.

User Acceptance and Compliance

We have understood the issues that Mr. F is facing, and have implemented ways with which provide him with the proper therapy needed. In order for Mr. F to put on the orthosis he will first need to strap the wrist section followed by the bicep section of the orthosis. He will then need to adjust his arm in to an angle he would like to improve his range of motion, placing the bar (under arm for flexion or over arm for extension) through the two brackets. He will keep his arm in this position for 15 to 20 minute intervals. He will need to pull the bar out first then proceed to unstrap the orthosis to take it off. We have designed an orthosis that will provide comfort, portability and easy accessibility for Mr. F to use. Our design is safe for Mr. F to use, providing support in all the regions where needed to keep a stable position. In terms of cosmetic design we have made the orthosis aesthetically pleasing for the user to wear. Our orthosis will provide Mr. F with the therapy that is needed to improve the range of flexion and extension in his arm.

Benefits

When considering our design, benefits arise from our choice of materials, and the details of our overall design. Our orthosis includes those of very light weight, sturdy and easy to find materials. This provides an efficient design that lessens the load on Mr. F, while providing the client the convenience of inexpensive easily obtainable materials. The overall design of our orthosis has numerous benefits to both Mr. F and the Hand Clinic. Our design is a very simple version of an elbow orthosis. This simple concept with minimal moving pieces and general user-friendly characteristics allows for mass production if needed in the future. Multiple parts can be constructed at once (wooden arches) with a simple machine at a very low price to the clinic. Our design of the elbow orthosis provides the effective flection and extension to the elbow while minimizing discomfort and pain. The wide straps and large surface area of the design evenly distribute the force acting on the elbow, reducing irritation to his skin while providing the force needed for therapy. Our design also considers the incapability's of the client and is composed of many attributes to compensate. These easily adjustable parts provide Mr. F the independence needed to manually adjust the orthosis to his preferred positioning.

Body in Motion Orthosis

Body In Motion
F05 -T04-3

The Body In Motion Orthosis (BIMO), shown below, is made of leather, PVC tubing, thread, cloth, Velcro and an Allen's Key with paint roller attached.

Problem Description

The problem presented to the team by Tara Packham of the Hamilton General Hospital Hand Clinic involves Mr. F, a 29 year old burn victim. He had to undergo surgery to fix heterotrophic ossification, fusing of the bones, in his left elbow. The surgery allowed him to regain some mobility, but he must continue to do therapy to increase range of motion. He must be able to change elbow position every hour for a continuous time period. Due to skin grafts, his arm is very sensitive. He also has limited finger dexterity and strength. The staff at the Hand Clinic have asked the team to design a device that would help him improve range of motion. The device must permit Mr. F to independently change arm positions. It also must be made at minimal cost and can be made by the staff at the hand clinic.

Design

The BIMO, shown in the visual above, is a range of motion therapy device designed to fit Mr. F's needs. It is very lightweight, weighing only about 2 pounds. This has been achieved by using parts such as the PVC tubing and leather arm straps that are not very heavy. The span of the orthosis reaches from the wrist to the upper arm and can be worn over clothes but not under clothes. The two straps attach at the upper arm around the bicep and at the wrist. The PVC tubing spans between the two straps applying the tension needed to help increase range of motion of the elbow.

Functionality

The main of function of the device is that it can apply different tensions to the arm to help increase the range of motion of the elbow. This tension can be adjusted using the locking mechanism which is a pin inserted into the PVC tubing. A unique function of the device is that the straps are lined with a washable piece of cloth. The cloth is attached with Velcro and in the case the brace starts to become sweaty from use the cloth can removed and washed. This means the device can be used for a longer period of therapy.

Materials, Components, and Assembly

The Body In Motion Orthosis is made out of leather, PVC tubing, strong thread, Velcro, cloth, an Allen's key and a small paint roller. The leather is used to make the straps and the cloth is used for a soft padding on the straps. The PVC tubing applies the tension to the arm and the Allen's Key with the paint roller acts as the pin to lock the device in place. The Velcro and strong thread are used to attach all the components together.

All the materials can be purchased at Canadian Tire or any hardware store and some also can be found around the house. To construct the device a drill, saw, scissors and sewing needle are required. The assembly is not difficult, but instructions on how to make the device will be provided. The total amount of time it takes to make it is about two hours.

Cost

The maximum cost of the device is $50.30. This is if all the components are bought. The PVC piping is about $12, the thread cost is about $6, leather is strapping $17, Velcro is $8, fabric is $2, the Allen's key is $.30 and the small paint roller is $5.

To decrease the total cost, the user could provide some components from around the house. For example, the user might have some extra cloth around that could be used for the padding of the straps and an old belt could be used for the straps themselves.

Since the Hand Clinic has no budget, the cost will be entirely for the user. They can decrease the cost if they have some of the components around their house.

User Acceptance and Compliance

The two main objectives of this device were making sure the device does not irritate Mr. F's skin and allowing him to independently adjust the angle. To reduce irritation of the skin the strap is padded with soft cloth. Also because burns are very hot the device has been designed so the cloth can be removed and washed. To allow him to independently adjust the angle a paint roller was attached with an Allen's Key so it is easier for him to grab the pin and pull it out. He does not have to fiddle with any tiny knobs just has to grab the large handle and lift the pin out. He could even achieve this without having to grip the handle as well, by sliding his flat hand underneath the paint roller and pulling the pin up using his palm as leverage.

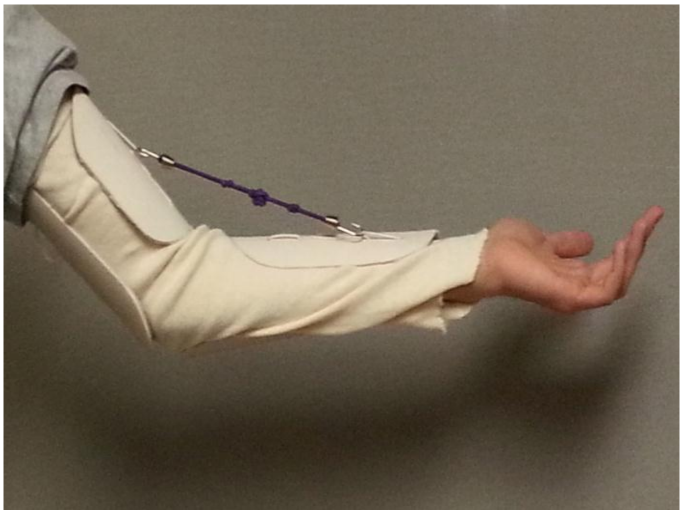
Mr. F would be able to put the device on using only one hand. It can be easily placed on the arm and then each strap attached one at a time with his free hand. Aesthetic considerations include making the leather and thread match so the overall look of the device is very clean.

Benefits

The benefits of the device are that it is inexpensive, washable, easy to construct, lightweight and can be independently used. The relative cost of the BIMO is small, especially because many of the components can be found around the house. The washable lining is a very beneficial attribute of the design especially since these devices need to be used for long periods of therapy. The device is simple to construct and does not take very long. It can easily be built by the team at the Hand Clinic. It also lightweight which will reduce the strain created on the user's shoulder. And lastly, Mr. F could use this device independently. He would not have to ask for help to adjust the angle of tension or to take it on and off. This was a major concern for him.

Static Progressive Elbow Orthosis

Cubitus Sustentationem
F 05 - T 06 - 1



Problem Description

Tara Packham at the Hamilton Hand Clinic has a client Mr. F who suffers from second and third degree burns over his face, arms, and upper back. These injuries lead to heterotropic ossification in his left elbow. As a result of his limited range of motion, he has difficulty eating, drinking, along with a number of other basic needs. Efforts were taken to remove the fused bone matter however his left arm still has limited range of motion. The client had issues with previous braces, mainly that they irritated his sensitive skin. He also found it very difficult to fasten the straps on the brace, often requiring assistance from family members. The device that we will develop should be able to be locked for short intervals at the maximum bearable flexion, and then switched to maximum bearable extension for another short period of time. Ideally, the device will minimize the amount of irritation on the client's skin, and be easily attached and removed by the client without assistance. Although this device is designed for Mr. F, it will be applicable to any other individual with an injury that requires regaining of the arm's range of motion. The brace will be able to be constructed at the Hamilton Hand Clinic with minimal outsourcing for parts and minimal cost. The clinic and the client will also be able to adjust and repair the brace if needed.

Design

Our orthosis is a full arm brace made from thermoplastic with a hinge located at the elbow. There are four to five holes drilled into either side of both the upper arm and forearm. Threaded through these holes are loops to which a low load force applicator can be easily attached and adjusted to provide different amounts of force. The inner side of the brace has been removed to allow for the client to easily slide the brace on or off without the need for straps. Any areas which impeded movement were removed to minimize discomfort for the user. An optional removable sleeve can also be worn underneath the brace to further reduce discomfort.

Functionality
The orthosis is able to apply a low load force in order to regain range of motion by using bungee cables connected to loops attached to the brace. These cables can be exchanged for thicker ones that provide a stronger force, if this is what is recommended for the user. The multiple loops allow for finer adjustments of the force so that it can be adapted for any user. These loops are located on either side of the arm so that the cables can be attached in such a way that they can provide a flexion or extension force. The orthosis can be easily attached or removed with only one hand because the sides of the brace have been removed. Since there is some flexibility in the thermoplastic it stretches to fit the user's arm and remains securely fastened without the need for any straps. The thermoplastic also allows for a custom fit to any user who is in need of a brace. It is made from parts found at the Hamilton Hand Clinic and could easily be made by one of their occupational therapists.

Materials, Components, and Assembly
The orthosis is made from five main materials; thermoplastic, string, bungee cables, a fabric sleeve and a hinge. All of these materials with the exception of thermoplastic can be found at any hardware store. The thermoplastic is already easily accessible to the Hand Clinic. Tools required to construct this device would include hot water, heavy duty scissors, and a drill. Construction of this device for someone with basic knowledge of construction will likely take between 10-30 minutes for molding of the thermoplastic to the user's arm. Then one hour for cutting the thermoplastic to the right shape, and drilling the holes in which the string will be looped through. The hinge should also be drilled through the elbow's natural rotational axis.

Cost
The cost of our model was 47$ and was mainly comprised of the cost of the thermoplastic. The Hamilton Hand Clinic could produce the same device at a much cheaper cost as a result of cheaper thermoplastic costs.

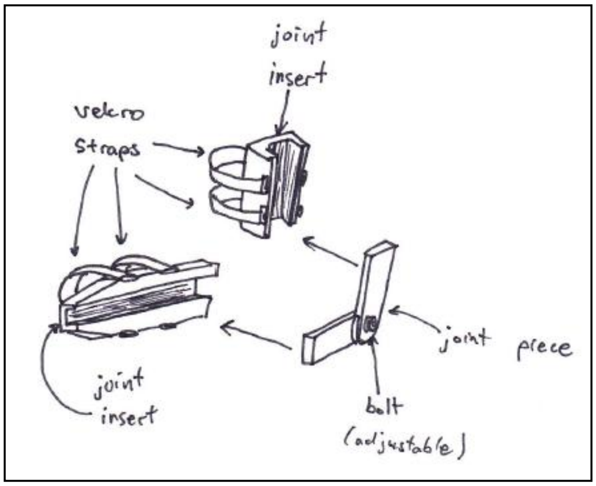
User Acceptance and Compliance
The main objectives of adjustability, user independence, reduction of discomfort, ease of construction, and affordability were all accomplished by this design. The user is able to put on the brace using one arm by simply sliding their injured arm through the cut out side. Since there is some flexibility it stretches and forms to their arm. The user is able to adjust the bungee cable to the different loops on the brace one side at a time using only their dominant arm. There is a sleeve that can be worn underneath the brace that eliminates skin to brace contact reducing discomfort. The user will want to wear the device for short periods of time every day and will experience minimal discomfort while maximizing their range of motion. The orthosis is simple and unobtrusive, and could easily be worn while performing daily activities. The removable sleeve can also be washed as needed. Safety features include prevention of hyperextension of the elbow by having a max angle that the orthosis can extend to.

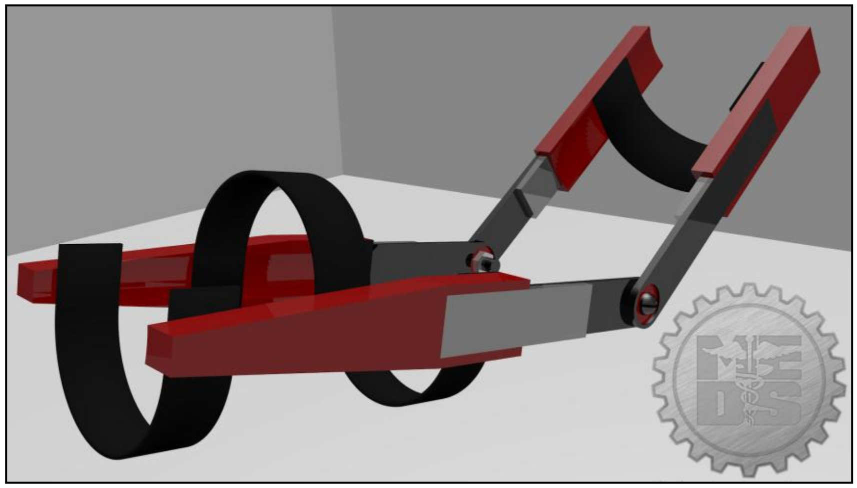
Benefits
There are numerous benefits to our design that are improvements over the current designs in the market. Our design requires no assistance to attach or adjust. There is also the option of attaching a flexion or extension low load force. It is made from parts that are easily accessible and replaceable to not only the Hamilton Hand Clinic, but also to the users themselves. It is relatively inexpensive, only costing $40-$50 where some devices can cost upwards of $500. Our device minimizes discomfort of the arm by being made of a small number of pieces in order to decrease pressure points, as well as by having a protective sleeve to reduce skin to brace contact. The protective sleeve is removable, replaceable and also washable, allowing the device to be used for longer periods of time. The orthosis can easily be adjusted to different users as it is formed to the wearer's arm, and can be re-adjusted as necessary. The brace can be used while performing daily activities as it is simple, mobile, lightweight and can be easily worn over top of clothing.

Mr. F

Elbow orthosis eltho.

Medical Engineering Design Systems
F05 – T06 – 2





Problem Description

The problem presented to Medical Engineering Design Systems (MEDS) involves Mr. F, a 29 year-old burn victim, who suffers from severe burns encompassing twenty percent of his body surface area (BSA), and originating from a property fire he was a victim of. As well as suffering from skin related injuries, he suffers from heterotrophic ossification, or bone fusion, in his left elbow greatly reducing movement and its use. In order to decrease and remove the ossification, a surgeon was forced to remove a calcium deposit inhibiting motion. As a result, it was necessary to insert a hinged elbow structure in the bone. He has also contracted respiratory issues stemming from smoke inhalation contracted during the incident. Thus, daily activities have become very difficult if not impossible. He hopes that a new orthosis will not only aid him in healing at an accelerated rate, but that it will also aid him in accomplishing chores as he uses it. The orthosis must not interfere with his skin's healing process as he has had many skin grafts since the incident and does not wish to prolong it. Rehabilitation must be taken into consideration as he is seeing Tara Packham, an occupational therapist, at a nearby hand clinic. During sessions with Tara Packham, he will endure extreme flexion and extension in hopes of re-acquiring movement in his arm by rebuilding the lost muscular strength. Finally, the device must be worn at the user's convenience (for long or sporadic periods of time) while solidly locking the elbow in certain positions to slowly increase Mr. F's range of motion.

Design

The *eltho* is a very simple and cost efficient design comprised of three major components. The *eltho* has a forearm and bicep component as well as a removable and adjustable joint piece. The arm components are only on the outside of the arm while Velcro™ straps wrap around the users arm comfortably. All the components are made of a wood and plastic composite which is incredibly durable and can resist relatively high impacts, water and bacteria. The arm components are shaped to have an insert on the outside of the piece so that the joint rests firmly in the insert due to magnetic strips and the frictional force between the walls of the components and the joint itself. The joint piece consists of two components, nuts and screws that join the joint piece.

Functionality

The purpose of the device is to hold the arm of the user in a fixed position, and have it remain there for a chosen period of time set by the user. The device will be put on by the user, and will be set in a desired position, and then strapped there by the use of the Velcro™ straps that are fixed on the side of the two parts of the brace. Once the brace is on firmly, the joint angle can be changed. There are two ways to adjust the joint. The first method is to place it comfortably in the braces, pivot it to the desired angle, and then fix it in place with the use of the locking mechanism (i.e. wrench). However, if movement is very restricted, the joint may be removed from the brace, adjusted separately, and then reinserted into the orthosis. The removal of the joint provides the user with a potentially easier way of adjusting the angle of the orthosis, so that they can simply move their arm to the desired angle, and insert the locked joint by pressing it into the braces. To remove the joint when desired, one must simply unstrap the Velcro™ cuffs that are holding the brace on the arm, and it will essentially fall off. It is very easy to remove our *eltho*, as it would not be ideal to complicate the removal process if the user's arm had grown sore from either extension of flexion.

Materials, Components, and Assembly

The orthosis featured this removable joint that was set into two braces, one located on the upper arm (bicep), and the other on the lower arm (forearm). These braces were constructed from a composite plastic/wood and we're shaped to the desired specifications. This means that the components retain some of the feel of normal wood (such as workability), but become much stronger due to the tensile strength of the thermoplastic within. The pieces of the brace are cut from a board of composite 2x4, and are planed to remove the upper half. Once they have been cut, they are shaped with tools, such as a miter saw, files and sandpaper. The braces are then attached to the arm with Velcro™ straps that contain elastic filaments, meaning that the straps are softer and can fit a larger range of client arm sizes. The joint itself was constructed out of 2 pieces of spruce of measurements 5/8'' x 5/4'' x 8''. The two pieces (upper and lower) of the joint are attached by a bolt passing through the pieces with washers separating them, and a locknut at the end of the bolt to ensure that it does not come loose after tightening it.

Cost

Some competition might offer their devices at an even lower cost; however, ours is focused on quality and ease of use. The cost to make a single *eltho* is $35.80. The hand clinic could thus sell *eltho*'s at a competitive $75.00 in order to make a profit upon selling it right away. In consequence, assuming no replacements are necessary, the hand clinic would make a single profit of $39.20 upon selling an *eltho*. Whereas the *eltho* might be marginally more expensive to purchase, it is infinitesimally cheaper to rent.

User Acceptance and Compliance

The purpose of the device is to hold the arm of the user in a fixed position, and have it remain there for a chosen period of time set by the user. The device will be put on by the user, and will be set in a desired position, and then strapped there by the use of the Velcro™ straps that are fixed on the side of the two parts of the brace. Once the brace is on firmly, the joint angle can be changed.

Benefits

As previously mentioned, although the *eltho* is marginally more expensive than peer competition, its quality is far greater and its design is simple, yet reliable. Parts are inexpensive and can commonly be found. Although construction of an initial model might be somewhat tedious, there is always the possibility of making molds and casting them at the hand clinic as demand require. If the option of casting them from liquid-drying plastics was chosen, the orthoses could also be cast in any color plastic desired. Hence, the benefits far outweigh those of any other othosis specifically tailored to our client's (Mr. F) needs.

Tensio-Care

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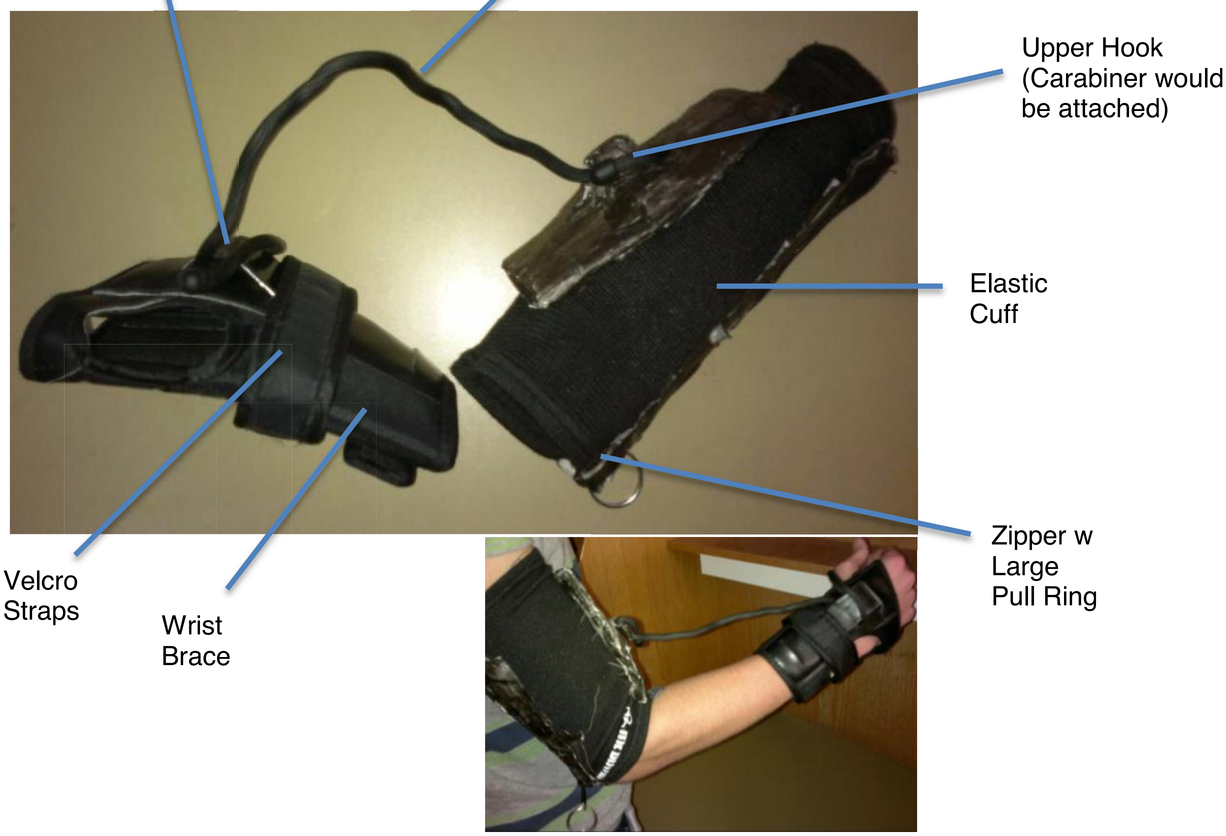
F 0 5 - T 0 6 - 5



Problem Description

The design team was asked to design an elbow orthosis device for Mr. F by Tara Packham of the Hand Therapy Clinic at Hamilton Health Sciences. The device is to be made to rehabilitate the muscles and ligaments of the arm through the application of tension. It needed to be easy to use, with little to no assistance needed. Due to serious burns covering his body, the device also needed to be as easy on irritated skin as possible. Everything designed then had to be built using only the materials available to or purchasable by the Hand Clinic

Design

The design consists of two main components: the upper cuff and the lower brace. A rubber, adjustable twist tie connects them by carabiner and applies the tension to the elbow. The upper cuff, fitting snuggly on the upper arm, is a breathable, soft material with a zipper sown into the side to ease putting on the device. The lower brace encloses around the wrist and encloses the thumb to prevent slipping, secured by large, easy to grasp Velcro straps. The lower brace is also lined with a soft, silky material. The device as a whole puts little weight on the shoulder and minimized skin contact.

Functionality

In the device, the twist tie connected to the lower cuff acts to support the lower arm. The device allows the user to adjust the elbow into a variety of different angles, providing tension on the joint and working to rehabilitate the muscles and ligaments. The device helps to restore the arm’s range of motion through this rehabilitation, and opposes the effects of the heterotropic ossification that occurred in Mr. F’s elbow.

Materials, Components, and Assembly

There is a minimal amount of components needed for this device. The upper cuff is made up of an elastic elbow cuff, found at Sport Chek, a zipper and a carabiner. These two items are found at a local dollar store. The lower brace is simply a wrist brace, purchasable a Walmart. The assembly that is required is the addition of the zipper to the upper cuff, which is sewn in either by hand or with a sewing machine. Also, the carabiner must be attached. Our prototype used tape for this, but it can also be achieved through sewing as well. The Gear Tie is then added in as the connector and is found at the Home Depot in packs of two.

Cost

The cost of the device is fairly low: buying all the components new comes out to approximately $43.00 after tax. The reusability of the components will help keep the cost at this low level.

User Acceptance and Compliance

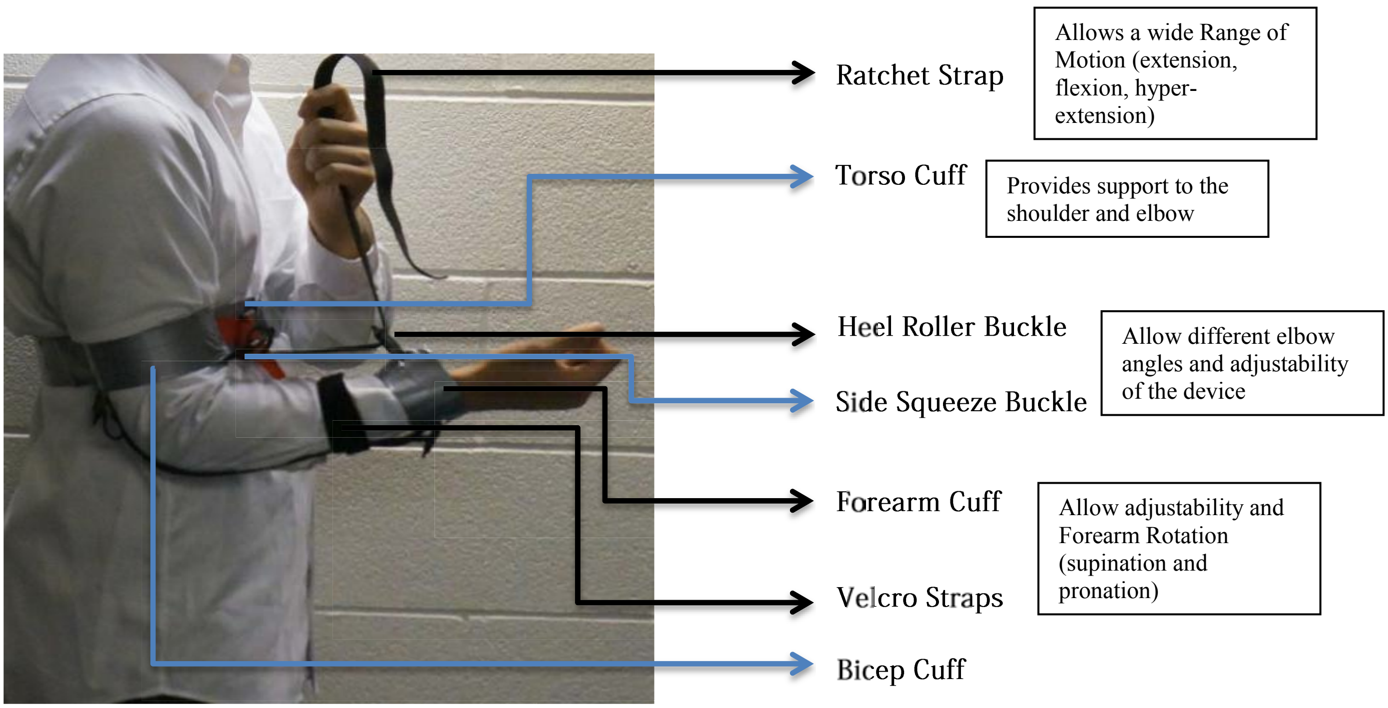
The design is easy to put on and take off with one hand, completely independently. The zipper is fitted with a large pull ring for easy use which also minimizes amount of skin contact when putting on. To put on, the user simply slides the upper cuff, zipper undone, up the arm. The user then secures the zipper once it is its proper place. The wrist brace is then secured with the large Velcro straps. The user then simply connects the twist tie to the upper and lower connectors and adjusts to desired angle. Arm position is very easily adjustable through the flexible connector, which can be adjusted at either end or even by twisting the middle section. The design itself is simplistic, not over the top in ugly parts with sleek black colouring. The material is breathable and soft, to be easy on the burned skin surface. Flaps of fabric within keep the metal of the zipper from connecting with the burned flesh. All materials used are safe and nontoxic

Benefits

The design provides a pronounced ease of adjustability and works to promote Mr. F's independence. The design itself is very simple, consisting of only a few components. The assembly is consequently very straightforward and requires little time. Most, if not all, components are then reusable. In the end, not only is it usable for Mr. F, but is applicable for various injuries of similar condition as well as other circumstances. It is an easy to make, easy to use, versatile device.

Infinity Elbow Orthosis

Pivot Point Designs
F05 – T06 – 6



Problem Description

In order to provide a safe and cost-efficient solution for our client--Tara Packham from The Hand Clinic at the Hamilton General Hospital—an elbow orthosis needs to be designed for users with arm injuries such as a dislocated shoulder or elbow. One such user in need of an orthosis is Mr. B who suffers from a compound fracture. The needs of the client include a design that enables the range of motion, forearm rotation and provides comfort for users with elbow and shoulder dislocation. The problem being tackled is to design an elbow orthosis that enables a wide Range of Motion and allows forearm rotation for users suffering with dislocation of the elbow and shoulder while providing ample support for the arm.

Design

Infinity Elbow Orthosis consists of one long, adjustable strap that is attached to the bicep cuff through a side squeeze buckle and runs freely though a heel roller buckle. Pulling up and letting the strap loose enables a wide range of motion for the user. In order to provide support for the elbow, there is a torso cuff that carries the entire weight of the elbow and provides no strain on the shoulder (see Diagram 1). The total weight of the device comes up to be a mere 160 grams. The positioning of the device on the arm is such that nothing above the torso cuff is involved in the orthosis, making the orthosis small, lightweight and simple.

Functionality

The infinity orthosis is a dynamic elbow orthosis; functionally speaking it allows users to have extension and flexion in the elbow, as well as supination and pronation of the wrist. Mr. B needed the orthosis to lock his elbow in various positions, have the ability to move his working wrist, and lastly have no load on his shoulder. Through the infinity orthosis' innovative design, most of Mr. B's needs were met. A load bearing strap which goes around his torso bears all the weight of his arm rather than putting strain on his injured shoulder. Locking of the elbow in various positions is taken care of by two strap and buckle mechanisms (similar to the straps on a back pack). One strap located on the upper area of the arm is used to create a tension upwards thus bending the elbow (flexion), and another strap located underneath his arm is used to create a tension downwards thus extending the arm (extension). Mr. B's arm is held up at a position on the wrist which contains a loose fitting strap which effectively allows the orthosis to suspend his arm while still being loose on his wrist and allowing him to move his wrist freely.

Materials, Components, and Assembly

The materials and components required include Velcro straps, ratchet straps, fiberglass tape, duct tape, super glue, side squeeze buckle and a heel roller buckle. All of these materials and components can be conveniently found at a local hardware store such as Canadian Tire, Home Hardware or Home Depot. The only tools needed to construct the device are super glue and duct tape to attach all the parts together and to construct the cuffs. The overall assembly takes half an hour and can be performed in any type of environment. The only instructions that the construction of the device requires is how to position all the parts correctly with respect to the elbow and how to correctly construct the torso, forearm and bicep cuffs so they are positioned correctly with respect to the body.

Cost

The total cost of constructing Infinity Elbow Orthosis is $7.50. For the clinic, costs include the materials, labor in constructing the orthosis as well as the assembly of the orthosis. To the user, costs include the maintenance of the orthosis due to low durability, as well as difficulty of set-up. However, the device is inexpensive to create as well as easy to repair. Therefore, the costs are minimal compared to the advantages to the both The Hand Clinic, as well as to the user.

User Acceptance and Compliance

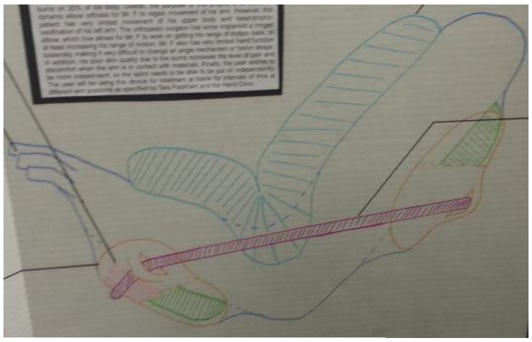
Mr. B's foremost compliance issue is that the elbow orthosis needs to enable the arm's Range of Motion including extension, hyper-extension and flexion as well as forearm rotation including supination and pronation. Another compliance issue is the extent of support provided to the shoulder and elbow. To consider these issues, the design is focused on the ease of use and the ease of setup to put a minimum amount of strain on the shoulder. To put the orthosis on, you need to put the orthosis through your body and your dislocated arm. Adjusting the strap along your torso, you can tighten it up by pulling the ratchet strap. In order to increase the comfort of the device, we employed our design to contain a higher surface area leading to an even distribution of force. The use of frictionless material on the skin also considered the compliance issue of his degloved skin. As a consideration of safety, there are no hard or sharp materials used in our design. We used soft straps as our main material, excluding the possibility of having heavy or dangerous material that might impair Mr. B's health even more.
In terms of aesthetics, the device is small and can be easily worn under other clothes to hide the complications of the straps.

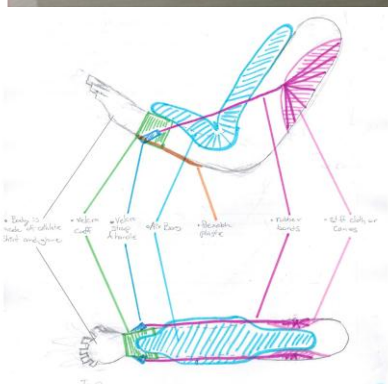
Benefits

The Infinity Elbow Orthosis stands out among other designs as it is definitely the most lightweight, inexpensive and simple design on the market. It completely reduces any strain that could be put on the shoulder of a user, making it even more comfortable to use during everyday tasks. While other designs employ use of heavy materials such as metal bolts or plates, Infinity Elbow Orthosis rejects all heavy materials that could put more strain on the arm or might be hazardous to the user, using only those materials that are lightweight and harmless. The user can easily put the orthosis on or off in seconds and no special considerations are needed for different sized users, as the orthosis is highly adjustable to all body sizes.

Elbow Maintenance Personnel (EMP) Elbow Splint Proposal

Team Name
F 06 - T 0 2 – 1





From Top Left, Clockwise: Final Drawing of Splint, Splint, Thermoplastic ‘cuffs’, Airbag, Prototype Drawing

Problem Description

Tara Packman and the Hamilton General Hospital Hand Clinic have a patient, Mr. F. Mr. F is a 29-year-old male who was burned in a house fire and received second and third degree burns on 20% of his body structure. Overall, the client has asked our team to create a dynamic elbow orthosis for Mr. F to regain movement of his arm. However, this patient has very limited movement of his upper body and heterotrophic ossification of his left arm. The orthopaedic surgeon has since implanted a hinged elbow so that Mr. F can begin to regain a full range of motion. Mr. F also has very limited hand function bilaterally, making it very difficult to change an angle mechanism or fasten straps. In addition, his poor skin quality due to the burns increases the level of pain and discomfort when the arm is in contact with materials. Finally, the user wishes to be more independent, so the splint is required to be applied by himself without additional help. The user, Mr.F, will be using this device for treatment at home for angle and time intervals as specified by Tara Packman and the Hand Clinic.

Design

The device is light; all materials except the thermoplastic are light-weight, and the thermoplastic is only in small pieces which will not result in any significant weight increase. For the comfort of Mr. F, there are no hard or irritating parts directly in contact with the skin. All materials are chosen based on the skin situation, making the device as comfortable as it can be so that there will be a high level of user compliance.

The entire device is the size of a sleeve, however, as seen in the above sketch, the airbag begins half way along the forearm and goes up almost to the shoulder. The Velcro in which one side of the bungee cord is attached to (see sketch with label Velcro cuff) is at the wrist of the arm and goes down about 1/3 of the forearm. Under the Velcro cuff (as seen in sketch) there is a piece of thermoplastic in order to disperse the force of the pressure on his skin. There is sponge added under the thermoplastic for additional comfort so there are no hard pieces in contact with his skin. The same idea was used for the upper arm where the bungee cord wraps behind his arm, both sponge and thermoplastic were used for the same reasons. This upper arm piece is about 5 inches long and 3 inches wide on the upper triceps. Finally, the bungee cord goes from the Velcro cuff up to the upper arm piece, diagonally, not following the shape of the arm, as seen in the above sketch.

Functionality

The device is user friendly: light, comfortable, and works on increasing range of motion. As the user and client requested, Mr. F will be as comfortable as possible and independent as it is easy to put on and adjust. It also meets all the objectives that the client requested. Including, being cost efficient, easily adjusted, comfortable and increasing the range of motion. In addition, this device can be easily made at the hand clinic with few parts and limited technical knowledge/expertise.

Materials, Components, and Assembly

Materials: Velcro, athletic shirt, inflatable rubber ball, gloves, thermoplastic, bungee cord, sponge, plastic bag. All materials can be obtained from local stores, Wal-Mart, home hardware, a dollar store, and or a toystore. The assembly took about 2.5-3 hours with the use of tools, such as scissors, knife, stove, frying pan, and contact cement. To assemble the orthosis you will need to follow these instructions. Have the intended user put on the correct sized shirt and glove. Pin the glove to the shirt the way it naturally is worn/hangs, and then sew the two together. Now cut out a mould an upper triceps and wrist thermoplastic piece, this must be done by placing a sponge in-between the users arm and the thermoplastic while moulding. The triceps' mould should have a loop on the back of it where the bungee cord can pass through. The wrist cuff should have two loops on either side. Then use contact cement to attach each sponge to each plastic piece. Next mark out where the thermoplastic sponge pieces are going to go on the sleeve. One on the upper triceps and one on the top part of the wrist. Sew cloth onto the areas previously marked to create a tight pouch for the thermoplastic sponge pieces to fit into. Next sew Velcro onto the sleeve around the wrist. Then hook one side of the bungee cord onto the outer loop on the wrist cuff, feed the other end through the loop on the triceps cuff and then feed it through the inner loop on the wrist cuff. The end of the bungee cord should have the other side of the Velcro glued to it. Mechanisms for flection are now complete. For extension an airtight bag must be built. To build this bag cut two equally sized pieces of plastic to the desired length(mid lower arm to upper bicep) and width(width of the users arm). Put contact cement on the two longest sides of each piece and then carefully sick them together. Next sew two lines into each side where the contact cement is. From the inflatable rubber ball you must cut out the top circle and glue it into the top of the plastic cylinder. Once this has dryed flip it inside out. Glue the other end of the tube closed and sew two lines into this as well. Next sew a pocket that spans almost the entire length of the sleeve for the airbag to fit into. Once the airbag is inserted the orthosis is complete.

Cost

It took around $30 to make this splint; and the prototype took less than $20.

User Acceptance and Compliance

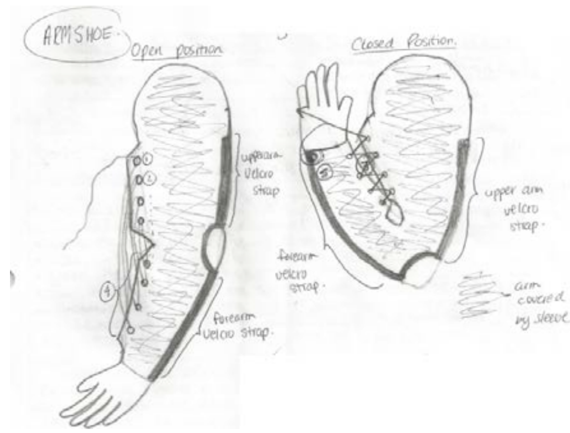
We believe that Mr. F will be very compliant with our splint, as it is very easy to use. He can simply put it on as if we he is putting on a shirt. All materials that are used are light and soft, pressure is distributed through thermoplastic and sponges, so, essentially nothing should hurt him. He could put the orthosis on anytime and even go outside with a jacket over top, if that is what he needs at the time.

Benefits

Our device is light, cost efficient, easy to make, needs few materials, is comfortable and easy to use for the user.

The Arm Shoe

Int Eng Group
F06 – T02-2



Problem Description
The problem was presented by the client, Tara Packham from Hamilton General Hospital. The problem was established due to the unknown user, “Mr. B”, a 23 year old male who was involved in a motorcycle accident. As a result he suffered severe injuries to his right arm, shoulder and chest. His injuries include: compound fracture and dislocation of his right shoulder, degloving of his right hand, nerve and muscle lacerations, and a torn brachial plexus. The compound fracture and dislocation of the shoulder eliminated his ability to movement around the rotator cuff. Mr. B wants a splint that is light and allows him to work on his active assisted range of motion. He has working wrist and finger muscles, as well as a working left arm. He desires a splint that locks at various locations to perform daily tasks. He would also like to be able to put on and remove the elbow splint with minimal to zero help. There is a slight possibility that “Mr. B” will go to prison, so the use of materials that cannot be weaponized are a constraint. Our firm, **Int Eng Group**, has designed an elbow splint suitable to fit his needs.

Design
The designed elbow splint involves a long sleeve shirt, with 8 holes made down the front of the arm, evenly split

between forearm and upper arm. A lace will be fed through the holes to create a lattice structure. The weight of the splint will be minimal due to the lack of heavy materials used (not exceeding a pound). It is the size of a long sleeve shirt.

Functionality

The prototype we designed is used to work on active assisted range of motion by locking the elbow between a 90 degree and complete flexion. The client wanted the prototype to help the user work on wrist rotation, forearm rotation and flexion/extension of the elbow. Most of the functions the client requested were achieved, except wrist rotation. It was believed in our group that helping "Mr. B" work on his range of motion and flexion/extension of the arm was more important.

Materials, Components, and Assembly

The prototype designed is made up of a thermoplastic, a cotton sleeve, washers, plastic hooks, instant glue, fasteners and Velcro. The thermoplastic was obtained from McMaster Titles. The cotton sleeve was purchased from H&M clothing store. The washers, plastic hooks, instant glue, fasteners and Velcro were all purchased from Home Hardware. There are two components: the first is the long sleeve shirt, and the second is the thermoplastic with the washers. The first component can be created using a shirt and scissors. This can take between 2-3 minutes. The second involves thermoplastic, hot water, and a pan. This component can take between 15-30 minutes to construct. In order for the thermoplastic to be modeled to the arm, it must be placed in water heated to 60° Celsius water and left to cool for 2-5 minutes. To join the two components, a very strong adhesive is recommended.

Cost

The cost of the thermoplastics was $67.50 for a sheet with the dimensions 18 inches by 24 inches, but we only used half. The cost for the cotton shirt was $16.21, the cost of the glue was $4.69, the cost of the washers was $0.60, the costs of the plastic hooks were $5.29, and the cost of the fasteners was $7.58. The total cost of the prototype was $68.12 tax included.

User Acceptance and Compliance

We believe that the device is simple, and easy to use, so there will not be a need to misuse it. The user will apply and remove the splint by applying and removing the shirt. The materials chosen to make contact with the skin are comfortable. The splint is used by pulling from the lace away from the body, making the forearm and upper arm contract in flexion. It is very modern, comfortable and visually appealing. All the objectives established were met. Our main objectives were low weight, low cost, and adjustability. The safeness of the design is due to the low number of parts.

Benefits

Our design is better than other existing solutions due to the fact that it is extremely light and versatile. All the designs that were previously reviewed by our team were heavy, uncomfortable, or contained parts that would not be allowed in prison. In addition, it allows the user to be independent, meaning that the user can apply it and remove it without any outside interference.

Dynamic Elbow Orthosis

H Flow Engineering
F 06 - T 02 - 3

Problem Description

Mr. B is a 23 year old male who was involved in a motorcycle accident. The injuries he sustained in the accident include a compound fracture and dislocation of the right wrist, degloving of the right wrist, tendon and nerve damage, and brachial plexus injury in the right shoulder. The client is the hand clinic at the Hamilton General Hospital. The clinic specializes in occupational therapy. The client needs an elbow orthosis for one of their patients that can be produced cheaply, and that can be made of materials easily available to the clinic. Mr. B, the user, needs the orthsosis to lock his elbow into place at various angles to allow him to use his right hand for day-to-day activities. He also needs the splint to assist in increasing the range of motion in his arm. The splint also must be very light or consist of some way to reduce the load of the splint on the shoulder to avoid causing strain on his shoulder.

Design

The orthosis is made up of two pieces of thermoplastic. One piece on the upper arm, and one piece on the lower arm. The two pieces of thermoplastic overlap at the sides of the user's elbow. They are held together using a wing nut and bolt system which is inserted into holes in the overlapping pieces of thermoplastic. This wing nut and bolt system also acts as the locking mechanism for the orthosis. The thermoplastic itself covers most of the underside of the upper arm, and forearm. A strap is attached to the orthosis and is worn around the torso and left shoulder to reduce the load of the orthosis on the user's right shoulder. Foam from the inside if a seat cushion lines the inside of the thermoplastic. A small piece of fabric taken from a washing mitt is placed between the two pieces of thermoplastic to prevent sliding when the device is locked.

Functionality
The wing nut and bolt system provides the ability for the user to lock his arm at various angles to accomplish day-to-day tasks. Unlocking the nuts allows for the angle of the orthosis to be changed which can also assist in static progressive range of motion. Tightening the nuts on both sides of the device then locks the two pieces of thermoplastic in place at the desired angle. The thermoplastic on the lower arm allows for wrist and forearm rotation since it does not cover the entire forearm.

Materials, Components, and Assembly
The materials required to build the orthosis are thermoplastic, wing nuts, bolts, a luggage strap, Velcro straps, super glue, and a cushioning foam material found in seat cushions. These materials can be found at stores such as Dollarama, Canadian Tire, and Home Hardware. To assemble the device, the two thermoplastic pieces must be molded underneath the user's arm. The thermoplastic must then be trimmed to prevent pinching of the arm when the arm is flexed. Holes need to be cut on each side of each piece of thermoplastic where they overlap. The nut and bolt system is inserted into these holes and then the bolt is attached to the inside of the thermoplastic using superglue. Velcro straps are attached to both pieces of thermoplastic using superglue. The luggage strap is attached to the upper piece of thermoplastic. The strap is adjusted to fit comfortably around the user's torso.

Cost
The cost of the thermoplastic required for the orthosis is approximately \$25, while \$67 was purchased. The wing nut and bolts cost around \$3. The luggage strap cost \$6.99. The Velcro straps cost \$1.15. Superglue cost \$1.15. The foam cushion cost \$2.60 and the washcloth cost \$1. The total cost of the device is approximately \$41.

User Acceptance and Compliance
Comfort for the user was considered by adding a cushioning material on the interior of the thermoplastic. This material aids in preventing possible pain or discomfort for the user caused by the device.

The user puts on the device by first putting the luggage strap around his torso and left shoulder. The user places the device around the arm and attaches the Velcro straps to hold the device on to the arm. To use the orthosis, the user loosens the wing nuts, which allows the pieces of thermoplastic to move. Once the user has positioned his arm at the desired angle he will tighten the wing nuts to lock the two pieces of thermoplastic in place.

The design meets the many of the set objectives. It is lightweight, and the luggage strap further helps to reduce the load of the orthosis on the shoulder. The orthosis allows for wrist rotation. The orthosis also provides a wide range of angles for extension and flexion of the arm. The device is affordable for the clinic and the user. The device is comfortable on the arm.

Benefits
The benefits of this design are that it is lightweight, relatively inexpensive, made of easily obtainable materials, fairly simple to assemble, and is easily adjustable by the user. These features cannot be found in commercial splints, making this design an ideal design for the clinic to use.

ARM™ Dynamic Elbow and Wrist Orthotic

ARM™
F 0 6 - T 0 2 - 4

The above two figures show the front and back views of the orthotic. The figure to the right shows the forearm cuff and the mechanism for pronation and supination of the wrist.

Problem Description

After experiencing a motorcycle accident, Mr. B suffered a brachial plexus injury and dislocation to his right shoulder including the laceration of the tendons and nerves in his arm. Additionally, his right hand was degloved, and he suffered a compound fracture in his arm. Due to his injuries, he has limited bilateral motion in his right arm and restricted muscle control in his shoulder and elbow. This limits the range of flexion and extension of the elbow and supination and pronation of the wrist. Our client, Tara Packham requested a device that would facilitate the execution of daily tasks through user adjustment alone without damaging his arm any further. An orthotic device was designed to allow the user to independently adjust his range of flexion and extension, in addition to pronation and supination of the wrist.

Design

The device, as shown above, is composed of a thin strip of aluminum which spans the distance of the forearm. Attached to it, are two cuffs -- one for the forearm, and a slightly larger one to fit the bicep. The bicep cuff was designed to fit users of varying size. Likewise, the forearm cuff provides a tight but comfortable fit for the user. The mechanism for pronation and supination provides both intuitive functionality, and comfort. The design is both light-weight and relatively small in size. For further design specifications, reference the sections below.

Functionality

The ARM™ Dynamic Elbow and Wrist Orthotic is designed to allow the user (Mr. B) to adjust their range of flexion and extension. The orthotic was designed using a thin strip of metal in which the forearm and bicep cuffs can lock in to using a simple wing-nut. The cloth vest is worn as a component of the orthotic. This garment provides support for Mr. B's subluxed shoulder, and relieves some of the weight of the orthotic. The 6 small ¼" screw eyes on the forearm cuff, act like hooks, and allow the user to attach a bungee cord between the glove and the screw eye, securing the arm in 6 unique positions for supination. Although the prototype is not suitable for incarcerated users, it can be easily redesigned to replace the metal brace, with a rigid, but easily machinable plastic, such as Delrin.

Materials, Components, and Assembly

The materials and components used in the construction of the ARM™ Dynamic Elbow and Wrist Orthotic device were chosen with simplicity, strength, and cost-effectiveness in mind. The materials used to build the forearm and bicep cuffs include 3" diameter PVC pipe (the bicep cuff was replaced later with 4" diameter PVC pipe) sponge padding, Velcro-straps, and a hinge to allow the user to adjust the size of the cuff. Individually, the forearm cuff also contained six ¼" screw eyes, while the bicep cuff's design includes a small plastic hook, used in the support of the shoulder. The flexion/extension component of the design was constructed from a thin strip of metal with several holes in it for adjusting the position of the arm. The mechanism designed to supinate the user's wrist was composed of a cotton gardener's glove, a bungee cord, and the screw eyes used on the forearm cuff of the orthotic.

Cost

The ARM™ design team created an orthotic device that utilized both robust, but inexpensive materials in its construction. In the final design, the PVC pipe would be replaced with light-weight thermoplastic, available at Hamilton General Hospital Hand Clinic, costing the user approximately 30-40$ for the amount required by the design. The velcro used in the design of the orthosic would cost the user an additional 5-10$ depending on how much is available at the clinic. Should this material not be readily available to the hand clinic, the cost to user might be anywhere from 10-15$. The bolts, screw-eyes, wing-nuts and washers used in the final design are of no cost to the client (due to their availability at the clinic), however, this would cost the user an additional 10$. The strip of metal used as a connector might not be available at the hand clinic, costing the client anywhere from 5-10$. In turn, the user would be charged 10-15$ for its use in the orthosis. The total cost to the user will range from 70 – 90$, whereas the clinic would need to pay 15 - 20$ for any materials that aren't available at the hand clinic.

User Acceptance and Compliance

To encourage user compliance, the device was designed in such a way that it was easy to put on and take off. In order to encourage the user's compliance with the device, we have lined the inside of the PVC cuffs with sponge padding, to prevent irritation of the forearm and bicep. The user can put it on with ease by placing their arm inside the device and tightening the cuffs individually. By painting the components, the design is now visually appealing, and may encourage user compliance with the device. This device meets all the design requirements, with exception of the user's incarceration — it allows the user to adjust the position of the arm from full extension to full flexion. The device also allows the user to pronate and supinate the wrist by use of the bungee-cord mechanism on the forearm. The design would not be feasible under conditions such as incarceration, which is a possible for our user, Mr. B. Most of the parts can be weaponized, and thus it is likely that this orthotic device would not be allowed in the general public.

Benefits

What sets the ARM™ Elbow and Wrist Orthotic apart from other designs, is that the user is able to adjust not only the degree of flexion and extension, but pronation and supination of the wrist as well. The device provides a relatively inexpensive solution to quite a complex problem; the materials used in its construction are both robust, but cost-effective. Since there is no 'hinge' mechanism that changes the device's degree of flexion and extension, it is a lot easier for the user to adjust independently. The sponge padding which lines the inside of the cuffs provides comfort while using the device.

Static Progressive Belt Orthosis

Elbow Orthosis Incorporated
F06 - T05 - 1

The inside of the device will be lined with memory foam to provide comfort for the patient

Duct tape straps to hold the device on the arm→these will be replaced by Velcro straps in the final product

Shoulder strap to reduce load of device

String used to adjust and lock the arm's position→this will be replaced by a belt in the final product

Strategic weakening of thermoplastic is shown here. This was done to allow the brace to bend along the same axis which the elbow naturally bends along

Note that the strap goes underneath the brace before attaching to it. This provides more support for the arm and reduces the load on the shoulder.

Problem Description

Mr. B suffered severe injuries to the arm and shoulder as a result of an accident. He requires a device which assists with range of motion therapy, allows normal daily use of his arm and provides space for forearm rotation. Due to the injuries to his shoulder, the device must not increase the load on his shoulder joint significantly and must be usable with only one arm.

Design

The design weighs slightly below two pounds. The elbow orthosis is approximately half the length of the arm, running from the midpoint of the forearm to the midpoint of the bicep. The orthosis is largely made of shaped thermoplastic which is strategically weakened to promote flexibility around the elbow joint's natural rotation axis.

Functionality

The Static Progressive Belt Splint provides a lockable forearm support, as requested by the user. It also provides a wide range of accessible angles to assist with range of motion therapy. The shoulder strap of the device spreads the weight of the device across the body, keeping the load on Mr. B's shoulder to a minimum. As requested, the device allows Mr. B to rotate his forearm and does not inhibit use of the fingers. Contrary to the user's request, the device is not acceptable for general population while incarcerated.

Materials, Components, and Assembly

The device is composed of thermoplastic, Velcro straps, a belt and a shoulder strap. The thermoplastic should be shaped to the user's arm, or a likeness of it, and then strategically weakened at the rotation point of the elbow to allow for rotation. This weakening is achieved with a V-cut sliced into the thermoplastic using a knife. The Velcro straps should be attached to the device at the halfway point of each section, to allow the device to be secured to the user's arm. A belt should then be looped through each strap to allow for tightening and locking of the orthosis. No special training or skills are required to assemble this device for a patient.

Cost

The device is relatively inexpensive when compared to commercial splints. The cost of the materials, not including thermoplastic, is no greater than 20 dollars. The thermoplastic required is the most expensive part. The sheet required is approximately 12'' by 12''. The estimated cost of this sheet is about $35. The device is relatively quick to put together, so man hours put in by the clinic should be minimal, thus keeping labour costs low.

User Acceptance and Compliance

The design has been produced for the most comfort possible for Mr. B. The inside of the product will be lined with memory foam, which will prevent skin irritation. Additionally, the load on his shoulder has been reduced as much as possible to prevent pain. This was done to encourage Mr. B to wear the device regularly. The device has been designed so that Mr. B can slip it on with one hand and then tightens the Velcro straps, thus removing the need for outside assistance when using the product. Mr. B simply slips the device on, places the strap over his shoulder, and then tightens the belt to the desired setting for his arm. The design has been made to go over clothing, but could fit underneath a jacket for outdoor wear. The finished product should attract no more attention than a standard arm cast, as it is approximately the same size. The product gives Mr. B a complete range of motion for his arm and allows him to lock it into place at any position, without getting in the way of his daily activities. Mr. B will not have to remove the splint to perform his normal daily routines, thus increasing his compliance. The final product will not have any sharp edges or corners, and will not have a significant risk of catching on a door handle, table, etc. The design does not have any major safety issues. Mr. B's arm will be held securely in place with almost no additional risk of further injury.

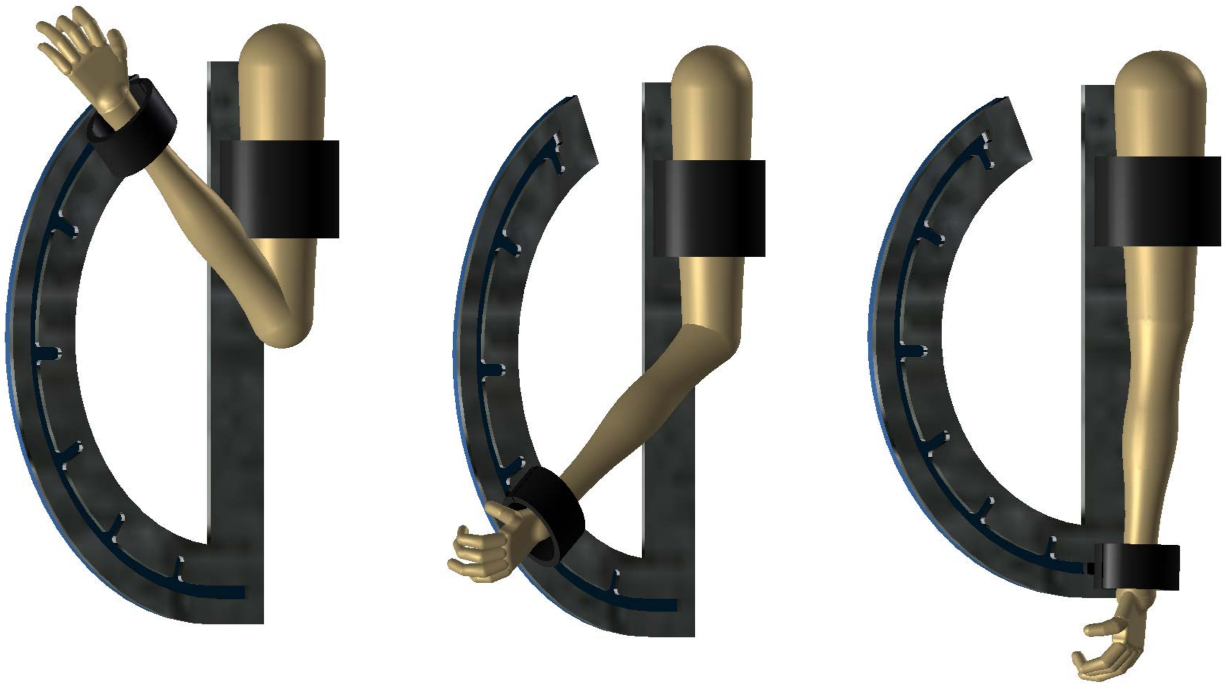
Benefits

This design is significantly less expensive than current commercial models which perform the same function. The product is about 10-30 % of the cost of most commercial splints. In addition, the product has no cast metal parts or hinges, which makes it easier to produce, repair and replace on site. The lack of cast metal parts makes the device a simple solution which can be quickly built by therapists on site. Another benefit of the device is its reusability. The device can be transferred between patients with a simple replacement of the foam lining. This not only promotes environmental responsibility, it also reduces the cost to both the client and the patient, because the cost of production can be spread over multiple patients. The orthosis also minimizes the load on the patients arm and shoulder. The design is lightweight, and utilizes a shoulder strap to spread the weight across the body, rather than focussing it at some single point. Perhaps most importantly, the design does not impact the patient's ability to perform everyday activities. The design provides space for full forearm rotation, and allows the arm to be locked in a wide range of positions. This allows the user to complete their daily tasks as if the device was not even needed. If the shoulder strap becomes cumbersome to the client, it can be removed from the device and stored for future use. This can be done with no special tools or skills. This device surpasses current commercial models because of its wide range of motion, multiple locking positions, inexpensive costs, simple construction techniques and its ability to be worn without hindering the patient's daily routines.

Mr. F

Sliding Elbow Orthosis

McMaster E-Team
F06 - T05 - 2



Problem Description

Due to burns, a patient is unable to endure the standard post operation procedures for improving range of motion of the elbow using a hinged splint. The *Sliding Elbow Orthosis* will help maintain and improve the range of motion gained from operations by allowing alternation of flexion and extension in intervals throughout the day. The patient desires an elbow orthosis that provides him minimal discomfort and that he can use on his own. An easily adjustable device will provide him with the independence he desires in the comfort of his own home.

Design

The *Sliding Elbow Orthosis* consists of two cuffs which attach to the arm at the upper arm and wrist areas. The cuff attached to the upper arm is stationary, while the cuff attached to the wrist area has the ability to slide along a curved track with the radius of the patient's forearm, and can lock into specific positions by sliding into notches along the side of the track.

Functionality

The *Sliding Elbow Orthosis* provides the user with complete range of motion, while providing minimal contact with the patient's sensitive skin. The orthosis is extremely easy to take on and off, with minimal dexterity required. The user can easily set the angle of the elbow in either flexion or extension with complete independence.

Materials, Components, and Assembly

The *Sliding Elbow Orthosis* consists of three simple parts: cuffs, track, and slider. The cuffs are constructed in two halves made of thermoplastic shells, lined with cotton balls to provide padding, and a spandex liner to minimize abrasiveness. Weak magnets are attached to the edges of the cuffs to help them stay closed, and the two halves are attached with a hinge.

Figure 1: Tunnel syste
for slider cross sectio

Materials, Components, and Assembly cont.

The track is constructed with three layers of plywood glued together with carpenters glue to provide a tunnel for the slider to run inside as illustrated to the side. The slider is constructed of thermoplastic cut into a circle with a thermoplastic peg attached vertically.

Cost

Plywood for the base: $20(can be reused)
Spandex for cuff lining: $5
Cotton padding for cuff: $2
Thermoplastics: max of $50(scraps can be used)
Hinges: $7
Glue: $3
Magnets: $2
Total cost for hand clinic: $89.00.

User Acceptance and Compliance

The *Sliding Elbow Orthosis* has been designed with the patient's comfort and unique needs in mind. There is minimal contact with the user's sensitive skin, and all surfaces that do contact the skin have been padded. The design has been optimized to allow donning and doffing with minimal bilateral movement and dexterity. The patient will want to use the device, because it provides him with independence unmatched by any other design currently on the market.

Benefits

The *Sliding Elbow Orthosis* is low in cost to the hand clinic, and the base can be reused and rented out to multiple patients, further lowering the cost. Due to the extremely simplistic design, the *Sliding Elbow Orthosis* is assembled and operated very simply. The orthosis is durable, lightweight, comfortable and easy to clean due to design considerations.

Dynamic Elbow Healer

Team Name
F 06 - T 05 – 3

Problem Description

Tara Packham, an occupational therapist at the Hamilton General Hospital has a patient, Mr. B, who has suffered a severe motorcycle accident causing him to lose all working muscle in his right elbow and most of the working muscle in his right shoulder. Mr. B has some wrist motion however it is limited and a full range of motion in his left arm. Mr. B wishes to have a dynamic elbow orthosis that will aid him in daily activities and recovery. Mr. B is currently on trial for drug charges that may result in him in prison, therefore our design must abide by Ontario prison laws.

Design

The prototype of our design doesn't weigh more than a couple pounds and that additional load is placed on areas of the body that weren't affected by the accident. The surface area of our design with respect to the right arm is small but attaches to other areas of the upper body with the use of straps, velcro, and various padding.

Functionality

Our design contains many different function that can aid in daily activities as well as recovery for Mr. B. Our design can support the right arm as well as adjust the right arm to desirable positions between 0-170 degrees. Our design also allows supination in the wrist to desirable positions.

The load of our splint is placed on the adjacent shoulder as well as the back to avoid causing additional pain to the already hurt shoulder. Our design also abides by Ontario prison laws (our prototype does not due to the use o metal clamps which are plastic in our design). To avoid unnecessary movement of the right shoulder our design locks the right should in place to avoid pain when adjusting positions.

Materials, Components, and Assembly

The materials required to make our design are relatively inexpensive and easy to access. The materials include Four sets of side release snap buckles (backpack clips), about 20" to 30" of winch strap, three plastic strap adjusters, a plastic snap hook, some Velcro, and some foam padding. The buckles, adjusters, and the snap hook can all be purchased at a local hiking or outdoors store. All three of them retail for between fifty cents and two dollars apiece, depending on the size and design. The straps can be purchased at Dollarama for two dollars per fifteen feet. Velcro can be purchased at any local hardware store from between two to ten dollars depending on colour, size, and strength. The padding can be salvaged from old backpacks, or purchased at a local textile, or foam store. The only things needed to build and then assemble the device are a pair of scissors, and a sewing kit or sewing machine. The device is built by simply taking some measurements of the user's torso, and arm length. After the measurements of the user have been taken it will take between forty-five minutes to an hour to build. The only expertise that will be needed is the knowledge of how to use a sewing machine.

Cost

The cost for the clinic is estimated to be forty-five minutes to an hour of labour to build the cast after taking measurements of the user and after receiving building instructions. The cost for the user is estimated to be less than thirty dollars if all materials are purchased.

User Acceptance and Compliance

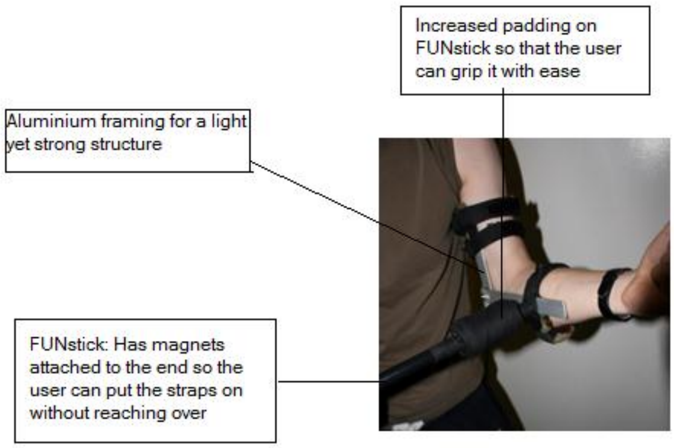
The users acceptance has been considered in several aspects of our design. First, our design can easily be put on and taken off with the use of one arm with the right instructions because our device is entirely connected. Second, our design is comfortable by using various padding on injured areas and doesn’t place additional load on the shoulder, therefore the user is more likely to comply with exercises. Last, our design uses colours, this also adds to the compliance of the user to wear the splint as required. The user is able to adjust the placement of their arm by simply pulling on the strap to tighten or pulling up on the strap adjuster to loosen the strap. Additionally the user can adjust the placement of their wrist by attaching the clamp and the end of the strap to the wrist cuff. Our objectives were to make our design adjustable, supportive, comfortable, safe, and inexpensive. All of these objectives have been fulfilled beyond our expectations and scored an average of 85 based on our metrics when we aimed for 80. All of the materials in our design are permissible in pubic because the materials used are fabrics, straps and plastic.

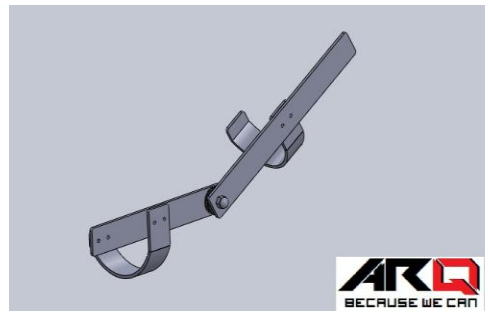
Benefits

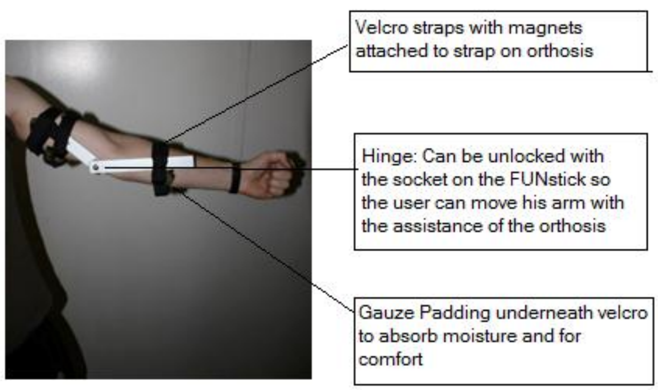
Our design has many benefits for Mr. B. The strap and strap adjuster allows for the user to adjust their arm to any position between 0-170 degrees. The buckles on the wrist cuff provides full supination in the wrist so that the motion Mr. B currently has isn’t restricted. The additional straps placed around the upper body eliminates any additional load placed on the right shoulder and locks the upper right arm in place so that the shoulder doesn’t move when adjusting the position of the arm. Our design can be easily attached and removed with one arm and has colour which makes it more visually appealing to wear. Overall our design is a highly effective solution to Mr. B’s recovery.

S.A.M.
(Stick Assisted Motion)

ARQ
F06 - T05 – 4







Problem Description
Design an elbow orthosis for a patient with severe burns to the arm, who suffered heterotrophic ossification in the elbow joint. Due to the injuries, the motion in his elbow is restricted and he wishes to regain the range of motion in the flexion/extension plane. The patient has poor skin quality and has trouble passing his arms across his body to attach, remove, or adjust the orthosis because of his condition. The patient has had troubles with commercial orthosis in that it is difficult for him to attach Velcro straps both due to crossing his body and rubbing the strap across his poor skin. The patient wishes to remain independent and therefore wants the ability to attach, remove, and adjust the orthosis on his own.

Design
As seen in the image above, the main frame of the orthosis is 2/3 the length of the upper arm and 3/4 the length of the forearm. It has Velcro straps on both the upper arm and the forearm. The model is very light and won't cause any tension on the wounds. It is compact and has the same width as the arm so the user can easily carry it and he can even wear it over or under his clothes.

Functionality
S.A.M. (Stick Assisted Motion) can help the patient by allowing him to adjust, remove, and attach the orthosis without having to reach

across his body. The “FUNstick” has the capability of attaching and removing the soft Velcro straps easily and allows quick and easy adjustment of the locked angle. The easy to attach gauze padding makes it easy to clean or replace if worn. The amount of contact with the skin is minimal therefore the risk of infection over a large area is reduced. The orthosis has a functional range of 340°. This allows maximum flexion/extension therapy capability and makes it easy to stow.

Materials, Components, and Assembly

The client needs to purchase some gauze, 1”X1/8”X2’ aluminum strip, a square head bolt (1/4”-20 X 3/4”), rubber washers, capped nut(1/4”-20), adhesive Velcro, rare earth magnets, a 3/8” socket, and an acrylic cylinder. The client can start off building this orthosis by constructing the frame. First, the aluminum strip is cut to approximately 2/3 the length of the upper arm and 3/4 the length of the forearm. 1/4” holes should then be drilled at one end of each of the bars. Next, the square based bolt is hammered through the one of the rods to form a square shape. The rubber washers are glued to the metal rods around the 1/4” hole and the capped nut is used to hold the rods together. The two arm straps are bent into shape around an approximately arm shaped object and then riveted to the frame. The Velcro is taped to the frame and taped to avoid friction on the arm. The gauze padding is taped into place and the magnets are taped into place on the straps. The FUNstick is made using an acrylic rod with a socket epoxied into one end and a magnet epoxied into the other. The FUNstick is then inserted into a pool noodle to increase its diameter for easy grip. The tools required to build this design are: a drill, hacksaw, and a hammer. This entire design will take the client approximately 45 minutes to build in her workshop.

Cost

The materials are relatively inexpensive and easy to find. The gauze was purchased from Shoppers Drugmart; the materials for the hinge, earth magnets, and aluminium were purchased from Princess Auto; and the acrylic rod(plunger handle) and Velcro straps were purchased from Dollarama. All these items were bought for a cost under $25. The market price for a commercial orthosis is approximately $150-300. Therefore, an approximate charge of 100$ to the user should be acceptable.

User Acceptance and Compliance

The user can use this orthosis wherever he goes and can put it on and remove it without assistance. He can also wear it on top or under his clothing without it irritating his skin, ripping clothes, or causing any problems. In order to use this product, all he has to do is merely place his left arm onto the orthosis, take the FUNstick with his other arm and hold the FUNstick against the straps until the magnets attract. He then just has to pull the straps off. After closing the straps on his forearm and bicep, he must adjust the tension of the splint. In order to do this, he must do take the other side of FUNstick that has the socket and unlock the hinge. By twisting it to the right, the system locks and is held into place. When twisting it to the left, it unlocks and the user can move his arm with the assistance of the orthosis. The user can take the orthosis off by loosening the bolt and using the end of the stick to pull the Velcro off. The Gauze padding makes the design very comfortable and non-irritating to his sensitive skin and therefore increases user compliance.

Benefits

SAM is a more beneficial design than current orthosis because the other products have heavy, thick padding which causes the orthosis to be bulky and heavy. The advantage with SAM is that it is light so it won’t cause any strain to the patient’s burnt muscles. Even a very popular orthosis, the “Elbow Split L3760” by LEEDer Group Inc, won’t be suitable for Mr. F because it does not allow the user to wear clothing over the orthosis. With SAM, convenience is at a maximum since the user can wear it over his clothing and be more independent. Another disadvantage of the Elbow Split L3760 is its locking hinge system. This unit will not be suitable for Mr. F due to the difficulty to adjust the angle of the arm to different settings. With SAM, the user can adjust the hinge and move his arm within any range of 340 degrees easily.

Design of a Static Progressive Elbow Orthosis

Gomito Stecca Design
F 0 6 - T 0 5 - 5

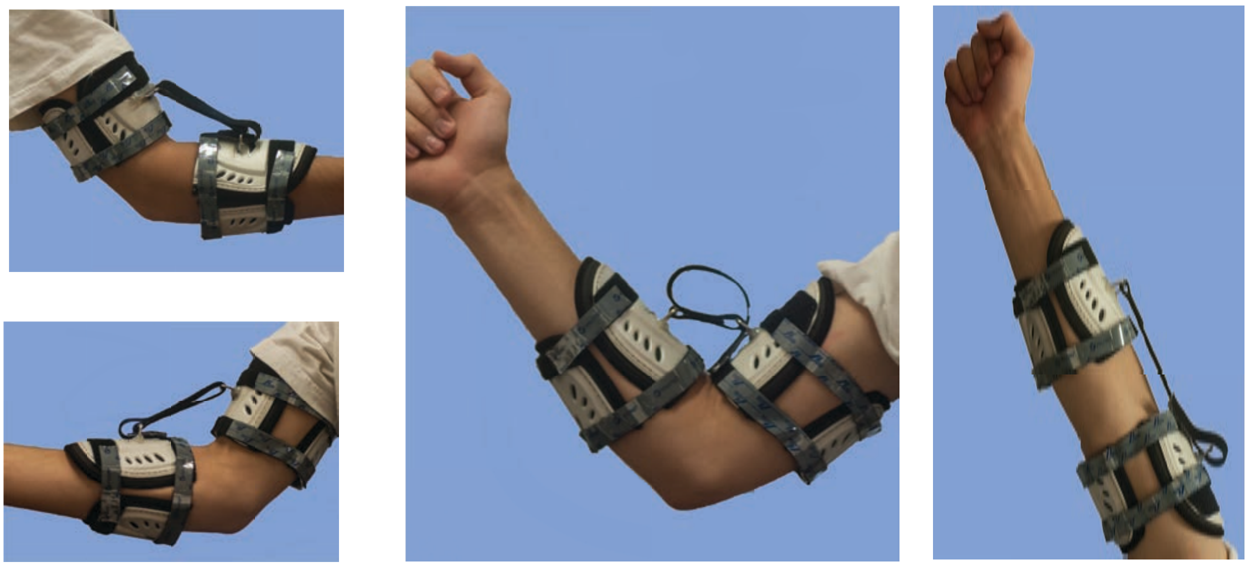


Figure 1: The image on the top left corner is an outside view of the elbow splint of the arm and the image on the bottom left corner is the inside view of the elbow splint. The image in the middle is the elbow splint in flexion and the image on the right is the elbow splint in extension.

Problem Description

The problem that is presented to the team involves designing an elbow orthosis for Mr. B, a 23-year-old man involved in a motorcycle accident. Due to this accident, he cannot perform any flexion or extension of the right arm, because the accident resulted in a compound fracture on his forearm with a brachial plexus on his right shoulder. Therefore, our team has given the task to create a device that would enable flexion and extension in his right arm and also support the weight of his right shoulder.

Design

The design will be approximately be less than a pound and very comfortable to wear due to the padding of the interior part of the elbow splint. The Velcro straps make it easily adjustable, which allows the splint to used with varying arm sizes. With the adjustability of the elbow splint, the device needs to have a secure grip on the arm of the user. Hence, the use of numerous Velcro straps as seen in the picture above.

Functionality

The main functions that this design achieves is to be able to allow the user to perform active assisted range of motion by enabling the user to adjust the degree of flexion or extension and locking that degree into place. It also allows the arm to pronate and supinate with his hand and forearm, while supporting the arm and shoulder. Therefore, most of the functions that the client desires are resolved with this elbow splint.

Materials, Components, and Assembly

The materials needed to make this elbow splint are shin pads, Velcro straps, Styrofoam, duct tape, D-loops and a belt. These materials can be bought easily for a cheap price at dollar stores and sport stores such as Dollarama, Convenience stores, Sportchek, and other hardware stores. Tools such as a glue gun and scissors are needed to create this elbow splint. The time that it would take to assemble the device is less than an hour, approximately 45 minutes, for it is fairly simple to assemble it. To assemble the device, first, we cut the two shin-pads in half and attach each larger end to shorter end of the shin pad with Velcro straps around it. The Velcro straps can be attached onto the shin-pads by using the glue gun. Once that is finished, the metal d-loops can now be attached using the glue gun to each shin-pad part so that it is facing forward when put on the arm. Then a Velcro strap can create a loop around the metal d-loop, which the user can pull or release the strap for flexion or extension. After that, the shoulder belt support can be made by cutting a L-shaped Styrofoam box out where the user's arm can rest and attach it to the belt with a lot of duct tape. From this the elbow splint is fully assembled with no special assembly required.

Cost

The prototype is very cost effective and the clinic would take less than $10 of materials to produce a similar model of the elbow splint since the clinic has most of the equipment used in producing the prototype.

User Acceptance and Compliance

The user will use this elbow splint adjusting the splint to different positions when he needs to do a certain task or activity. When he is standing or resting in one position, the user would want to use the shoulder belt support to support the weight on his shoulder. The user will want to wear it as it would be very comfortable but will not like wearing the shoulder belt support outside and so it should be preferred to be worn inside. The safety of the design is that the elbow splint for the user will be safe and comfortable but instead of the metal d-loops, it can be replaced by plastic.

Benefits

Some benefits that make our design of the elbow splint better than our peers is that it's simple and easy to put on. It is also very comfortable due to the padding inside the elbow splint. It is also has the benefit of being able to adjust very easily by the user himself.

The Wrap and Strap Orthosis Device

El-Sci
F 06 – T05 - 6

Visual of Protoype of Final Design of Prototype

Problem Description

The Hamilton General Hand Clinic has a victim, Mr.F; who is suffering from 2nd to 4th degree burns caused by a house fire. He suffers from elbow ossification as a result. Moreover, the severity of the burns stripped the outer and inner layers of the skin to various degrees; some almost to the bone. He would like an elbow orthosis that allows him to move his arm in a greater range of motion than is currently available. The elbow orthosis should be adjustable for Mr. F's elbow in a particular angle and be stabilised. Moreover, the contact surface of the splint should be minimized and the material has to be also soft and clean to avoid the pain, and prevent the risk of infection. In addition, Mr. F is living with his parents but he wants to live independently instead of being forced to constantly ask for their help. In conclusion, the elbow orthosis should be easily adjustable, easy to put on and off and also allows his arm to participate in basic physical activities to make his life easier.

Design

The finished design includes three parts. The main part is a wood stick with five rings, and there are straps on each ring. The rings are connected to the wood evenly by screws. The rest of parts are a long Velcro strap and a loop device. The five rings are made of aluminum and covered by memory foam. The thermoplastic is placed on the memory foam to covers patient's whole arm. The size of device is about half of patient's arm. The weight is approximately 750 grams with the thermoplastic included.

Functionality

First of all, it stabilizes the elbow in a fixed angle by attaching the straps from the aluminum rings to the patient's arm. The strap is easy to fasten and provides enough force to stabilize the elbow. The second function is to protect the patient's skin b having thermoplastic and memory foam between the device. The third function is to adjust the angle; simply attach one ring on the wood stick to a position on the upper arm and another ring to a position on the lower arm and then fasten the straps on the rings. For the smaller angles

Materials, Components, and Assembly

The materials used are five aluminum mason-jar lids, one aluminum snap-lid, hot glue, one wooden paint stick, one 3/16inch nut and bolt, one 1/4inch washer, two feet of soft Velcro and two feet of hard Velcro. The materials can basically all be found in any regular hardware store. The design will take approximately twenty minutes to make. Start with drilling one hole in the paint stick at left end. Then weave Velcro straps around a mason-jar lid and attach the straps undersides using the adhesive. Next, glue a snap-lid onto the mason-jar lid using a hot glue gun. Puncture a hole in the snap-lid with an approximate radius of .75cm then use a screw, nut and washer to attach the lid and ring mechanism to the paint stick, keeping the bottom of the metal ring facing away from the paint stick. Place excessive amount of hot glue on the screw that is inside the lid to cause the screw to be fixed and immoveable. Using the hot glue gun, attach four more rings to the paint stick. Space them evenly. Then attach strips of the rough side of Velcro to the reverse side of the paint stick. Next, glue long, thin pieces of Velcro to the bottom of each metal ring (make sure to glue them on with the soft side of the Velcro facing up). Obtain a long, rolled-up piece of Velcro for support during maximum flexion.

Cost

All of the material used to make the apparatus is available at the Hamilton Health Sciences Clinic. The total cost would not exceed ten dollars excluding the cost of the thermoplastic. The thermoplastic would cost 84$ per device and is the singularly expensive item. The cost to the clinic would then be virtually zero, since the clinic already possesses the required items. The client however would incur a cost of 95$ minimum if just the accounting cost is considered for a single use.

User Acceptance and Compliance

Mr F can use it entirely independently. The use of extremely soft memory foam will ensure that his skin will not be in contact with the main device (thermoplastic) and he will still be comfortable wearing it. Thermoplastic and memory foam both fit to the shape of his arm; this makes it much more comfortable to wear and use on a daily basis. It also reduces the probability of knocking it against a surface and injuring himself. He can adjust the angle easily. This will help him rehabilitate the use of his arm faster. His lack of dexterity has been resolved by having an external force to adjust the straps. The user can even wear a heavy jacket over it as it would not affect the device much. He has added mobility as the device keeps the elbow fixed. He can choose the color of the thermoplastic to suit his cosmetic want.

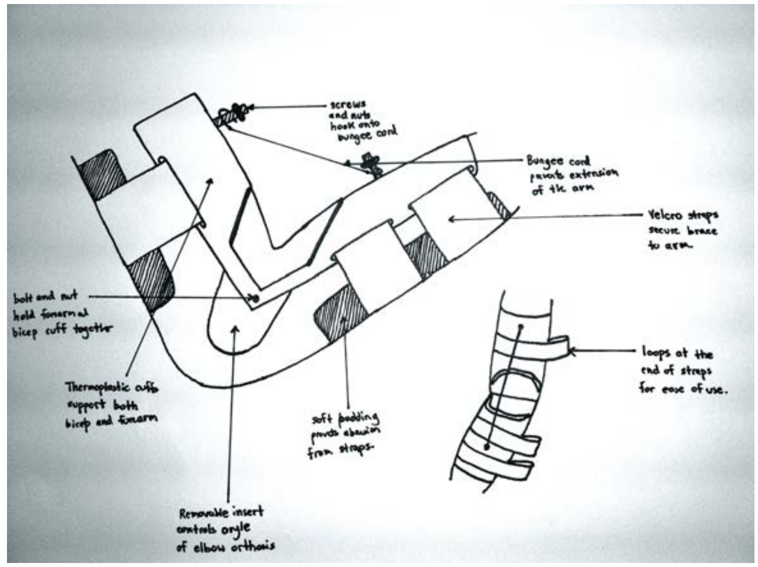
Benefits

Most devices either use steel or neoprene as their main component of their orthosis device. Both are unfeasible for Mr F. Thermoplastic however overcomes both the inherent problems of weight and inertness. It can be remolded continuously to provide the strength and shape required. It can also be available a lot easier than neoprene and is inexpensive. Dyeing is easier too, allowing for a greater range of colours, satisfying the aesthetic requirement of a user or client.

Most existing orthosis devices are patented with the use of an electronic device to monitor angle the device is set at. Mr F however has insufficient dexterity to operate. Our device takes these into account and uses just Velcro straps, which provide an adequate ratio of tensile strength to weight to be beneficial. Additionally, they are inexpensive and easy to replace.

Dynamic Elbow Orthosis

MediSolve Design
F07-T05-1



Problem Description

The goal is to design and develop an elbow orthosis for Tara Packham, Occupation Therapist at the Hamilton General Hospital Hand Clinic. The device is to be used by the victim of a house fire known as Mr. F. The user has suffered skin and nerve damage; 20% of his body-surface area is covered by 2nd and 3rd degree burns. His hands are included in that 20%, therefore he has very limited hand functioning bilaterally. He also experienced heterotopic ossification of the elbow, which required surgery, and resulted in the loss of extension and flexion in his elbow. The skin grafting he received also left him with poor skin quality. The orthosis must provide support to the elbow, and be adjustable to lock the elbow at different angles. Adjusting the orthosis should not require a large amount of hand or finger dexterity, and should preferably not require the assistance of others. The orthosis should not be abrasive or damaging to the skin it is in contact with. While accomplishing these tasks, the orthosis should also be relatively inexpensive.

Design

The design consists of two cuffs that attach to the upper arm and the forearm arm, and are joined at the elbow with a hinge. In between the cuffs, a thermoplastic insert slides in to prevent flexion at the elbow, and a bungee cord attaches the forearm cuff to the upper arm cuff to prevent extension. The bungee cord and insert combination allows angle adjustment at the elbow, as different lengths of bungee cord and different sizes of insert are used. The cuffs are secured to the arm using Velcro straps and non-abrasive fabric padding. The amount of material required to make the orthosis is relatively so, optimizing the weight of the design to be not very heavy. The orthosis is fairly compact, so that the user is not overly inconvenienced during his every day activities. The only protruding piece is the bungee cord that extends between the bicep and forearm, but the majority of the orthosis conforms nicely to the shape of the arm, drastically reducing the size.

Functionality

The orthosis provides comfort at a relatively low cost, while simultaneously fulfilling all the needs and requests of the client. To address the issue of the user's poor skin quality, the orthosis has been design to maximize comfort with soft non-abrasive padding on each cuff. Thermoplastic is also a very smooth material, and would not cause any damage to the skin upon contact. To satisfy Mr F's desire for independence, the orthosis is easy to put on and take off without the assistance of others. The inserts are big and do not require much finger dexterity to put into place, and besides the inserts and bungee cords the orthosis is all one piece, which makes it much more user friendly and easier to take on and off. Furthermore the Velcro straps are made of weaker Velcro, but cover a larger surface of the cuffs so that the orthosis will stay on, but not require too much force to remove. Finally a small addition that was made to accommodate Mr F's damaged hands is the loops at the end of each strap. Fingers can be inserted into the loops to do up or undo the orthosis without having to pinch the straps, which may be difficult.

Materials, Components, and Assembly

When designing the brace it was essential that all materials used were easily accessible by the Hamilton General Hospital Hand Clinic. The orthosis is made out of thermoplastic, bolts with their corresponding nuts, Velcro, bungee cords, straps (luggage straps were used for the final model) and padding (seat belt pads were used for the final model). Fasteners include double-sided adhesive to secure the Velcro to the thermoplastic cuffs, and needle and thread to sew Velcro to the straps. The orthosis is comprised of an upper arm cuff and a forearm cuff both made of thermoplastic and padding, a hinge connecting the two cuffs made using a screw, straps to fasten the cuffs to the arm, thermoplastic inserts, and different lengths of bungee cord. The only tools required for construction are scissors or a knife for cutting/piercing the thermoplastic, a needle for sewing, and a device to heat water in for moulding the thermoplastic. Construction of the orthosis takes approximately one to one and a half hours, provided that the manufacturer has experience sewing and heating/moulding thermoplastic.

Cost

The approximate cost of the orthosis factors in the use of $20.00 of thermoplastic, $5.00 for straps, $4.00 for Velcro, $2.00 for nuts and bolts, $1.00 for thread, $10.00 for padding, $6.00 for bungee cords, and $2.00 for adhesive, totalling at around $50.00, give or take a few dollars depending on the size of the user's arm, which would have an effect on the size of the orthosis and the amount of thermoplastic needed.

User Acceptance and Compliance

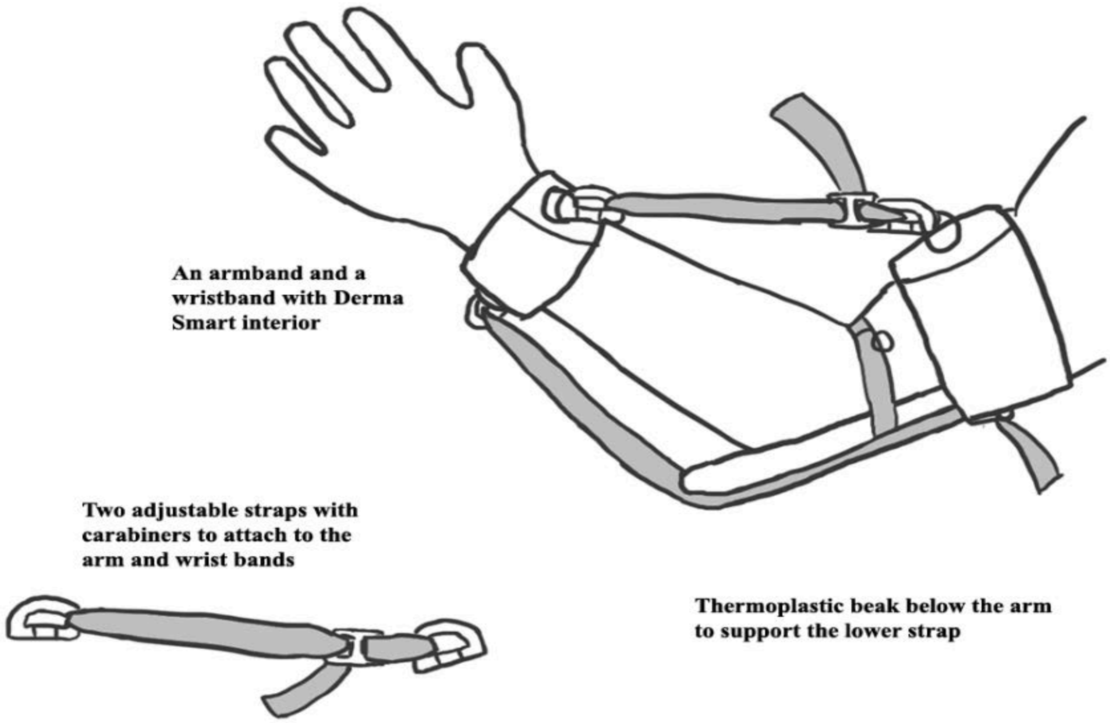
The orthosis is a product that has been designed specifically so that the user will want to use it. Soft and smooth materials were used for the majority of orthosis to provide comfort, and loops at the end of large Velcro straps make it easy to put on and take off. Adjustability is optimized using large thermoplastic inserts and bungee cords that do not require too much finger dexterity. Finally the fairly small, compact design makes the orthosis not only less of an inconvenience, but also contributes to a more sleek, less obvious appearance as opposed to a design that is big, bulky, and unappealing to look at.

Benefits

Our design is effective for the needs of Mr.F because of its unique and innovative design. The removable inserts, which allow for the angle adjustment of the brace limit the need for finger dexterity. The broad and comfortable straps limit the amount of pressure on the sensitive skin and possibility for further damage while maintaining a snug fit on the arm supporting the elbow. Finally, this design is made of inexpensive materials, which are easily accessible to the hand clinic. For the above reasons, our design is ideal for Mr.F the user and client of the Hamilton Hand Clinic.

Orthomaster 2000

Team Name
F07-T05-2



Problem Description

The LWOB design firm's client is Tara Packham. Tara is the Occupational Therapist at Hamilton General Hospital and the Hamilton Hand clinic. The case she brought to the firm involves a user named Mr. F with Heterotrophic ossification. The goal for Mr. F is to design an elbow orthosis that will increase his range of motion about the elbow. Along with Mr. F's elbow issues he is suffering from second and third degree burns that cover his arms and hands, this means that the orthosis must also be easy to use and be gentle on Mr. F's burns. The orthosis should also be as inexpensive as possible.

Design

The design has 4 components, two wristbands, and 2 adjustable straps. The device changes the angle of the arm by either lengthening or shortening the adjustable straps. These straps attach to the hooks the armbands. The device is very light because of the materials used and can be worn over clothes. Our orthosis is very small in size, it does not completely cover the arm so that it will not affect Mr. F's burns.

Functionality

The Orthomaster 2000 is fully functional and it meets all the requirements. The design uses adjustable straps attached to the elbow and the bicep to lock the elbow in wide range of angles. This mechanism satisfies the function of a regular orthosis. An orthosis that can be used by Mr. F needs to be non-irritating to his burnt skin, and Mr. F needs to have the ability to operate the orthosis independently. Our product uses carabineer hooks and several rings that Mr. F can loop his fingers through attached on various places of the orthosis. This feature allows him to wear the Orthomaster 2000 independently. All contact points between the device and the subject's skin is cushioned by Derma Smart fabric, a material sensitive to burnt skin. Derma Smart fabric makes the Orthomaster 2000 irritation free

Materials, Components, and Assembly

The orthosis is made of 4 separate components a wristband, an upper armband, an adjustable strap for flexion, and an adjustable strap for extension. Both armbands are made of Velcro with a pull tab, so that they are easy to put on and off. They are also covered in a fabric known as Derma Smart that is gentle on burns and reduces further inflection to burns. This fabric costs $40-60 (shipping included) and can be ordered online through their website in a range of sizes. Each strap has two rings sewn into the fabric on opposite sides, one for flexion and one for extension. The upper armband has a thermoplastic piece with a Velcro strap attached to it that supports the arm, and allows for extension. This plastic piece is positioned down the arm to the elbow. Each strap has 2 karabiner hooks, that are attached to the strap by sewing a loop to the end of each strap. The shorter strap is for flexion, the longer for extension. All of the materials other than Derma Smart and thermoplastic can be obtained from Canadian tire, for under $30. All the components can be constructed with a sewing kit and a hot glue-gun in approximately an hour. Our orthosis is a very simple design making it easy to fully assemble

Cost

The total cost to completely recreate the orthosis without previous materials is $60. For the clinic this cost should be lower because the orthosis is made of materials that are found in the clinic.

User Acceptance and Compliance

We have considered Mr F by making the orthosis easy to put on and off. Since he wanted complete independence we set one of our goals to make it easily adjustable and easy to put on and off. Mr F. puts it on by putting on both armbands and then hooking on the extension or flexion strap. The device is comfortable since there is fabric that fully covers the Velcro used so that there is no itching or scratching. It is also comfortable because of its light weight. The user can wear the orthosis for a long period of time without excess stress on the arm. Mr F will use it by adjusting the strap lengths to adjust the angle of his arm, which will cause his range of motion to increase. Our device is small meaning Mr. F is more likely to wear it because it does not hinder his everyday life. He can also wear the orthosis over any type of clothing, and fully pack the device to take it anywhere he wants to go. We considered safety throughout the design process. The device is very safe for Mr F. and people around him. The only hazard could be the thermoplastic “beak” hitting someone, or knocking something over. This is not a large safety issue since there are no sharp edges on the “beak”

Benefits

Cost- The overall cost to completely create the orthosis is much cheaper compared to others in the current market.
Materials- the materials we used gave our orthosis an advantage above the others. The fabric known as Derma Smart is what sets us apart from others. Derma Smart is made from microfiber and it glides over the skin’s surface. The material dries quickly and uses tiny amounts of silver to prevent bacteria build-up. The silver works as an antimicrobial, a substance that kills or inhibits the growth of bacteria and mould. Although there is Velcro used, (which could cause issues for our user) the Velcro used all has an easy pull-tab. Also all of our materials used can either be found at the hand clinic or easily ordered online to deliver straight to the clinic
Ease of Use-The user only needs to attach 2 armbands and then hook either the flexion or extension strap. The karadiner hooks used in the design are easily opened and closed with minimal force and very little dexterity. The straps are completely adjustable so that a full range of motion can be achieved.
Easy to Create- the orthosis can easily be produced again by the orthopedic therapists at the Hand clinic.
Fully Portable- the orthosis can be taken anywhere because of its small size and flexibility.

Velcro Master

Solutioneering
F07 – T05 - 3

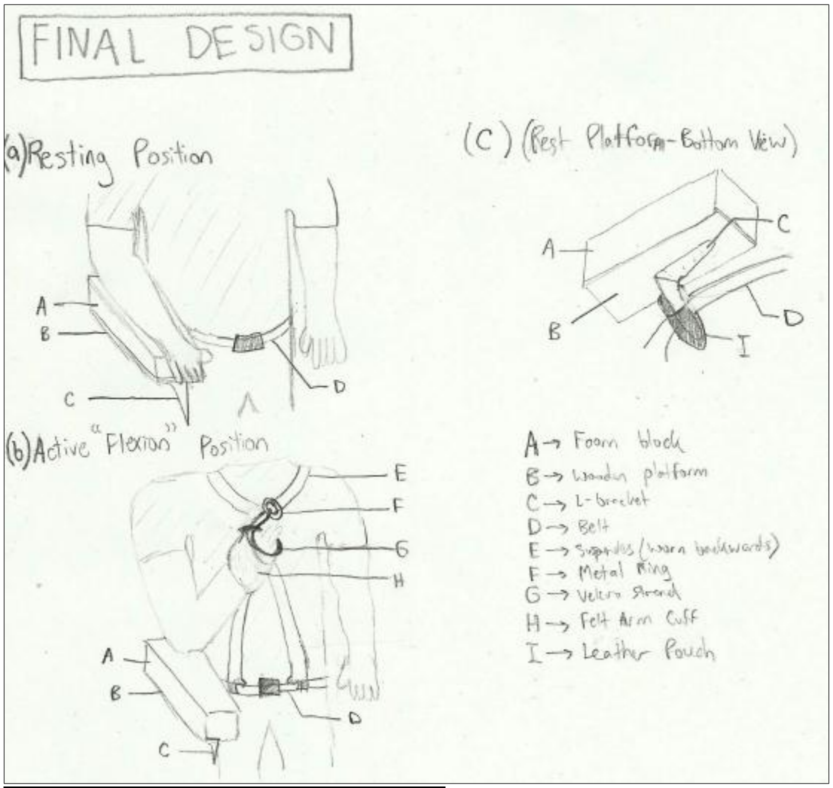


Figure 1: Sketch of Final Design

Problem Description

The Hamilton Hand Clinic has a patient, Mr. B, who has suffered a compound fracture/dislocation and degloving on his right wrist with tendon and nerve lacerations. For this patient, activities that require elbow and shoulder movement, such as getting dressed, writing and typing are significantly more difficult because of the dislocation and lack of movement in his elbow. There is particular evidence indicating that the patient displays the ability to type and possibly write when the right elbow is kept stable, with assistance from a health professional. The Hamilton Hand Clinic has a asked Solutioneering to try to design an elbow orthosis that would allow elbow exaggerations and help Mr. B with forearm rotation, while being safe amongst the general population. The device should be light in weight, create a range of motion depending on the activity of the hand, for example, low in position while typing. Essentially, the device should allow Mr. B to perform tasks sans the dependence of family members and friends. The Hamilton Hand Clinic desires the device to be safe and free from hazard as a result of personal issues regarding an upcoming trial. Fundamentally, a range of patients with an elbow orthosis issue and similar consequences should use this device.

Design

The Velcro Master serves two functions: to provide a neutral resting position and allow for assisted flexion for ROM therapy. The neutral resting position as seen in part Figure 1(a) above allows the user to rest comfortably by taking weight off of the upper extremity. The Velcro master does this with its resting platform composed of a foam block “A” secured to a light wooden plank “B”, which is supported by an L-bracket “C”, which sits in a leather pouch “I”. The user wears a belt “D” which wraps through the leather pouch and around their waist. When the user’s arm rests on the platform, it pushes down on the whole system and the belt allows the weight to be distributed across the user's torso. The belt can be tightened to the desired level as well as desired height. The neutral resting position allows for the user to perform activities such as writing, drawing or typing. The Active Flexion position as seen in part (b) allows the user to adjust the degree of flexion they want their arm in by pulling on the Velcro strand "G". This Velcro strand originates from the felt arm cuff "H", goes through a ring "F" attached to a backwards worn pair of suspenders "E", and then wraps around the hand and sticks to itself. The arm is supported across the entire upper body as the suspenders successfully distribute the weight of most of the arm and the remaining arm weight is supported by the foam block "A" as the elbow remains in contact with it. The weight all of the combined parts of the device was just over 3 pounds. It is also fairly accurate with the proportions portrayed in Figure (figure number) above. The resting platform itself measured 36cm long and 16cm wide.

Functionality

For Mr. B, the Velcro Master has a multitude of functions. Particularly, its main function is to provide an increased range of motion. This is mainly accomplished through the Velcro component, attached to the wrist and the core part of the suspenders. By adjusting the length of the Velcro strap, closer toward the chest, one is driving the arm to different positions. Essentially, it is hoped with this forced movement that the arm will gain movement once again. As well, functionally, the Velcro Master offers a neutral position for the typing position Mr. B desired. By having a support to lay the arm over, there is less pressure on the arm during strenuous activity. However, it also allows for a low enough position so typing and other activities are easily accomplished. Realistically, the device does not do everything the client has requested. For Solutioneering, it was vital to focus on the rehabilitation aspect and cost - in other words, keeping the cost low and providing a significant range of motion. This focus was taken since these characteristics represented the purpose of the orthosis.

Materials, Components, and Assembly

Materials that need to be obtained include suspenders, a belt, sponges, an L-bracket, a snap clip, Velcro straps, a wooden board, a work pouch, screws, a stapler, tape, string and fabric. The materials can be bought at Canadian Tire. To construct the device, the L-bracket was screwed into the wooden board and the opposite end was placed into the work pouch. Sponges were attached to the top of the board using tape, and the entire element was covered in a fabric. A belt was passed through the work pouch. The arm pouch was constructed out of felt formed into a thick hoop; slits were cut for one end of the Velcro strap to pass through. A snap clip was placed on the cross of the suspenders for the other end of the Velcro strap to pass through. This process of construction takes about 45 minutes to 1 hour by hand.

Cost

The average cost to make the device for Solutioneering was $70, with materials left over. However, if the client buys materials in bulk, the average cost to make one device will be $50 and the price to the users can be $60.

User Acceptance & Compliance

User compliance has been considered because of how the user is only able to use one arm to put on the device. The user will simply put on the suspenders and belt and strap them together. It is designed to be comfortable when having the elbow resting on the comfort cushions. The user will just rest elbow on the device, and adjust the height of the wrist to their disclosure. They will want to wear it because it keeps the elbow in a position where the user can type and do basic life tasks. We have considered placing a cloth over the cushions, so that it does not look so drastic.

Benefits

The Velcro Master offers three main benefits to the user. Firstly, it takes a significant amount of strain off the shoulder. This is especially useful in Mr. B's case, considering that his shoulder is partially subluxed, but it offers an added benefit to any user regardless of any potential shoulder injuries by making the device more comfortable to wear. The second is that it allows the user to comfortably perform tasks like typing for an extended period of time. Lastly, it allows the user to participate in range of motion therapy. Other devices on the market will surely also have one or two of these benefits, but the Velcro Master is the only device that offers all three.

The Air Light Orthosis

Team FSU
F07- T06 - 1

This is the final, functioning version of the Air Light Orthosis

Problem Description

The problem that was presented involves the patient Mr. F, a 29-year-old single male currently residing with his parents. Mr. F was caught in a house fire, in which he received 20% 2nd and 3rd degree body surface area burns. As a result of the burns, he suffers from heterotrophic ossification, which gives him very limited motion in his elbow. Due to the severe burns, it has been very difficult for him to change angle mechanism, fasten Velcro straps, etc. Additionally, he wants to stop depending on his parents help and wants to gain back the independence he once had. Currently Mr. F wants to have the ability to move and lock his arm at a certain place without having to ask his parents for any assistance. As a result of Mr. F's condition, a splint will be designed that will help Mr. F easily move and hold his arm at a specific angle. The splint will provide comfort in a way that it does not irritate the skin. The splint will also help him move his arm easily and he will be able to put on the splint without anyone's assistance allowing him to increase his functional independence. Therefore the splint will have to be a device that Mr. F can wear for long periods of time.

Design
The orthosis will have three main components which include the forearm padding, the bicep padding and the adjustable strap. The padding for both forearm and bicep will be made of foam thus the design will be extremely light, less than a pound, and will allow user to operate the device without much weight on the arm. The padded pieces can be placed in any spot on the forearm and bicep as long as the pieces are properly secure, the device will function. The device will be fairly small as the padding will be about half an inch thick and the strap just lies over the padding. When the device is removed from the arm, it can be compacted by overlapping the padding. When the device is in use by the user, the padding will be the only part in contact with the skin.

Functionality
The orthosis provides independence for the user. Looking at the current devices the user struggles with, instead of using a twisting mechanism to adjust the angle this device adjusts angles by pulling the strap on the arm. The strap acts like a pulley where less force is required to cause movement. The user will need to use a sufficient amount of force to break away from the snapped Velcro. The padded pieces will wrap around the users arm and the inside of each piece is equipped with Velcro so the user will be able to adjust the pieces to the size of their arm. Both padding pieces are made of foam to provide a greater level of comfort for the user since the foam is soft enough not to irritate the severely burned skin and provides enough friction so the padding does not slide down the arm. The device is also easy enough to put on by oneself.

Materials, Components, and Assembly
For the final design, there are 4 kinds of materials and components required. They are:

- Light fabric material
- Velcro strap
- Normal buckle strap
- Tape (anything that would hold the components together)

The only tool needed to construct the final design is a pair of scissors, which is used for cutting the foam, duct tape and the strap. These materials can be obtained at any superstore. The design is very easy to construct. It will take about 30 minutes to 1 hour to construct. Further, it does not need any special introduction. The clinic only needs the written instructions and a simple drawing to assemble the orthosis designed by the team.

Cost
Since the device is made out of inexpensive materials, the cost to build the device is fairly low. The total amount of money that was spent on building the device was just over $10.

User Acceptance and Compliance
The Air Light Orthosis is a device which takes into consideration all of the problems associated with Mr. F's condition. All of his concerns are addressed with simple, yet effective solutions. The material from which the padding is made is soft, light foam padding which not only reduces strain on the user's arm, but also minimizes any skin irritations. Due to the fact that Mr. F has limited hand dexterity, the Air Light Orthosis contains a tab which requires minimal force to fasten, and more importantly requires no small movements with the fingers. Unfastening and fastening of the padding is made easier due to the tab. Comfort is an issue that not only has been considered for Mr. F's condition, but also for the conditions of a variety of other users. The portability and light weight of the design will appeal to all users. The great visual aesthetics of the orthosis ensure that Mr. F will want to wear this. It fits comfortably over any shirts or sweaters. Due to the fact that the orthosis is light in weight and contains only padding and a strap, the user is not at a safety risk.

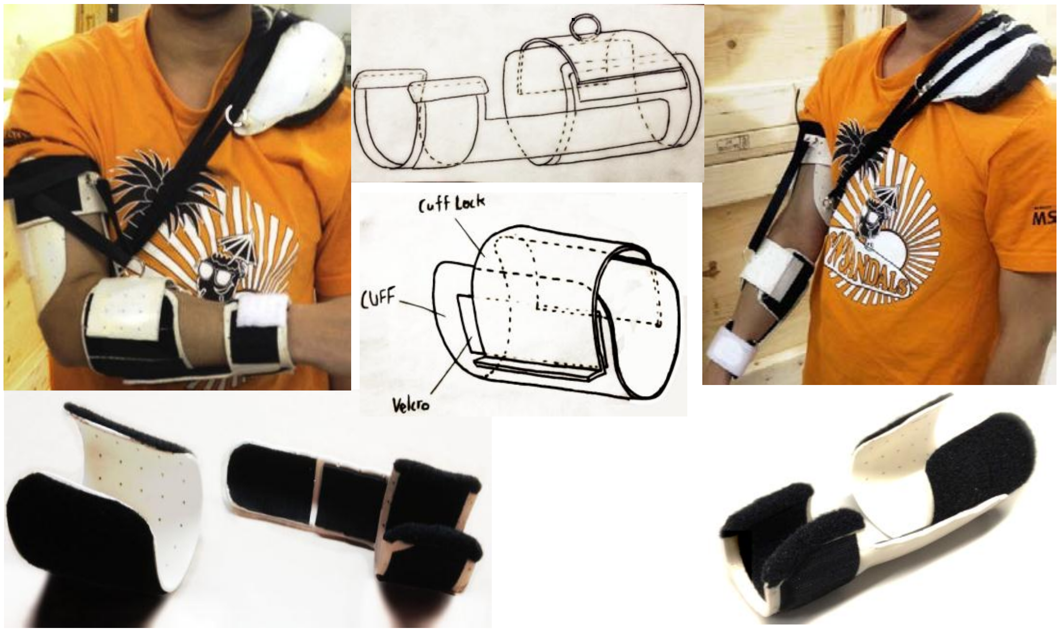
Benefits
The device can be folded easily so it does not need a lot of room giving another advantage toward its portability. On the other hand, since Mr. F has 2nd degree burns on his arm, the lightweight foam used will not irritate his skin.

The device responds to Mr. F's needs, as it gives him full independence thus requiring no further assistance.

Project Arm

AOD.co

Arm Orthotics Design Corporation
F07 - T06 - 2



Problem Description

The problem presented to the team involves a 23 year old, single male referred to as Mr.B. He has recently been in a motorcycle accident and suffers from a brachial plexus injury. Mr.B's right hand dangles at his side, however he still has full hand mobility. When Mr.B uses slings to hold his arm to his side, his arm becomes unusable. Tara Packham, an occupational therapist at Hamilton General Hospital, has asked the team to design a device that is adjustable and will hold Mr.B's arm in place. The device should allow him to perform everyday activities (i.e. writing and typing). The focus of the design is to create a cost effective, mobile device that is durable, and allows Mr.B's injuries to heal properly. The device will be used through the healing process in environments including but not limited to his home. Ideally, the device should have to potential to be used by other patients who suffer from similar arm injures as Mr. B.

Design

The final design that we decided upon implements the use of Velcro around the wrist, elbow, and shoulder to lock the forearm at different angles, thus increasing the range of motion of Mr.B's arm. As can be observed from the above picture, the strapping loops through keychain rings and can be fixed to various components of the device by means of Velcro. The straps can be easily adjusted with one hand, which is extremely convenient. The device is large enough to stabilize the arm, however, it can also be worn under clothing, thus it more fitting for public use and is more user friendly. The shoulder component reduces the load significantly, and even off the arm the individual components are very light. The rigid nature of the forearm allows for stability and allows the arm to be fixed into different positions with ease.

Functionality

The device utilizes the downward propulsion resulting from the force of gravity as a means of achieving pronation. This is done by loosening the strap to the point where the users arm can lie flat. This design is beneficial over a rigid structure because it is likely to cause less discomfort for the user. The device can also be adjusted into supination by tightening the straps. The wrist is able to lock in place and can be easily adjusted by separating the two Velcro pieces, rotating the wrist, and then reattaching the pieces. The design is ideal for the Mr. B, because it allows a simple way to adjusting the wrist positions and arm angles. The combination of the shoulder pad and bicep cuff serves to distribute the load of the entire device across to Mr. B's uninjured shoulder. The shoulder pad also has a wide surface area which further helps to distribute the load and minimizes discomfort. The client has requested that the device should allow for the user to have independence, and the design of this device allows for this. The device is easy to operate in the sense that it can easily be taken on and off as well as adjusted using one hand.

Materials, Components, and Assembly

The components are made up of thermoplastic, Velcro, strapping, keychain loops and foam padding. There are four main components: the shoulder pad, the bicep cuff, the forearm cuff, and the wrist piece. Thermoplastic can be easily obtained by ordering it online, while the rest of the materials can be found at Home Depot, Walmart, or any other local retailer. The tools required for construction of the device include: hot water, a sewing machine, and scissors. The device is very simple to make, the instructions are easy to follow, and if all the steps are carried out as instructed, the device should only take a total of 2-3 hours to build. Instructions include heating, cutting, and moulding the thermoplastic to the arm, as well as fitting the strapping and Velcro to the required components. Special instructions include paying close attention for potential spots of skin pinching from the thermoplastic mould. This can be prevented by rolling the edges of the cuffs upwards where needed.

Cost

It will cost the clinic a mere $50 of useable materials to make! A third of the thermoplastic sheet was needed which comes to about $30. The Velcro and straps cost approximately $13, and the foam padding, clips and hoops costs only $7. Since it takes about 2-3 hours to assemble, it will cost the user about an additional $30, which leaves the final product to cost $80.

User Acceptance and Compliance

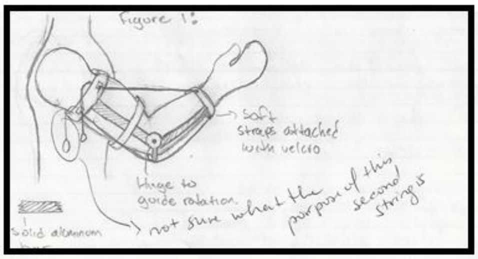
User compliance has been considered by changing the position of the shoulder pad from the right shoulder to the left shoulder. This will effectively reduce the load of the device on Mr.B's injuries and allow for optimal recovery. The straps were changed from having buckles to strictly using Velcro. This will allow Mr.B to easily adjust the device as well as put it on and take it off it all with one hand. The device can be removed by first taking off the shoulder straps and the straps holding the forearm and the bicep cuff in place, and then removing the individual components. The device has been designed to be able to be moulded to the user's arm. The customizable thermoplastic components work in unison with the foam padding to maximize comfort. The entire device can be adjusted to be at the side or at an elevated angle, and by simply adjusting the wrist component Mr.B will be able to perform activities such as writing and typing. The design implements neutral colours for the extent of being cosmetically pleasing. Overall, the device is light-weight, comfortable, safe, user friendly, looks nice, is functional, and is rather in-expensive.

Benefits

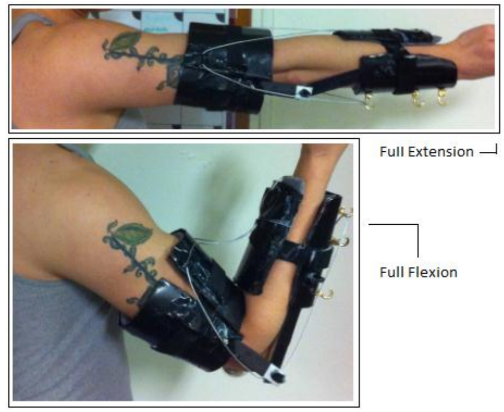
This design is much better than any commercial device because it has components that are able to perform complex functions with very simplistic methods, materials that are very easily accessible, can be easily assembled, and is easy to put on and take off. Lastly, this device is custom made meaning it will fit the user much better than commercial designs, and will be over all more comfortable, more effective, and more user friendly.

Actum Recovery System

VisCuratis Medical Systems
F 0 7 - T 0 6 - 3



Design Alternative – Model "Beta"



User application of the product in flexion and extension.

Problem Description

A representative approached the firm for the interest of a 29-year-old client that suffered 2nd/3rd degree burns to 20% of his body. The burns primarily affected his arm and hands, resulting in prolonged hospitalization that rendered the muscular use of his arms (primarily the left) ineffective and drastically reduced his finger dexterity. The client is seeking an elbow orthosis to aid in flexion and extension of the arm. The device should be lightweight and should not irritate the skin. It should also require a minimum amount of finger dexterity and should support independent user adjustment. Finally, the device should not be so cumbersome as to fetter the user's daily activities.

Design

The Actum Orthosis is a conveniently dimensioned 1.7kg system that sits no more than 1" off of the arm in any location, as is visible in the above images. The user will be able wear regular clothing with only minor adjustments. This design promotes functionality without the sacrifice of spatial constraint. In terms of aesthetics, ultra-sleek gloss black components retain a modern elegance, allowing for a mechanical yet sophisticated appearance. The slim figure of the model enables optimal spatial management, and doesn't interfere with the user's daily activities.

Functionality

The designed system approaches the flexion and extension of the arm in an innovative and effective manner. The method of user-adjusted tension over the outer and inner arm applies fixed extension and flexion respectively. This can be seen clearly in the images above which illustrate both flexion and extension of the arm. The user pulls on a looped string and fixes the string on hooks set at varying distance over the forearm. Gravity acting on the arm holds the arm at the selected angle of flexion or extension.

Materials, Components, and Assembly

The product was designed and constructed with publically accessible products that could be purchased at any given hardware store, with the exception of the thermoplastic outer shell. Assembly could be reduced to less than 6 hours with instructions and knowledge of the product. Thermoplastic should be moulded using a model of the human arm, pressed in three layers of thin plastic, or one layer of thicker plastic. It should then be glued together with contact rubber. This process applies to any of the four contact areas. The only tools required are a power drill and scissors. A power drill will be necessary to drill holes where the hinge can be applied.

Cost

The cost of the system was minimized since the firm had access to free materials such as thermoplastic. We made considerable use of recycled materials such as Velcro, surface contact material, and backpack straps. In total, our cost of production including waste was $61.24. Using only store-bought materials, this cost could be approximated to $104.25. However, with knowledge of the product and instructions for construction, waste materials could be minimized and more reasonable alternatives such as thicker thermoplastic could be sought after. This would generate a considerably lower production cost, which could be minimized to $60-75 if approached properly.

User Acceptance and Compliance

The Actum system offers the best in personal comfort and ease of use. Cotton-foam padding allows minimal skin irritation and is easy to clean. The user’s ability to select the level of compression in the sleeves allows them to manage their own comfort. In addition, the close-to-profile format of the device allows the user to go about their daily routine without the device causing problems due to its size. Features like this, coupled with the aesthetic appeal and ease-of-use of the product promote a very favorable user compliance rate. The firm approached user interest with the goal of complete user compliance in mind.

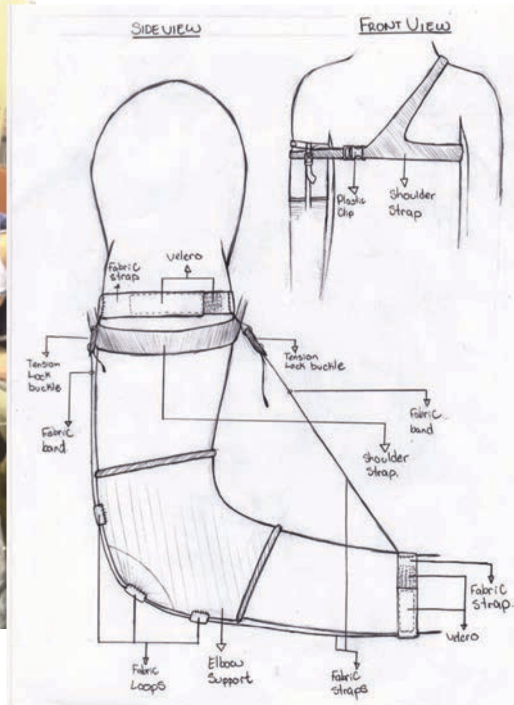
Benefits

The Actum Orthosis offers many features exclusive to its design. Namely, the easy-to-adjust locking straps allow users with limited muscular ability or dexterity to remain independent to the highest degree possible. Ultra comfortable, removable padding reduces skin irritation and is machine washable. Because of this, bacteria buildup and consequent risk of infection is eliminated.

In addition, the design is aesthetically appealing, modern and sophisticated looking while maintaining a low profile and absolute spatial efficiency. Within the elbow orthotics market, these features are not commonly offered in combination, and many features are exclusive to this design.

Into the Buckle Dynamic Elbow Orthosis

Outside the Box Engineering
F 0 7 - T 0 7 - 1



Problem Description

This proposal outlines the design of a dynamic elbow orthosis for the client Tara Packham, an occupational therapist working at the hand clinic at Hamilton general hospital. The orthosis will be used by, and is based on, the particular needs of Mr. B. The user just suffered a dislocation of his right shoulder and wrist fractures. In addition, his muscles and nerves were severely damaged in his right arm. Hence, his right arm can no longer reach a full range of motion. The main goal of the project is to design an elbow orthosis that will help the user to recover from his injuries by providing a way to work on his range of motion, to lock his elbow at a certain positions and to adjust the angle without help. The final product should also minimize the extra load of the orthosis on his shoulder and other potential points of stress. This product also needs to be affordable for the clinic to make and the user to buy or rent. It must be made from cheap and common clinic materials that will be safe for him and others around him and not be considered weaponizable. (e.g. any sharp or heavy piece should be avoided).

Design

The design consists of various fabric pieces and straps, which run from the upper bicep to wrist. A support strap, seen in top right of centre picture, runs from one shoulder across the ribs and up over the opposite shoulder, this provides support to the injured shoulder and helps keeps the bicep strap from sliding down the arm. The wristband, yellow in the prototype photos, is attached to the front and back straps and is used to pull the arm into extension and flexion. The picture on the left shows the device prototype with the arm fully extended and the picture on the right displays the device prototype being used to pull the arm into flexion. As the design is completely made from light fabric, and light plastic tension lock buckles, it is only minimally heavier than an average shirtsleeve. The materials used are highly flexible therefore the design can be conveniently folded into an average sized digital camera case.

Functionality

The Into the Buckle Dynamic Elbow Orthosis fastens comfortably to the user's arm and incorporates a shoulder strap to the opposite shoulder to reduce the already small load the of apparatus on the injured shoulder. As requested, the orthosis can lock the user's arm in virtually any anatomically correct position allowing the user to use their hand to perform range of motion therapy while wearing the orthosis. The cuff of the orthosis is also loose enough to allow the user to pronate, supinate and flex their wrist. Furthermore, the orthosis' weaponizability and general bulk have been reduced as much as possible to allow the orthosis to be worn in public. Overall the design covers all the functions asked for by the client and does so in an inexpensive way that is easy for the clinic to construct.

Materials, Components, and Assembly

The materials required are, an elbow support, fabric straps, Velcro and 2 tension lock buckles. These can easily be obtained from local dollar stores and fabric shops for a very reasonable price. All that is required to construct the design is a needle and thread; a sewing machine is recommended, as it would cut down on the construction time. When sewing by hand it would take approximately an hour but with a sewing machine the time could be estimated to be approximately 20 minutes. The assembler of the design would have to follow a simple set of instructions, but no special skills are required. As to instructions they would need to be told or shown where each strap, the Velcro and the tension lock buckles need to be sewn using either a diagram or step by step instructions.

Cost

- 2x tension lock buckle ($2.00 ea.)
- 0.2m Velcro strips ($3.50/m)
- 0.5m soft straps/yellow straps ($3.00/m)
- 1.0m strap/red and black straps ($1.50/m)
- 1x elbow support ($1.50 ea.)
- 1x pink strap ($1.25 ea.)
- Total cost: $10.45 before taxes

The total cost will vary depending on what is available to the clinic and where they choose to purchase the materials. The cost to the user will likely be just the cost of materials.

User Acceptance and Compliance

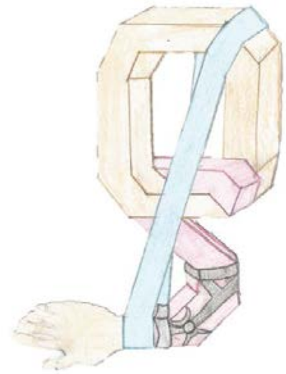
In order to ensure that the objective of user compliance was met, the design was designed to be as comfortable as possible, minimizing the weight and using fabric which is soft and breathable. Also this design can be made using any combination of colours for which the clinic can find fabric. To put on the device the user has to slide the elbow support over his/her elbow and Velcro the bicep and wrist strap onto his/her arm. Then they have to pull the support strap over their opposite shoulder and under the front and back adjustment straps then clip the strap together. For cosmetic considerations the design can be worn over clothing if need be and straps can be tucked into the fabric or elastic bands which are on the front and back straps. For these reasons the design is one that user's will want to wear. As for the objective of a safe design, the design is made to minimize weight in order to prevent strain on the user's body, and the number of sharp edges and removable parts was also minimized or eliminated.

Benefits

- Lightweight
- Highly portable
- Allows a large range of motion
- Allows user to lock the elbow at any angle within normal range of motion
- Not considered a weapon (as dangerous as a backpack)
- Relatively comfortable
- Inexpensive
- Simple to make
- Machine washable

Mr. F

Dynamic Elbow Orthosis



Orthotic Solutions
F 07 - T 07 - 2

Problem Description

A device must be designed that would enable Mr. F., who suffers from lack of muscle control throughout the arm, to live his day-to-day life comfortably. The device would enable him to improve his mobility, allowing him to move and adjust his arm, and locked to a desired angle. This device must not be too oppressive or heavy. The device should also be simple and comfortable, and not be complex. This is to ensure Mr. F and the Hand Clinic at the Hamilton General Hospital can use the device and its functions without complications. Due to Mr. F's skin condition, this device must limit the external pain endured, while minimizing the amount of day-to-day infection. Therefore, skin contact with the device is minimized. The device should be extremely durable so that replacements or repairs would not be necessary. This device should maximize the suitability for the Hamilton General Hospital's Hand Clinic and Mr. F. respectively

Design

The design shows a small chain connecting the wrist guard to the bicep pad as it is hooked on the chain. The chain can be adjusted by moving up or down the different links giving different angles. The design is very light in terms of mass since it doesn't have heavy components. The wrist guard, bicep pad, and chain are very light, and will not cause further straining of the injured muscles of the arm and elbow. It will not be big or bulky, but rather small and compact.

Functionality

The device is able to perform all of the client's requested functions. It is able to lock the elbow at a wide range of angles. Each chain link represents a different angle of which the arm can be refracted and stretched, being able to refract and stretch the arm at any desired angle by hooking the desired chain bit unto the hook attached to the arm band, while still supporting the entire arm.

Materials, Components, and Assembly

This orthosis requires several components: a wrist guard, a metal chain, a bicep pad, two plastic pins and two gluing pads for the hooks. These components can be obtained at any hardware store such as Rona or the Home Depot, and pharmacies. Its manufacture is very simple as it requires no tools to construct. The chain is connected to the wrist guard, and one hook is glued to the belt buckle and the other to the bicep pad using the gluing pads. The glue should be left for a while to properly glue. The chain can then be connected to either hook depending on the desired angle. Overall, the orthosis is ready for use in less than one hour. Special instructions include waiting for the pins to properly glue to the belt buckle and to the bicep pad, because if they do not glue properly the entire orthosis is virtually useless.

Cost

The cost to purchase the materials and build the entire orthosis is $40. This consists of a bicep pad, metal chain, hooks and a wrist guard, with the bulk of the cost being devoted to the wrist guard. The hooks, bicep pad and metal chain can all be found at a local Canadian Tire while the wrist guard can be found at a local pharmacy in the brace section.

User Acceptance and Compliance

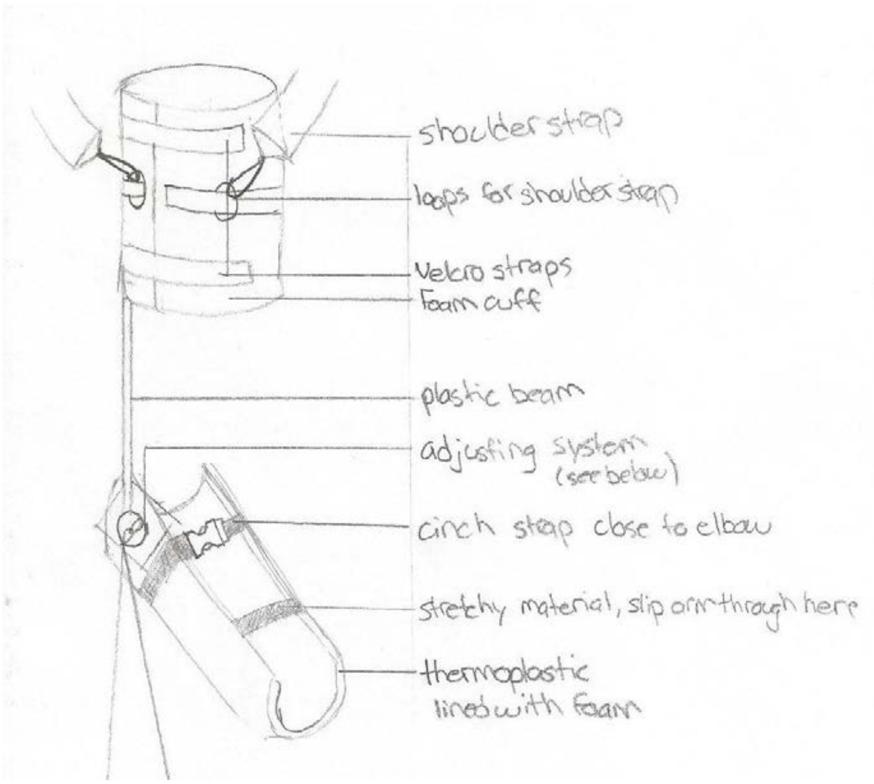
The orthosis was designed on the bases for high user compliance. The orthosis accomplishes this on many fronts. Firstly the orthosis is extremely lightweight; the user can go about his/her day with out the feeling of any extra weight. Secondly the orthosis can be worm overtop of any clothing so it does not restrict or change the user's wardrobe. Thirdly the orthosis is easy to adjust to the user does not feel the need to ask for assistance in the adjustment of the orthosis or the application/ removal or it. Lastly the orthosis does not draw unwanted attention to the user, it is small, does not cover much skin and does not have the typical "awkward" shape many traditional orthosis on the market have. The small size allows it to be worn under heavier jackets and coats during the colder seasons.

Benefits

Our design is better than existing solutions because it reduces contact with the skin of a burnt patient in order to minimize irritation so that healing of both burns and broken elbow are sped up and it is a more comfortable orthosis. It is very small, light and compact, whereas other products are quite big and heavier which can cause further straining of shoulder and elbow muscles. It is also more aesthetic in terms of visibility in public, barely exposing the disability, and allowing Mr. F to feel comfortable in public.

GEOFFE: Great Elbow Orthosis For Flexion and Extension

ARME Engineering
F 0 7 - T 0 7 - 3



Problem Description

To design a progressive dynamic elbow orthosis for Tara Packham, an Occupational Therapist at the Hamilton General Hospital's Hand Clinic. The orthosis will be used by Mr. B, a patient of Tara's who was in a motorcycle accident and as a result has no muscle support in his right shoulder and little to no movement in his right elbow. He also had wrist injuries which have since healed. The device should reduce the load on the users shoulder so as to not further the injury of the shoulder. The device should allow motion of the users hand and wrist, as well as forearm rotation for daily activities. The device should be able to lock the elbow in place at various positions to assist in the recovery of the injuries. The device should be able to be used independently, cause minimal pain and be low in cost to purchase or rent. For the client Tara Packman, the device should be low in cost to manufacture, should be able to be manufactured in the clinic with the resources they have or can easily get, as well as help with the rehabilitation of the patient.

Design

Geoffe is an elbow orthosis with the forearm component made out of thermal plastic with foam for the arm to be cradled in. The arm can slip into the thermal plastic and be tightened by a cinch strap. A cuff made out of foam wraps around the center of the upper arm at the bicep and is adjusted using Velcro straps. The two components are connected by a plastic beam that protrudes from the cuff and travels down the upper arm, meeting the forearm at the elbow. The two components are connected by a wing nut, nut and bolt. The nut is attached to the plastic beam, the bolt is attached to the thermal plastic and the wing nut is free to move.

Loosening the wing nut allows the orthosis to rotate, thus changing the elbow position. The third and final component is a shoulder strap that connects to the cuff at the upper arm via two key rings on the Velcro strap, and goes around the neck providing extra support. The orthosis is the whole length of the forearm and two thirds of the upper arm.

What does it do?

The design allows for flexion and extension of the arm, and locks it in various positions. It allows for forearm rotation. The device can be used as a form of therapy assisting in the user's recovery. The device also reduces the load on the shoulder by being light weight and having an additional strap for extra support.

Materials, Components, and Assembly

Geoffe requires thermoplastic, a foam mat, a wing nut, a nut, a carriage bolt, lock washers, a plastic beam, Velcro, cinch strap, stretchy strap, key rings and a shoulder strap. The components are: the forearm component consisting of the thermal plastic, foam mat, stretchy straps and chinch strap, the upper arm component consisting of the foam mat, plastic beam, Velcro, key rings, and a shoulder strap. The materials can be obtained at any Canadian Tire or hardware store, with the exception of the thermoplastic, which needs to be ordered. The tools required to construct Geoffe were hot glue gun, scissors, and a sewing kit. It would take someone approximately 2 hours to construct the orthosis. Instructions required for the assembly of Geoffe are:

First, mould the thermoplastic to the users arm, keeping room for a thin layer of foam. Next, drill a hole at the outside elbow of the thermoplastic and hot glue a bolt at the hole.

Attach the cinch strap an inch away from the elbow, and then sew on a stretchy strap onto the thermoplastic three inches from the wrist.

Secure the nut to the plastic rod with hot glue.

For the cuff, cut two pieces of foam, size against the arm. Finally, attach the plastic rod to both sides of the cuff with glue.

Cost

What will it cost the clinic and user?
All the materials needed to be purchased
Capital investment: $133
All the materials that were used for the device
Cost per device: $62

User Acceptance and Compliance

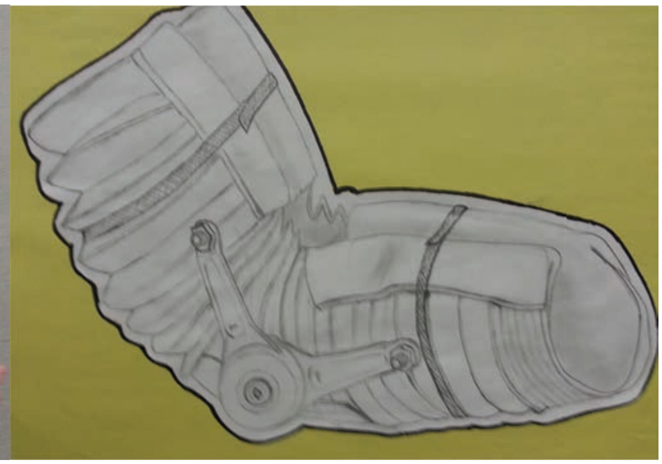
Geoffe was designed with user compliance in mind. If the user does not want to wear the device how will they recover? Geoffe was designed to be comfortable with padding along the arm for comfort, light weight as to not add a load to the users arm, and a strap for extra support. Geoffe is designed to be put on and taken off individually with the use of one hand. The lower part of the device is slipped on as well as the angle is chosen, and the upper part of the design is strapped in with Velcro using one hand. The design can also be made with different colours as to appeal to different users. The device is easy to use by loosening the wing nut with one hand, adjusting the elbow position and then tightening the nut to secure it in place. The safety of Geoffe was considered when the straps were cut short so they could not be used to injure anyone; the straps also are easily adjustable and cannot tighten enough to cut off circulation to the arm. The design's cosmetic appeal was taken into consideration with Geoffe's design because it is not extremely bulky and the colours of the orthosis can be changed.

Benefits

Geoffe provides many benefits for a user. Geoffe can be used for any daily activity as well as for assisted range-of-motion therapy. The design is very comfortable, lightweight, and comes with a strap to reduce the load on the shoulder. Geoffe was designed to allow the user to rotate their forearm, and also to lock the elbow in positions that can vary in degrees. Finally, Geoffe is exceptionally easy to put and adjust independently, even for someone using their non-dominant hand.

Elbow Orthosis

VSTOD Engineering
F 07- T 07 – 4



Problem Description

The problem presented to us by Tara Packham, who works at the Hamilton General Hospital as an occupational therapist, involves Mr. B, a 23 year old male who was involved in a motor bike accident that resulted in a compound fracture/dislocation and degloving the right wrist. He also suffered from tendon/nerve lacerations, injuries to the nerve fibers in right shoulder. He has found it really difficult to move his shoulder and he cannot move his elbow at all. The team has been asked to design a device that can vary the forearm motion with the minimum weight on his shoulder. It should be able to stabilize his elbow as easily as possible. The device should not hamper his ability to do everyday tasks, and he should also be able to do them without too much assistance. She has requested that this device should be able to be worn in a prison, whereby it's considered to be safe. Furthermore, the device should be portable, and ease of use of the design and to be easily accessible by users.

Design

- Plastic Drainage Pipe, quarter of the top portion is cut.
- Two Velcro Straps; one around the bicep and another around the forearm
- Flap Stay Duo located on the side of the drainage pipe
- Camping Mat Padding on the inner layer of the drainage pipe
- Begins at the bicep and ends after the elbow.

Functionality

- Stabilizes elbow and allows large ROM based on the flap stay duo
- Shoulder strap allows for pressure to be directed away from the elbow
- Hole at elbow relieves pressure from elbow joint
- The design achieves most of the objectives requested by the client

Materials, Components, and Assembly

Materials (Home Depot):

- Plastic Drainage
- Flap Stay Duo
- Velcro Straps
- Camping Mat Padding
- Bolts and Nuts

Tools used to assemble:

- Scissors
- X-acto Knife
- Tape
- Glue gun

Assemble:

- Cut drainage pipe in half
- Slice a quarter from the top of the drainage pipe
- Pierce two holes for bolts on the side of drainage pipe
- Fasten flap stay duo
- Glue camping mat padding
- Attach Velcro straps

Duration to Assemble:

- 1 Hour to 2 Hours

Cost

- Velcro Straps → $8.96
- Flap Stay Duo → $ 21.99
- Drainage Pipe → $11.76
- Camping Mat Padding → $10.00
- Bolts and Nuts → $0.50
- Shoulder Strap → $5.00

User Acceptance and Compliance

- Comfortable with camping mat padding
- Achieves most of the objectives and functions
- Adjustable and removable with one hand by Velcro straps
- Affected arm can be slid in, shoulder strap can be attached with one hand
- No sharp edges, which increases comfort and safety
- Design weighs 0.5 kg, which is really light weight
- Regarding cosmetic considerations, different colours of plastic can be used to appeal to different types of users

Benefits

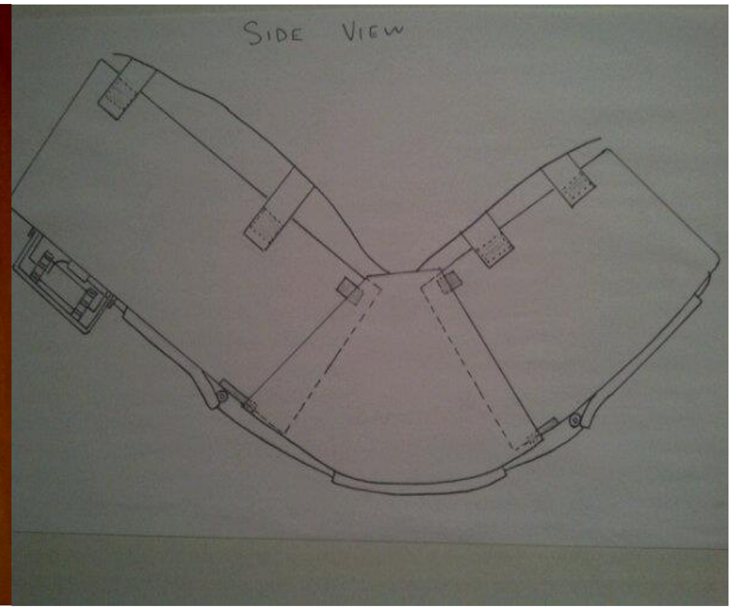
- Light weight
- Inexpensive to construct
- Easy to remove and adjust
- Comfortable
- Can be mass produced
- Great ROM
- Easy to use while also performing daily functions

Extension Roller Orthosis

Student Engineering Corporation-
Design, Education and
Communications Sector
F 08 – T03 -1

Final Prototype

Final Sketch



Problem Description

Design a device for the Hamilton Hand Clinic to help restore the range of motion of the elbow that is accessible to the user, convenient to wear, can be used/adjusted independently and minimalizes pain, without causing further damage to Mr. F's already damaged skin. The device must be manufactured by the Hamilton Hand Clinic in an inexpensive, cost effective manner.

Design

The device is custom fit to the user so the weight will be light in ratio to the user. The device is made of a spool/spring/string system which pulls the arm straight, padding to provide comfort for the arm, an elbow cup to keep the weight off of the elbow and allow the elbow to move, Velcro straps to make it easy for the user to take the device on and off, and loops to keep the string in line along the orthosis.

Functionality

The function of the elbow of orthosis is to provide enough force to extend the arm. As the spool spins the string wraps around the spool to pull the arm straight. The spring keeps the spool from spinning back the other way. The device is easy to put on and take off. The client requested a device that would provide enough tension to move the users elbow, but still provide comfort and allow the user to put the device on himself.

Materials, Components, Assembly, and Cost

The materials and tools needed are:

Thermoplastic - $60.00
Foam padding- $7.00
Spool with thread- $4.50
Velcro- $7.00
Elastic Straps- $8.00
Wire with green tubing- $2.00
Hot glue gun- $10.00
Glue sticks (20pc)- $5.00
Duct tape- $5.00

Only half of the sheet of thermoplastic is needed for the construction of one orthosis.

Assembling the orthosis should take approximately one to two hours. The thermoplastic can be purchased from Remington Medical. The rest of the materials and tools can be easily purchased from any local crafts store such as Michaels, Curry's Art Store Ltd, and more. The cost to the clinic and user is the sum of the costs of the materials and tools listed above plus labour. The assembly instructions:

1. Cut thermoplastic into three pieces, one for the upper arm, one for the forearm and one for the elbow cup.
2. Heat the thermoplastic in water at 170˚F in the electric griddle.
3. Cut foam padding into two pieces the same size as the upper arm and forearm thermoplastic sections.
4. Mold the upper arm and forearm sections around the foam padding (The foam padding will adhere to the hot thermoplastic so no extra adhesive is required.)
5. Mold the elbow cup according to the size of the upper arm and forearm sections.
6. Smooth out all edges of the thermoplastic.
7. Cut the elastic straps into four pieces, two for the upper arm and two for the forearm, according to the circumference of the arm.
8. Cut slits into the outside of the forearm and upper arm thermoplastic sections for the elastic straps to fit through.
9. Hot glue the one end of the strap to the outside of the thermoplastic, opposite the slit and feed the other end through the slit from the inside of the thermoplastic to the outside. Repeat for all for straps.
10. Cut the Velcro into 4 pieces.
11. Hot glue the rough side of the Velcro to the elastic strap on the thermoplastic. Hot glue the soft side of the Velcro to the loose end of the elastic strap. Repeat for all of the straps.
12. Cut the elastic straps into four more 3" long pieces and two 4" pieces.
13. Attach pieces to the upper arm to the elbow cup and the forearm to the elbow cup with hot glue and duct tape.
14. Strip the wire of the green tubing by cutting the green tubing at each end and sliding the wire out. Cut the green tubing into three 3" pieces and glue one piece to the outside of each thermoplastic section along the centre line.
15. Cut notches into the edges of the spool at 90 degree intervals.
16. Cut a section of wire and insert it through the spool. Bend the wire into a "[" shape. Push the wire into the upper arm of thermoplastic along the centre at the edge closest to the shoulder
17. Bend another piece of wire to fit into the notches on the spool. Remove the springs from the clothes pins and bend them back to approximately 80 degrees. Attach the springs to the end of the wire with hot glue and duct tape. Hot glue the bottom of the springs down.
18. Run the string from the spool through the green tubing to the front of the forearm section. Attach the thread to the outside of the thermoplastic at the front of the forearm with hot glue

User Acceptance and Compliance

The design takes into consideration many of the user necessities. One being the addition of foam paddle, this addition will make it more comfortable for the user when having the device on. Through the addition of Velcro straps we made the orthosis adjustable, meaning the user can tighten or loosen it to their preference. This also makes the othosis require no help to putting on or take it off, since the user just slides the device to don it or doff it. Realizing that functionality is as important as aesthetics, we can provide the device in a variety of colour to appeal to the user 'style'.

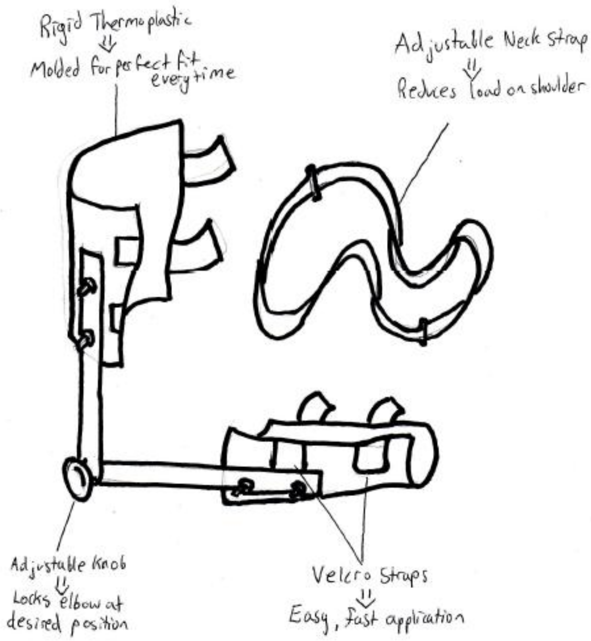
Benefits

For the advantage of marketing, this elbow orthoses is more personalized and less expensive than commercial products. For the medical benefits of patients, it can provide the force of extension efficiently, and it has softer and more breathable material for sensitive skin, also the extended area of braces can distribute the pressure on damaged skin. This design also considered the convenience of patients: the low weight makes the elbow orthoses portable; the orthoses is easy to put on independently and the special roller is easy to operate with limited hand mobility.

Mr. B

Locking Elbow Orthosis

Orthosis Association of Engineers
F 0 8 – T 0 3 – 2



Picture 1: Sketch, functions

Picture 2: Photograph, applied orthosis

Problem Description

To develop a device that will promote rehabilitation of the arm and elbow with ease of use by the user. The device should control and restrict arm movement, minimize pain while in use and while adjusting, and promote independency in the user's daily life. To meet the specific needs of Mr. B the device should actively assist with range of motion in the elbow and forearm, while having a minimal weight. The device will be implemented by Tara Packham, a representative from the Hamilton Hand Clinic for use by Mr. B and clients with similar injuries. The Hamilton Hand Clinic requires the device to be made from relatively simple and cost-effective materials.

Design

The design is composed of four components with minimal complexity. The forearm and upper arm portions are relatively identical, each composed of a piece of thermoplastic and two strips of Velcro. Imbedded into the thermoplastic are two plastic screws that are used to attach the hinge. The hinge is composed of two thermoplastic rectangles with two holes on each end piece for it to screw into the arm components. A large wooden knob is used in the middle of the hinge as the factor of adjustment and secures the position by means of friction. The last component is the adjustable shoulder strap which can be applied in many different ways to meet the user's needs. The orthosis weighs approximately 3 pounds without the shoulder strap reducing any weight. It is a slim fitting design so it can be worn with relatively tight clothing underneath or loose clothing above it. All components are seen applied in Picture 2.

Functionality

The orthosis designed allows for a range of motion in the elbow, supports the injured shoulder, and protects the arm from further injury. It was requested that the orthosis allowed range of motion exercises in the elbow in order to stimulate rehabilitation of the injured area. The hinge installed permits the user to adjust the angle easily and secure the brace at many different positions for required therapy exercises and for their daily routine. Lightweight material was used along with an attachable shoulder strap to allow the user's injured elbow to heal. The orthosis was made to protect the arm from further injury and to promote healing. All corners were rounded to prevent irritation, no sharp edges or materials that may puncture the skin were used, and the material selected was durable making it an overall very reliable device. All requests made by the client were factored in and met.

Materials, Components, and Assembly

This orthosis can be composed using thermoplastic, Velcro and plastic screws, which will be used to make up the forearm, upper arm, and hinge components. For the strap component all that is needed is an adjustable Velcro strap that can be purchased at a local hardware store along with the rest of the materials. The thermoplastic must be purchased from a thermoplastic distributer. To successfully construct the design the Hand Clinic will need a pair of scissors, a pan to boil hot water in and an utility knife. It will take under 30 minutes to assemble, less time for those with familiarity with dealing and moulding thermoplastic. To create the orthosis one would have to measure and mould 2 pieces of thermoplastic to the users arm, one for the upper component and one for the lower component. The edges can be rounded and the Velcro straps can be added; 2 to each arm component. From here the hinge can be made from the thermoplastic, following the stencil guide provided. Heat up the arm components once again to fit the screws in; cut holes where indicated and flush the screw through enough that will not irritate the arm. Now the final product can be assembled, attach the hinge to the screws and add the bolts.

Cost

The cost of materials comes to $50, majority of which derived from the thermoplastic. All tools required to assemble the orthosis are common at-home items, but would range up to $15 if unavailable. The cost to the user would be in the range of $30 - $50, depending how much thermoplastic is needed for their arm size.

User Acceptance and Compliance

With a slim design, light components, and a comfortable material, the design appeals to users in a way that encourages them to wear it. It is put on and taken off in three easy steps: simply slide the arm into the mold, secure the Velcro straps, and then tighten the knob to the desired elbow position. Application takes less than 30 seconds to put on, take off, and adjust. The user turns the knob one way to loosen the hinge and the opposite way to tighten the hinge. Due to the large radius of the knob, minimal force is required to do this, indicating that it is ideal for anyone with a bilateral injury. There are no sharp edges or dangerous materials used, making it entirely safe and acceptable in public. By using thermoplastic as the prime material the device is remarkably light and has a smooth fit. It will not irritate the skin, snag on clothing, or pull on the arm in any unpleasant manner, resulting in a comfortable fit for the user. With a low-profile look, the device can be covered easily or made personal by cutting designs into the plastic.

Benefits

This design was engineered to exceed all others in user compliance, efficiency and usability. It effectively aids elbow and shoulder rehabilitation through a simple efficient design. By combining lightweight components, soft materials and a shoulder strap, the device reduces the weight on the injured shoulder and maintains comfort to the user. The orthosis has a range of adjustable positions in the elbow which are very easy to change, allowing the user to independently participate in range of motion exercises and adjust the angle for their daily routine. It is inexpensive in comparison to other products as well as very easy to fabricate, with a construction time under 30 minutes. The orthosis is created with durable materials that add reliability to the product, withstanding accidental drops, pressures and human actions.

Hand Clinic Elbow Orthosis

Bio-Gen Mechanics
F 0 8 - T 0 3 - 3

Figure 2: This image shows the belt glued on the thermoplastic (represented by sleeves, coat hangers, and paint sticks), as well as the resistance band that is stapled to the braces. The white Velcro straps are shown underneath the upper and lower arms.

Figure 1: This image shows the sling that supports the shoulder. The hook at the end of it is attached to the underside of the thermoplastic brace.

Problem Description

The design incorporates a way to support Mr. B's subluxed shoulder, as well as to lock his arm in stable positions, which is difficult for him to do due to nerve damage. Enough load has been attempted to be taken off the patient's shoulder so that the patient feels little to no discomfort. He is able to pronate and supinate his wrist, and therefore the design tries to provide the patient with some way of performing this motion without restriction. Furthermore, comfort, ease of use, and cost were taken into account when specifically developing the brace components and the locking mechanism.

Design

Our design consists of two thermoplastic braces with a belt attached to both. The thermoplastic is formed to the top half of the arm (represented by coat hangers, sleeves and wooden paint sticks), and Velcro straps from the bottom. This design also includes an elastic resistance band that is connected between the braces. A sling is located across the upper body, and is connected to the underside of the lower brace.

Functionality

The purpose of the resistance band is simply to prevent the arm from dropping; the band itself is elastic but the spring constant is not strong enough to raise the arm thus it only reduces the speed the arm moves. The belt locks the lower arm in various positions, performing similar to a ratchet. The thermoplastic material is lightweight and comfortable, reducing some load on the shoulder. Furthermore, the sling also performs this function, but to a greater extent. Adjustability is supported with the use of a tension clip (backpack buckle) located on the sling.

Materials, Components, and Assembly

This design requires Velcro straps, a belt, and a sling that can be purchased at most dollar stores. The sling comes from a ratchet cargo belt (also found at the dollar store) and must have a tension lock attached to it. Thermoplastic can be found at the Clinic already, and a hot glue gun can assemble all the parts. No special instructions needed to assemble everything, and it takes less than half an hour.

Cost

Materials from dollar store would cost a maximum 8 dollars, along with the thermoplastic a maximum 30 dollars could be spent.

User Acceptance and Compliance

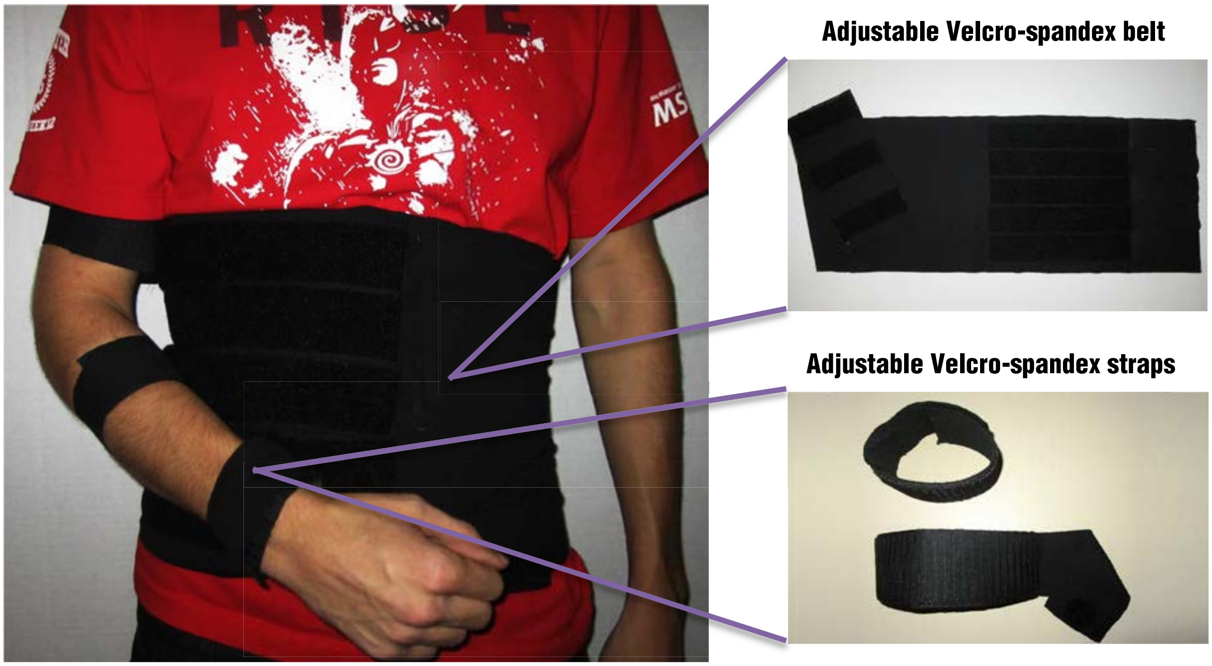
Originally, the design consisted of a ratchet, but being too heavy, the ratchet was replaced with a belt for better user compliance as it is much lighter and more feasible. The material used is soft and comfortable for the skin while evenly distributing pressure around the arm. Supination and pronation is not restricted so the client does not have to remove the brace in order to perform certain tasks. In addition, the prototype was originally constructed without the use of the resistance bands but they were later added to prevent any jerk that would occur from lowering the arm. Mr. B would wear this over clothing, and would want to wear it because it is lightweight, cheap and has no protruding parts that cause harm.

Benefits

This design has advantages over other existing designs, as it is cheap to manufacture and purchase, easy to assemble, and lightweight overall. It can be taken on and off relatively easy using the Velcro straps. The sling can also be taken on and off using one hand.

Dynamic Elbow Orthosis

AfterShock
F 0 8 - T 0 3 - 4



Problem Description

The assigned task is to design a dynamic elbow orthosis that satisfies both the Client's objectives and the needs of the user. The Client wants an in-house solution that can be made at the Hand Clinic, is easy to implement, is inexpensive, and meets the needs of the user. Design an elbow splint that satisfies the Client's objectives, is easily adjustable, comfortable, easily portable, safe, and has appropriate support to lighten the load on the shoulder.

Design

The DEO (Dynamic Elbow Orthosis) holds the arm in a wide variety of positions and angles by way of a large Velcro belt and Velcro armbands; great for a user that needs various flexion and extension angles. It is composed of two basic parts, stretchy-adjustable Velcro arm straps and belt. The DEO weighs in at less than a pound (0.52 lb.), which is virtually weightless. This makes the product great for the user because it conforms to the arm with ease; it is able to adjust to various sizes. The size of the DEO is fairly small, it covers the stomach from front to back and only covers three parts of your arm (due to the three straps).

Functionality

The DEO is a simple orthosis that allows the user to go back to doing their everyday task. Functionally, the DEO helps with support of the arm – to reduce load on the shoulder and disperse it over the torso. It also helps with flexion and extension of the arm in a wide variety of angles. Additionally, with the aid of the other arm supination and pronation of the arm are also possible.

Materials, Components, and Assembly

Unlike other orthoses, the DEO is a very easy dynamic splint to construct. All it requires is spandex, Velcro, and some thread plus other adhesive materials (hot glue). These general items can be obtained from any local fabric shop/craft store (Michaels or Fabricland). With some scissors, a sewing machine, and possible glue gun, this orthosis can be easily constructed for use.

Cost

The cost materials is approximately $11.00. The MSRP is set for $14.99, which can be adjusted as higher or lower.

User Acceptance and Compliance

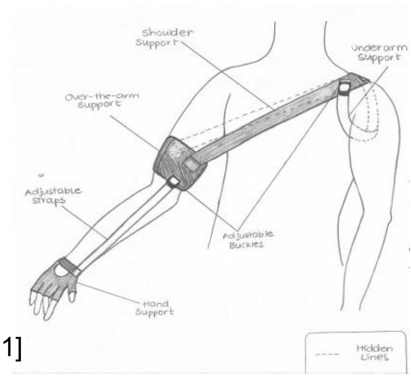
Through its sleek, compact, and versatile design and fit, the DEO conforms to user compliance. With an easy Velcro fastening panel, the user can adjust the belt to fit over any clothing material, from a light casual t-shirts to a heavy sweater. All that is required is to hold the belt in place with the immobilized arm and use the other hand to attach the Velcro parts. Taking the orthosis off cannot be easier as all one needs to do is pull the Velcro parts off one another with just one hand. The Spandex material used for the belt and arm straps makes this orthosis very comfortable as it allows for easy movement around the torso, it conforms to the user's body shape, and it is not too tight on the arm or waist area. The user will be able to carry on with daily life tasks with the DEO. While wearing the DEO the user can type on a keyboard, carry a book, and even write a text message. The device can also be personalized for the user through a wide choice of fabric colour and pattern options. The DEO is inexpensive to make and distribute, easy to make, easy to adjust for a range of flexion and extension of the elbow, easily portable, very comfortable, safe with no sharp or hard components, and has support to lighten the load on the injured arm and shoulder.

Benefits

The DEO is a very unique orthosis. It has the ability to do a lot more than other orthosis on the market. Other then it's low cost and easy of manufacturing; it's also: washable, light weight, inconspicuous, comes in various colours (as desired), no mechanical parts, penitentiary safe, easy to manufacture, easily adjustable to various sizes, wide range of extension and flexion.

ISplint

I³ Inc.
F08–T07–1



[1]

[2]

[3]

[4]

Problem Description

The user, Mr. B, has suffered nerve damage to his brachial plexus and has no control over his elbow movement, in addition to the acute dislocation of his right shoulder. His wrist and finger motion, however, has been preserved, and as such he wishes to have an orthosis designed that will allow him to position his arm in order to carry out everyday tasks.

In addition, the client, the Hamilton Hand Clinic, wishes to be able to manufacture the device in their on-site workshop, as well as to keep costs down by using either in-house materials or cheaply purchased components.

Design

As can be seen in [1], the ISplint is designed to conform to the shape of the arm as much as possible, both in order to reduce the visible profile and to reduce the feeling of actually wearing the orthosis. This is further augmented by the extremely low weight of the device, since it will be made of cloth materials.

Functionality

The ISplint will be able to change and lock the elbow joint in an almost unlimited number of positions, through the use of a simple mechanism that can be operated with one hand, as can be seen in [2].

The device will also reduce the load on the dislocated shoulder in two ways: it will redirect and redistribute it across the clavicle, and the weight of the device will lower any additional load created by the ISplint itself.

Materials, Components, and Assembly

The ISplint can be built almost entirely out of cloth-based materials, with the exception of a few mechanisms that can easily be made out of bent coat hanger. This means that the only tools required to build the ISplint are a pair of pliers and a sewing machine. Any of the components or materials can be purchased from local hardware or fabric retailers. The assembly of the device should take a relatively short time, ranging from a few hours to one working day depending on the skill of the seamstress. For optimal results, the ISplint should be tailored to the shoulders and frame of the user, Mr. B.

Cost

The total cost of the device comes out to around $20-35 per two devices (one for a left arm and one for a right arm). Since the cloth materials required to design the device are relatively inexpensive, the bulk of the cost of the device comes from buying the glove [3]. These costs can be further reduced or inflated by the quality of the materials purchased.

User Acceptance and Compliance

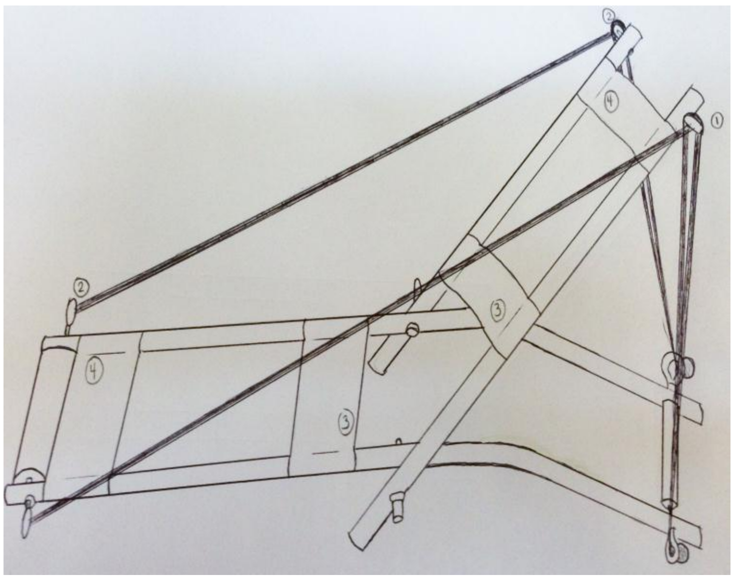
The ISplint aims to increase user compliance by offering customization options. For instance, the user can change the texture or colour of the device by choosing different cloths, and, due to his driving a motorcycle, Mr. B. can even have the glove of the device replaced by a bike glove if he so chooses. Cloth materials will also increase comfort and versatility: the device can be worn under or over clothing without a loss of functionality. The device can also be put on or taken off using only one hand, and the task becomes increasingly easier with constant use. The simple mechanism of the ISplint can also be operated with one hand. Finally, with regards to safety, the cloth materials used to build the ISplint minimize the risk of harm to the user or to others.

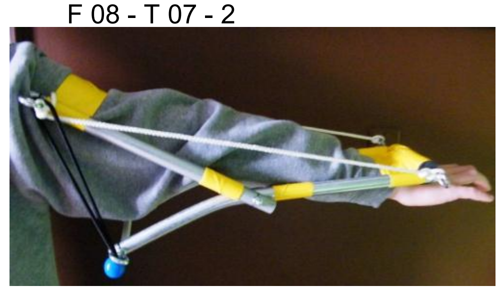
Benefits

The ISplint has numerous advantages over its existing competition. It is not only a lighter solution, but also a more effective and cost-efficient one. The simplicity of the mechanism and overall design means that the device is more consistent and reliable, and that any part that breaks can be quickly and easily replaced. The ISplint is customizable while at the same time remaining easy to manufacture. The materials from which it is built allow for a high degree of compression, such that the entire orthosis can fit into the user’s pocket [4]. An infinite number of lockable positions improves user compliance over existing solutions, and the ability to use it with one hand, not just the mechanism but also donning the device, leads to overall superiority.

Orthos-o-Rama

NCDS
F 08 - T 07 - 2





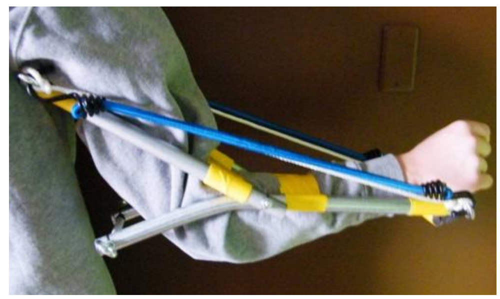


Figure 1: Extension View
1. Tension chords split and attach to eyelets
2. Hooks on the rope's ends attach to eyelets to limit overextension
3. Material goes under the arm at the elbow (opposite for flexion)
4. Material goes above arm (opposite for flexion)

Figure 2: Elbow Extension (top)
Figure 3: Elbow Flexion (bottom)

Problem Description
Design a dynamic elbow orthosis usable by a patient with limited or compromised manual dexterity. The device must provide therapy to increase both extension and flexion of the elbow.

Design
As seen in Figure 2 and Figure 3, the Orthos-o-Rama extends along the entire length of the arm. A small portion of the metal profiles protrude behind the arm, and rest comfortably on the side of the body. The total weight of the device is 3lb.

Functionality
The device provides both flexion and extension of the elbow. Locking at various degrees of extension or flexion is made possible by the implementation of eyelets. Limited hand function is affectively addressed through the use of hooks, large tension chords, and optional thermoplastic. The device can be locally made, and is relatively inexpensive. Although the user's skin condition was not fully addressed, few components of the Orthos-o-Rama come in contact with the skin.

Materials, Components, and Assembly
The Orthos-o-Rama requires components and materials which can be found at common hardware stores. These materials include metallic profiles, tension chords, cloth, eyelets, and rope. Thermoplastic is optional. Common tools, such as a wrench, a vice, pliers, an electric drill, and a sewing machine are necessary for the construction of the device. Assembling of the device requires no special construction techniques, assuming that the metallic profiles have been previously bent. The device's construction is very straightforward, and the total construction time is estimated to be about two hours.

Cost

Because there are no exotic materials or custom parts needed for the construction or use of the device, the cost is relatively low. It will cost the clinic $50.00 for building materials, and the cost for the user will depend on the clinic's margins.

User Acceptance and Compliance

Comfort of the user was implemented in the design through the use of material straps and soft parts around the wrist. Application of the device is simple. The device rests on a table as the arm weaves between the material straps. The direction of the weaving and the location of the tension chords and ropes depend on which therapeutic form is required (extension or flexion). See Figure 2 and Figure 3 for clarification. When the arm is comfortable, the tension chords are pulled up and fastened to the top eyelets. Removal of the device requires a small lift of the bungee until the arm can easily slide out. Various lengths and sizes of tension chords come with the device, along with a set of instructions referring to the degrees of flexion of each chord. These instructions make the device safe to use, and limit the possibility of overextension or over-flexion. The ropes also ensure that overextension or over-flexion do not occur. A patient will choose to wear the Orthos-o-Rama for its versatility, safety, and the many therapeutic benefits.

Benefits

The design is incredibly beneficial to the client and the user. To begin, the Orthos-o-Rama does not require assistance to apply or remove. The device is also versatile for flexion and extension provision. Assembly of the device is straightforward, and the cost of the device is low due to locally found materials. The device folds for ease of portability, and is relatively lightweight.

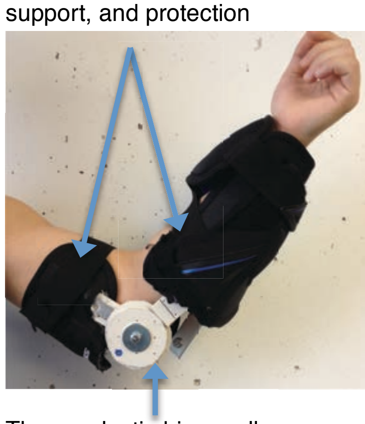
E-TECH
Dynamic Elbow Orthosis

Orthosis Technologies Ltd.
F 08 - T 07 - 3

Free moving hinge: provides stability and support

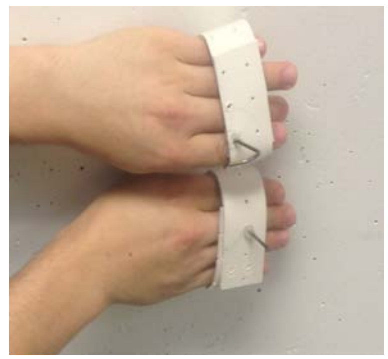
Velcro straps: removable with the hooked pin to maximize user independence

Elbow pad: provides comfort, support, and protection



Thermoplastic hinge: allows user to set the desired angle of extension or flexion

Top: curved hook allows user to adjust Velcro straps



Bottom: straight pin allows user to lock the hinge at the desired angle

Problem Description

The problem presented by the client, Hamilton General Hospital's Hand Clinic, involves a 29-year-old man, Mr. F., who suffered serious injuries in a house fire. Much of his upper body is covered in second- and third-degree burns; as such he has undergone skin grafting. He suffered from heterotropic ossification in his left elbow, so it is locked 70 degrees of flexion. His hand muscles have atrophied due to his injuries, making it difficult to perform basic tasks.

The occupational therapists at the Hand Clinic have requested the design of a mechanical device that will lock Mr. F.'s elbow into a position of extension or flexion that will not irritate his sensitive skin. Mr. F would like a device that he can use independently (despite his lack of dexterity) and while performing daily tasks.

Design

The design consists of a modified hockey elbow pad with a hinge attached to either side. The thermoplastic hinge is adjustable, so it is closest to the body. The metal free-moving hinge simply provides support. The pins are attached to thermoplastic handles that Mr. F. can slide his hand into so that he can manipulate them.

In full extension, the device is 45 cm long, 13 cm wide, and 11 cm tall. It weighs _ pounds.

Functionality

Functionally, this device performs everything that was required by the user and the client. It would hold Mr. F.'s elbow in both extension and flexion, be adjustable by Mr. F. without assistance, protects the elbow and burnt skin, and still allows Mr. F. to perform other tasks.

Materials, Components, and Assembly

The device consists of a hockey elbow pad (sports equipment store), thermoplastic (hospital's suppliers), soft fabric (dollar store), coat hanger wire (dollar store), and two metal hinges (hardware store). To make the device, a handsaw, drill, hot glue gun, and box cutter are required. Approximately 60-90 minutes are required for assembly.

Separate the pieces of the elbow pad. Saw off the plastic at the back of the lower arm pad; cover the edge with fabric. Apply hot glue to cover some of Velcro on straps; cut a small hole in end of each piece. Make the thermoplastic hinge by cutting out two disks and two thin rectangles. Drill a hole in the center of both disks, a single hole in the small disk about halfway between the centre and the edge, and holes every 30 degrees (from 0 to 180 degrees) in the large disk. Reinforce the thermoplastic rectangles with metal rectangles from the metal hinge and glue a metal rectangle to each thermoplastic disk. Use the bolt and screw from that metal hinge to assemble the thermoplastic hinge. Make slits in the upper and lower parts of the elbow pad on either side; cover the hinges in hot glue. Insert the thermoplastic hinge in the slits closest to the body and the metal hinge in the slits farthest from the body. Make the pins by bending thermoplastic around the user's hand and inserting a straight piece of wire in one and a hooked piece in the other.

Cost

The total cost to manufacture the device is approximately $46.50 dollars: elbow pad ($35), thermoplastic ($7), metal hinge components ($2), coat hanger wire ($0.50), hot glue sticks ($1), soft fabric ($1).

The cost to the user and the clinic is reduced in part because the device is adjustable and can be tightened when there is less swelling in Mr. F.'s arm, eliminating the need to manufacture another device to fit him properly.

User Acceptance and Compliance

The pins were designed so that Mr. F. could use the device despite the lack of dexterity in his right hand. He can remove and fasten the Velcro using the curved pin and lock the hinge with the straight pin because of the hand straps.

The elbow pad is lined to prevent skin irritation, but it could easily be lined with a different fabric if required. The sharp edge created when sawing off the back of the pad is also covered in fabric to prevent irritation.

Mr. F. could presumably wear the device on top of clothing (provided that the clothing does not bother his skin), but he would have to limit the amount of bulk in order to still fit his arm in the orthosis. It would be somewhat difficult to wear under clothing because of the bulky pin.

Aesthetically, the pad could be painted to suit Mr. F.'s style.

The nature of the pins makes them somewhat hazardous if misused, but if they are used as intended they pose no serious risk.

Benefits

Our design fulfills all functional requirements presented while being comfortable, cost-effective and simple to construct. At under $50, it is significantly cheaper than other similar products on the market. Moreover, the materials required are readily available.

The hockey pad protects Mr. F.'s elbow from further accidental injury while preventing skin irritation from external sources. Also, the Velcro straps allow it to be able to fit Mr. F.'s arm regardless of swelling.

The device can be used to hold the arm in extension or flexion without having to alter its mechanics, which allows him more independence.

In addition, Mr. F. can use the device while performing other tasks (because it does not hinder the movement of his fingers).

Distinct Splint

Distinct Designs
Unique Biomedical projects

Team Name
F 0 8 - T 0 7 - 4

Problem Description

The problem presented to the distinct designs team involves Mr. F, a 29 year old male who was burnt in a house fire. Twenty percent of his body surface area was covered in second and third degree burns. Because of this he received skin grafts and now has very sensitive skin and very limited finger dexterity. He also developed heterotrophic ossification in his left elbow and had to go through surgery to get the excess bone scraped out. He was left with a limited range of elbow movement and was sent to the hand clinic at Hamilton Hospital for rehabilitation. However, traditional devices cause blisters to his sensitive skin and are impossible for him to put on himself. Tara Parker, an occupational therapist at the hand clinic has asked the team to design a device that would increase the range of motion in his elbow without further damaging his skin. The device must hold his arm at different degrees of flection and extension, must be able to be made at the hand clinic, and should ideally allow Mr. F to put the device on without assistance.

Design

The design of the Distinct splint is simple but effective. The main component that sits on the arm goes from the top of the bicep to the middle of the forearm. Inside of this sleeve there is either a bent or a straight piece of aluminum metal with padding on the edges. There are three straps on the device, one at the bicep, elbow and forearm. Each are long enough to wrap around the arm one and a half times and have Velcro and a red loop at the ends. Each strap also has a buckle that they loop through.

The top and bottom straps are about 2 inches wide and the middle strap splits into two straps which go on either side of the elbow. The device is to be placed on top of the arm for flexion and underneath the arm for extension. The device weighs 0.8lbs.

Functionality

The Distinct splint most importantly provides flexion and extension at the elbow using the aluminum metal, but also meets all requirements requested by the client. It can force the arm into all degrees of flexion and extension by tightening the bottom strap only to the degree desired. The soft fabric prevents damage and infection to the skin and the red loops and buckles allow Mr. F to put on the device without assistance.

Materials, Components, and Assembly

The materials for the Distinct Splint are easily found and it is simple to make. The skeleton of the device is made of quick dry fabric attached to which are the buckles, Velcro and fabric loops all of which can be purchased at fabric stores such as Lens Mills. The inserts are made of aluminum metal with padding on the ends which can be purchased online or in store from places such as the Metal Supermarket. The assembly of this device requires only a sewing machine and some tape. The straps are sewn onto the main component and the Velcro, buckle, and fabric loops are sewn onto the straps. The metal is cut to size by the store and padding can be added using duct tape or other adhesives. The entire device will take between two and three hours to make.

Cost

The cost of the device is extremely low, totaling to a maximum of $25 to the client and user.

User Acceptance and Compliance

The design of the distinct device was strongly focused on user acceptance and compliance. The device is discrete, comfortable and easy to get on and off. To put it on, the user simply slips his arm through the loosened straps and inserts his hand into the red loops to tighten and then attach the straps to the Velcro. To take it off, the user once again inserts his hand through the red loop to release the Velcro and then slips his arm out of the straps. The red loops are specifically added so that the user does not have to grab hold of anything but simply has to put his hand into the entire loop and pull. The buckles prevent the user from having to fumble with dangling straps and the Velcro provides a simple way to fasten the device. The quick dry fabric is soft and will wick away moisture from the skin preventing any further damage to the users sensitive skin. It is also very discrete, can be made out of several different colours and can easily be hidden beneath clothing. Also, the metal strip can be removed from the device and the rest can be thrown into the washing machine as to prevent infections to the client’s skin. Lastly, the padding is added to the ends of the metal so that it does not puncture or dig into the client’s skin.

Benefits

The Distinct splint not only performs the basic function of flection and extension but it does so in a manner specific to the users conditions. Unlike existing commercial splints, this device will not damage the user’s already sensitive skin and the user will be able to use the device without assistance. It is aesthetically pleasing and comes at a maximum cost of $25.

I Dynamic Elbow

Milk
F 08 - T 07 - 5

Problem Description

Team Milk's objective was to create a dynamic elbow orthosis that could meet the specific needs of its user, Mr. B. The client for the device was the hand clinic at Hamilton General Hospital where Mr. B is a patient. Mr. B is a 23-year-old male who was seriously injured in a motorcycle accident. In the accident he received a compound fracture and degloving of his right wrist along with tendon lacerations in his arm. He suffered a serious brachial plexus injury and nerve grafting was done six months later. Due to these injuries he has little to no working muscle in both his shoulder and elbow, so he has very little range of motion in his right arm. However he can still use his hand and fingers, as they were not seriously injured in the crash. The elbow orthosis can lock his elbow into various positions, which can be adjusted with minimal effort on his part. This was one of Mr. b's prime objectives was to be able to lock his elbow in specific positions to be able to do work or allow him to work on rehabbing his arm. It was important for the elbow orthosis to be light because Mr. B's shoulder was already subluxed due to the lack of muscle in the shoulder. By creating an orthosis as light as possible it would reduce the discomfort in wearing the orthosis for an extended amount of time. Mr. B also wanted to work on active assisted range of motion with the device on. To accomplish this, the device needed to be easy to adjust and not obtrusive. Ideally the splint would be designed so that it would be safe to use in a prison in case Mr. B is incarcerated.

Design

The design is not very big or obtrusive and is very light. These are two major advantages to the I-Dynamic-Elbow. Mr. B wants to be able to work with the orthosis on so it was important to make it a reasonable size to accommodate this. The orthosis was also designed with very light materials in order to reduce the strain and weight on Mr. B's shoulder. The cuffs fit securely on the arm, thanks to the straps and cuffs that ensure a tight fit. One cuff is typically worn on the forearm while the other cuff is worn up on the arm closer to the shoulder.

Functionality

The I-Dynamic Elbow can be locked into multiple positions very easily and offers excellent range of motion with the device on. These were two of the major objectives of Mr. B and this orthosis easily meets those needs. The orthosis also meets Mr. B's request to do assisted active range of motion with the orthosis on. This is accomplished by having an orthosis that offers very good range of motion.

Materials, Components, and Assembly

The materials used for our dynamic elbow orthosis are wooden bars, sheet aluminum, a screw with a wing nut, fabric, and four buckles with straps. The materials used to construct the orthosis include a drill, a glue gun, glue gun glue, scissors, and a sewing machine. The orthosis should only take between 45 and 60 minutes to build if all the tools and materials are on hand.

Cost

The overall cost of the materials is approximately 15-20 dollars depending on the quality of the material used. The cost increases significantly though if thermoplastic is used instead of fabric for the cuffs.

User Acceptance and Compliance

The user will use the orthosis as a splint. To put the orthosis on your right arm securely, you need to make sure the buckles are undone and loose. Secondly, the right arm is inserted into the orthosis, going all the way up the arm, and then you use your left hand to hook the buckles and fasten them tightly on the arm. Now that the dynamic elbow orthosis is secured to the arm, you are able to adjust the position of your arm by using your left hand to unscrew the wing nut from the screw holding the wooden bars together. Remove the screw, and then you can adjust the orthosis by changing the position of the screw. The easiest part of the design is to remove the orthosis, which is done by simply unbuckling the buckles and then removing it from your arm. The design is very comfortable thanks to the use of soft materials and fabrics and is also very light which reduces strain on the shoulder. The orthosis was designed to be as safe as possible but there is still wood and the wing nut screw that if not handled carefully could hurt the user or another person.

Benefits

There are several major benefits to our design. The first is the cost of the design. It only costs about $15 to make in materials it is a lot cheaper than many of the other designs especially those that utilize thermoplastic. Our design is also comfortable to wear. It is lighter than designs due to its use of fabrics are soft and comfortable unlike designs using metal, PVC, piping or plastics. Our design is also very original. No other groups have a sliding system like ours, which sets us apart from other groups. A lot of creativity and thought went into designing and building the sliding device, so it was practical and functional.

Refined Align Design v1.2000

Align Research
F 0 8 - T 0 8 - 1

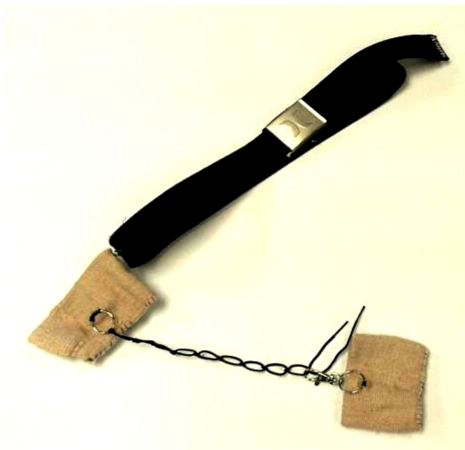


Fig 1.1

Fig 1.2

Fig 1.3

Fig 1.4

Fig 1.5

Problem Description

Design a user friendly elbow orthosis for a user such as Mr. B who is able to control the function of his hand, but is unable to use it due to his inability to control the function of his elbow and shoulder. This device will allow the user to perform a number of everyday tasks that are important to them. It will be created by Tara Packham at the Hand Clinic for patients including Mr. B and those with similar needs. The device should be low cost, light weight, and easy to use (put on and adjust). Additional consideration should go into making a device that is unable to be used as a weapon if the user were to be incarcerated. (In this case the user is awaiting a trial on drug charges.)

Design

The Refined Align Design v1.2000 is a lightweight simplistic elbow orthosis. It consists of a support strap that crosses the chest (Fig 1.4), two cuffs on the arm (Fig 1.3), and a string chain that is attached at the upper cuff (Fig 1.5). There is a trigger clip (such as those sometimes found on key rings or lanyards) on the lower cuff (Fig 1.5), a hook on the upper cuff and a corresponding eye on the support strap(Fig 1.1). The strap reaches from the underarm of the affected side of the body and hangs across the opposite shoulder. The cuffs slip on the arm and the hook on the upper cuff connects with the eye on the strap. The clip on the lower cuff provides the connection to the string chain (Fig 1.5). The entire orthosis weighs under 200 grams and the materials are entirely flexible allowing it to be contained in a space smaller than a softball. When it is on the user, each cuff takes up approximately one third of the upper or lower arm. (Fig 1.2) The strap spans across the chest but is only the thickness of a belt. (Fig 1.4)

Functionality

This orthosis supports the arm at varying degrees of flexion-extention and allows the user to use the hand of their injured arm to perform everyday tasks that they would otherwise not be able to do (Fig 1.2 and Fig 1.3). With minimal effort on the part of the user, it can adjust to support their arm in the required position for a given task. (Fig 1.5)

Materials, Components, and Assembly

The materials required to produce our orthosis are available to the public and can be found in a variety of retail chains such as Shoppers Drug Mart or Walmart. It requires a tensor wrap, a fabric belt, a hook and eye, two key rings, a trigger clip, a shoelace, and nylon thread. The construction of the device requires the ability to sew. Nothing is needed for construction other than a sewing needle. The process of creating the orthosis takes very little time compared to other devices made of thermoplastic that require time to harden. With detailed instructions, it might take one person approximately one hour to produce our orthosis. In addition, measurements of the user's torso and arm will be needed in order to ensure that it fits properly and the hook and eye line up properly.

Cost

The entire cost of materials is under $30. In addition to the low cost of materials, the orthosis takes very little time to construct and would not require any additional appointments with the user other than to take measurements, which can be done quickly and easily at any point when they would be at the clinic for other reasons.

User Acceptance and Compliance

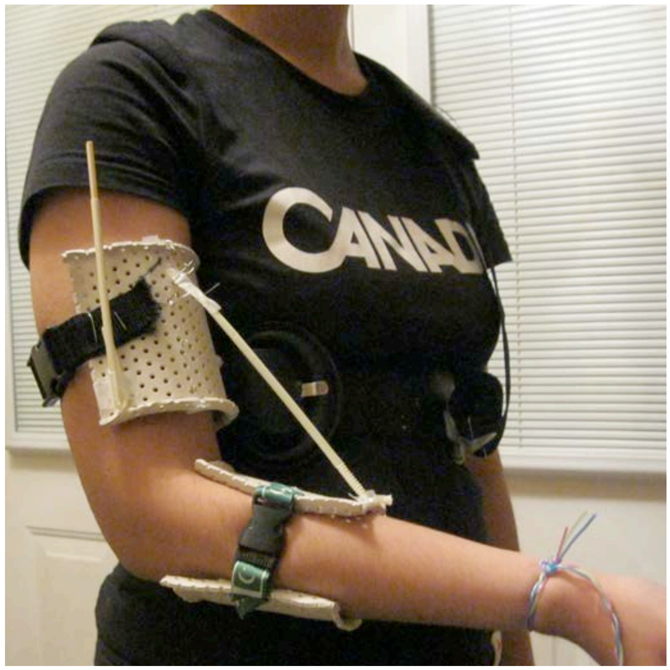
The Refined Align Design v1.2000 has been designed to be user friendly. By designing an orthosis that can assists the user in performing daily tasks that they would otherwise be unable to perform, the use of this device becomes desirable. If the undesirable effects of wearing an orthosis are sufficiently limited, the user will want to wear it. A common problem experienced by users of this type of device is their inability to put it on due to the physical limitations caused by their injury. The Refined Align Design v1.2000 is easy to put on, even in the case where the user's injury would limit their ability to put on other devices. The device is designed such that it can be put on one component at a time, and then assembled once it is already on the user. Each component is designed to be easily put on while being as comfortable as possible and remaining functional. The orthosis does not have any sharp edges or hinges that could pinch the user's skin. The cuffs were designed to be large compared to the size of the arm making them less likely to slip off while also spreading out the force required to support the arm. The ability to easily adjust the position of the arm using the trigger clip and string chain makes the device more desirable from the user's perspective, as they can change between tasks easily. Additionally, the user has no reason to be embarrassed about their injury in public because the Refined Align Design v1.2000 can be worn unnoticed under clothing. (Fig 1.4)

Benefits

The Refined Align Design is impressive on a number of different levels. The adjustment mechanism involving the trigger clip provides the user with a simplistic way of adjusting the position of their arm, Unlike in the case of other devices, the user is able to do this on their own. In this as well as in other ways, the design gives the user independence. In allowing the user to put the device on themselves, adjust it without help, and perform every day tasks on their own, the Refined Align Design v1.2000 gives the user the opportunity to live more independently than they would be able to with other devices or with none at all. The device is also discreet as to allow the user to wear the device in public without feeling embarrassed. Furthermore, due to its low cost, this orthosis will be able give a number of people their independence back including those who are unable to afford alternative devices.

Dynamic Elbow Orthosis

Team Name: UncoverB
F 08 - T 08- 2



Problem Description

The client, Tara Packhard, a practicing occupational therapist has asked Team UncoverB to build a device that can assist a certain Mr. B. Mr. B has had a bike accident and has torn much of the nerves of his right arm, and dislocated his shoulder, severely limiting his range of motion. He has asked for a device that he can put on without any assistance, and that will help him do day-day tasks since the function of his hand and fingers is intact. This means that he should be able to adjust it into any angle he wants, be able to pronate and supinate and it should not bear a load on his bad shoulder.

Design

The device has two contact points for on the arm, both made out of thermoplastic. One is smaller and wraps around the forearm, the other is larger and wraps around the bicep. A strap attached to the larger one which can be secured around the torso, like a belt.

A string is looped around the wrist, and can be tightened by a stick that, when used as a lever rotates the hand, allowing supination and pronation to occur. The components along the arm, as well as around the waist weigh approximately 450 g .

Functionality

The device's large components work to hold the arm at different angles as per requested by the client and the second component aims to provide movement for the wrist's, mainly pronation and supination.

Materials, Components, and Assembly

The materials that the design requires are thermoplastic, two buckles, a laptop case strap, a belt, a bendable straw, string, foam, Velcro, a stick, pipe cleaners and paper clips.

The thermoplastic will be available from the clinic, the laptop case strap can be obtained from an electronics store such as Future Shop or Best Buy, the belt will be bought from a clothing store, and the other components can be purchased at the dollar store.

The tools needed to build the device are a pan and hot water (to shape the thermoplastic), pliers (to bend the paper clips), scissors, glue, and tape. It will take approximately four hours to build, including the time it takes to shape and cut the thermoplastic.

Instructions for Assembly will be the following:

1. Cut and shape thermoplastic to fit arm in two spots, the forearm and the bicep using hot water and a pan (these are your casts), round off the edges
2. Glue on foam inside each cast, and glue buckles onto the top of each cast
3. Using pliers and scissors cut and shape the paper clips into loops which can then be threaded into the holes on the thermoplastic and taped into place (on the bicep cast)
4. Bend a paper clip into the hook using the same technique as before and tape into the straight end of the bendable straw. Glue the bendable end of the straw to the forearm cast
5. Thread pipe cleaners through belt's loop and insert into the holes in the thermoplastic wrapping around many time to secure the belt to the bicep cast. Glue in place.
6. Hook on the laptop strap to a loop made of a small piece of pipe cleaner taped on the reverse side of the bicep cast at the top
7. Attached Velcro to the other end of the laptop strap, at intervals of 3 cm and to the belt at one location
8. Tape a bendable straw with the bottom bent up to the forearm cast, (becomes a stick holder)
9. Lastly, take 3 pieces of string, braid them into one large thick string and tie a lose knot at one end, thread the other end through the knot and tighten, this is a lasso, which can be tightened around the wrist

No other special instructions will be needed

Cost

The costs will consist of materials used:
Thermoplastic: $76.24
Straw: $2.00
Buckles: $10.00
Belt: $15.00
String: $2.00
Laptop case strap: $20.00
Velcro: $4.00
Wooden stick: $1.00
Paperclips: $2.00
Pipe Cleaners: $3.00
Foam: $6.00

User Acceptance and Compliance

User compliance was taken into account for this design. It is non-complex, aesthetically appealing and fulfills the user's current needs. This device has only two parts that must be put on the arm which will then be joined to the torso with a belt-like strap. This means that it will require only a short time to take on and off and the adjoining parts make it easy to store.

Comfort has been covered with foam and rounded edges so it does not cut into the skin or interfere with arm movement to make it painful in anyway. The user needs only one hand to operate the device. They can control the angle with the straw that can be hooked to different loops to lock into position, and pronation and supination is controlled via a string that acts like a cuff around the wrist rotating the wrist to the preferred pose.

The user will wish to wear it as it requires very little maintenance and is quite useful for tasks at hand. In terms of aesthetics the design is a standard black and white, appealing to the user for its simplicity and compatibility with any clothing. Safety, was taken into consideration as well; the device had no sharp edges, removable parts, or anything that hinders normal bodily processes.

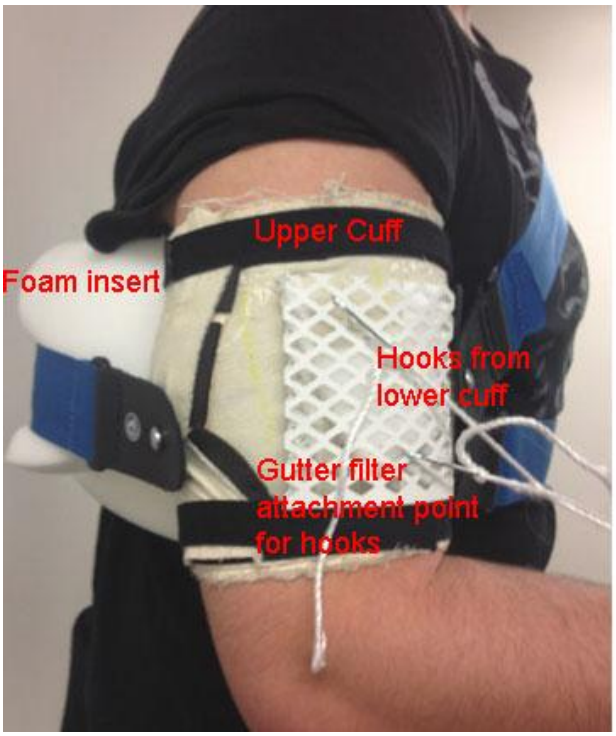
Benefits

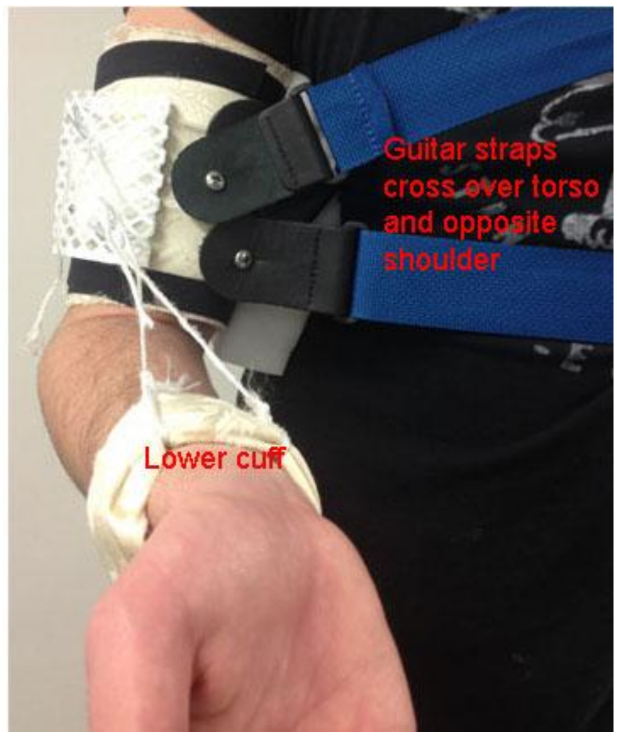
Our design is customized to the user's current needs and so will provide them will the help they need to live their life comfortably and perform day to day tasks with ease.

Commercial devices are not tailored to the client and are made to be mass-produced only to gain profits while our design takes input from the user, such as the number of angle locking positions preferred, is very simple to put on and take off, and is lighter and sleeker than other leading brands.

Atlas Elbow Orthosis

Synovial Designs
F 08 - T 08 - 3





Problem Description

The problem statement presented by the client Ms. Packham, of the Hamilton General Hospital Hand Clinic is interpreted by Synovial Designs as following: the patient and user Mr. B has suffered injuries due to a motorcycle accident and requires a dynamic elbow orthosis to enhance his performance of daily activities. This device is intended to enable elbow flexion and extension, to lock the elbow in different positions, to pronate and supinate the forearm and to provide shoulder support. The device will be used indoors for example in the patient's home and in the clinic, as well as outdoors. This device will allow him to be able to use the hand of his injured arm in a wider range of daily tasks. This orthosis will be constructed from materials easily accessible by the Hand Clinic such as fabrics, common fasteners and straps.

Design

The orthosis has three (3) components: an upper cuff, a lower cuff and a foam insert, weighing a total of 2lbs. The lower cuff is made of fabric with foam in the middle and fastened with Velcro. Two strings are wrapped around the cuff with hooks attached at the ends. The lower cuff is around 1/4 the size of the forearm in width, 12" long and ½" thick. The upper cuff is also made of two strips of fabric and foam cushioning. It is held closed with Velcro. It has 4 attachment points for the guitar straps which loop over the body. It has a plastic perforated sheet which provides attachment points for the lower cuff's hooks. The upper cuff is about 2" shorter than the upper arm of the patient, 12" long and about 1" thick at its highest point. The foam insert goes in the underarm of the injured arm and is 12"x12"x2".

Functionality

Our elbow orthosis varies the angles of flexion and extension of the elbow, it allows pronation and supination of the forearm, it locks the elbow into different positions and it provides support for Mr. B's subluxed shoulder. The orthosis will allow Mr. B to perform daily activities that require the elbow's range of motion.

Materials, Components, and Assembly

The materials used to assemble the orthosis are the following: foam sheet, foam pipe insulation, plastic gutter filter, 4 round-headed machine screws, 4 bolts, 2 guitar straps, fabric, double-sided Velcro, 2 curtain hooks and 2 feet of twine. The materials were bought from the local hardware, guitar and fabric store and assembled using a hot glue gun, sheet metal clippers and an X-Acto knife. The assembly of the device is very personalized to the user and can be assembled within an hour. First the width of the user's forearm and upper arm are measured. Then using the measurements plus 2", 2 strips of strips of cloth are cut for each measurement. Foam insulation is placed between the strips of the same length and the fabric is hot glued together. Velcro is attached width wise on the lower cuff and length wise on the upper cuff with 2" of overhang. Two lengths of twine are wrapped around the lower cuff and a hook is attached to the end of each string. Four holes are marked, 3 located on the inside of the cuff and the fourth is located on the outside of the cuff. The screws are inserted in the marked holes and held with bolts. The patient then wears the cuffs and the strings with the attached hooks are shortened so that when pulled up to the level of the upper cuff they cause the elbow to bend. The plastic gutter filter is cut to about half the width of the upper cuff and about 4" long then hot glued to the cloth on the outer edge where the hooks are level with the upper cuff.

Cost

The cost of the orthosis is a maximum of $50.00 for all the components. A breakdown of cost is: guitar straps-$15.00, foam pipe wrap-$8.99, Velcro-$8.96, nylon rope-$4.99, curtain hooks-$2.99, screws and bolts-$2.96, fabric-$5.00, gutter filter-$2.39, foam sheet-$2.00.

User Acceptance and Compliance

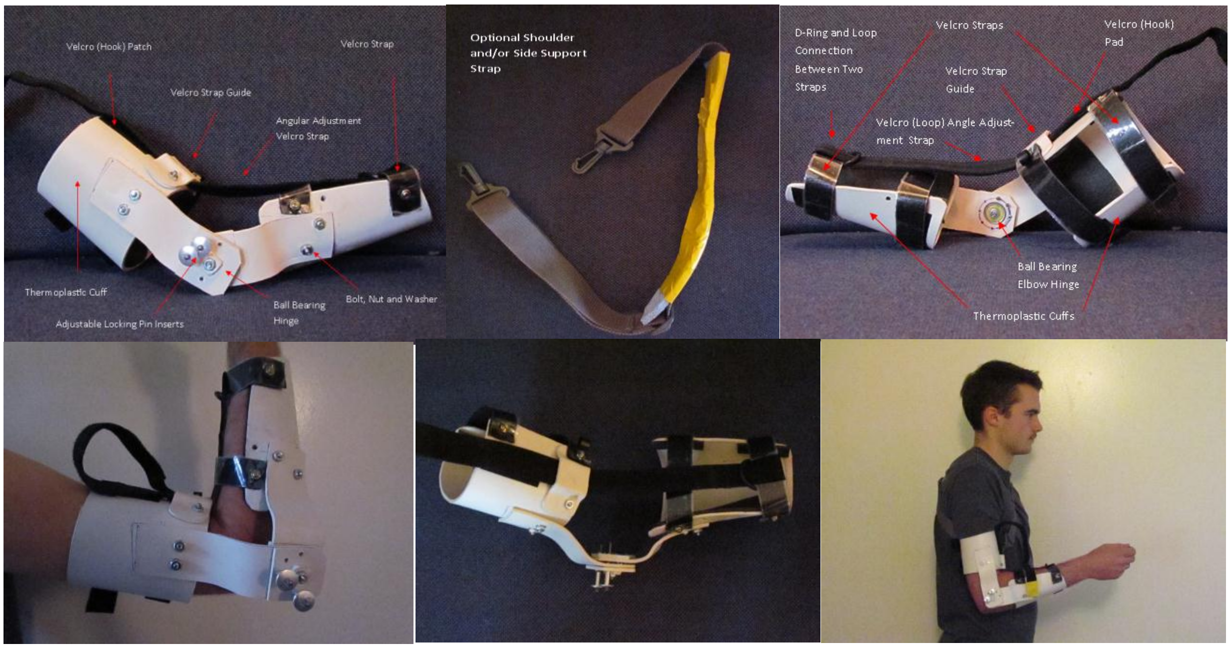
User compliance was important in the final design. The orthosis has brightly coloured guitar straps, patterned fabric and soft padding. The orthosis components are all interconnected leading to fewer separate pieces, making it easier to put on for the user. Safety was also an important consideration of the design so soft fabrics were used and a lightweight orthosis was designed. The orthosis is easily adjustable since the hooks allow the arm to lock into different positions. The orthosis allows the user to pronate and supinate easily because they just need to cross the lower cuff's bottom string across the forearm and attach it to the plastic sheet on the upper cuff. The orthosis provides support for the injured arm and balances its weight along the body using the straps and the foam inserted under the armpit. The orthosis immobilizes the arm by strapping it to the body and keeps the humerus near 90 degrees in the socket, the ideal position for healing subluxion. The orthosis is easily tightened using the guitar straps and the Velcro to fit the user. The device is also compact and fits to the user's body without making the user appear disproportionate.

Benefits

Synovial Designs believes that our orthosis is a better solution than existing devices on the market for Mr. B. This is true because the orthosis is tailored to fit the user compared to the one size fits all solutions available today. The orthosis is lightweight which is important for Mr. B's subluxed shoulder, it is cost effective with the materials totalling to $50.00 tax included, it is also cosmetically appealing with bright colours and patterned fabric. It uses soft materials and an interconnected approach to the components, making it is easier for the user to wear since there are less individual pieces that must be put on separately. In short, the orthosis designed by Synovial Designs is a functional, easy-to-use, cost effective and user orientated device which is better than any other orthosis on the market for Mr. B today.

The CRS Dynamic Elbow Orthosis

Creative Rehabilitation Solutions
F 0 8 - T 0 8 - 4



Problem Description

The hand clinic at the Hamilton General Hospital has a patient who was involved in a motorcycle accident and sustained extensive injuries to his right forearm, hand, and shoulder. The accident left the patient with no function in the muscle of his right arm due to tendon and nerve lacerations. Since the accident most of the injuries have healed, but the lack of elbow function and shoulder drop still remain.

The patient wants a device to return function to his elbow, which would support his forearm and allow his elbow to be locked in a variety of positions so he can perform basic tasks. He would also like to be able to perform active assisted ROM exercises with the device on. Furthermore the client would like the device to put the least amount of load possible on the subluxed right shoulder of the patient to prevent further damage to that area. The patient wants to be able to vary forearm rotation so he can make full use of his functioning hand, fingers, and wrist. Finally the brace should be non-weaponizable, so it can be worn in prison. The device will be designed and constructed attempting, meet all of the objectives stated above.

Design

The CRS elbow orthosis is a lightweight, relatively small brace made up of three main pieces, one part supporting the biceps, one supporting the forearm as well as a strap which connects the other two components. The device has been designed to be small and convenient enough to be worn under or over certain articles of clothing. The elbow orthosis prototype is approximately 33 centimeters in length and a maximum of 14 centimeters wide. The final design may have different dimensions as the device must me molded to the patient’s arm. The prototype and all of its components weigh approximately 1.30 kg; however the final design should have a slightly lower mass by utilizing different materials and methods of construction.

The orthosis stays very close to the arm in all areas except for the elbow hinge which is slightly removed from the arm to prevent any interference.

Functionality

The main function of the device is to provide support for the forearm and allow the user to lock the elbow at a desired angle for extended periods of time. The device allows the user to freely adjust the flexion and extension of the arm and lock it in place using a Velcro strap and pin locking system. The design of the orthotic also allows the user to freely rotate their forearm with little resistance as requested by the patient. Forearm rotation is possible due to the shape of the brace as well as how it is attached to the arm. The “cup” shape of the brace supports the bottom of the arm without restricting all of its movement and affecting the rotational motion. The forearm straps can be easily loosened or removed to let the forearm rotate even more freely. This dynamic elbow orthosis, in addition to being light weight, is designed to keep most of the weight off the injured shoulder of the client. One or two straps encircle the body and spread the weight of the orthotic to the rest of the upper body. If the client is not in need of these straps they may easily remove them. The device would aid in the user performing common day to day tasks, improve his quality of life, and assist in the healing of his injuries.

Materials, Components, and Assembly

The device employs the following materials: thermoplastic, Velcro straps, rivets, nuts, bolts, washers, a nylon spacer, a ball/roller bearing, foam padding, supportive straps, a small aluminum rod, and adhesive. Most of these materials should already be in the hand clinic’s possession, but if not they can be purchased from a local hardware store or medical supply company. To construct the device the following tools are required: screw driver, electric power drill, boring drill bit, standard drill bits, adjustable wrench, hack saw, box cutter, thermoplastic heating pan, pop rivet gun, scissors, and vise grips or clamps. The entire construction process should take approximately 240 minutes. Most of the device could be recreated based on a visual representation, but the construction and implementation of the bearing hinge would require very detailed instructions. In general the assembly of the device would require special instructions.

Cost

One of the many reasons for going with a minimalist design for the orthosis was to minimize costs. The design utilizes many of the materials the Hand Clinic already possesses and any extra materials are easily attainable and inexpensive. The final product is estimated to cost approximately $104. This cost seems very reasonable compared to the price of many commercial products on the market.

User Acceptance and Compliance

You should be discussing how you met your objectives.
User compliance has been considered throughout the design by making the orthosis comfortable, inexpensive, discrete, and versatile. The patient can easily put on and remove the device by laying it flat, open to 180 degrees, and placing his arm in the cuffs. The straps can then be tightened and the arm position adjusted for comfort. Comfort was ensured through the use of foam and supportive straps to distribute the load and pressure from the device. Safety was also a major design factor and was periodically discussed in the design process. The final safety tests were done using the prototype.

Benefits

There are many benefits to using the CRS elbow orthosis as opposed to other orthotics on the market. First off, the device is custom made to provide the best and most comfortable fit possible. Next the elbow orthosis allows for quick and easy elbow angle adjustment and a varied range of motion so the user can make use of their arm. The device reduces pressure on injured shoulder by using straps and a lightweight design preventing further injury to the shoulder. The brace is also easy and inexpensive to construct which will reduce cost and boost patient compliance. The features of the elbow orthosis provide many benefits to the client and user, and give it an edge over the competition.

Bungee Splint

Limitless Engineering Solutions
F 0 9 - T 0 1 - 1

Problem Description

Tara Packham from the Hamilton Hand Clinic would like our firm to design a dynamic elbow orthosis for a patient, Mr. B., who has suffered a compound fracture and has lost all motor control in his right arm. He has limited control of his fingers and a perfect elbow joint. However, he doesn't have any muscle supporting his shoulder at the moment. The user would like to be able to perform daily tasks such as typing and brushing teeth. In order to do that, he would like to be able to lock his elbow at different angles to allow for flexion and extension and would like to be able to alter his forearm between supination and pronation. The user would prefer a device that could be set up independently and to not cause strain on the right shoulder. He would like to use it at home as well as in general population if incarcerated.

Design

The design of the Bungee splint is optimized to allow for the maximum amount of functionality and mobility while maintaining a lightweight profile that has a high probability of being allowed if incarcerated. The PVC pipe, commonly called eaves trough was used as a lightweight alternative to a bulkier thermoplastic. Having a lightweight frame allows for a slender cross-body support which makes the orthosis less bulky. The open top of the PVC pipe allows for air to prevent the arm from sweating and smelling. It also allows for supination and pronation of the arm. The neoprene belt acts as a durable, strong cross-body support while remaining low profile. Additionally, it helps stabilize the arm to help with tasks that require finer motor control. The bungee cords allow for the user to flex and extend his arm while not being completely rigid to allow for natural shock absorbance. The second bungee cord is added as a failsafe In the event the other one becomes damaged. The entire design based on the materials used is low profile and can even be folded into a small package that can be carried around anywhere whether it is being worn or not.

Functionality

The splint allows the user to easily lock in his arm at various angles and supports the arm at both the shoulder and elbow joint. It also allows the user to pronate and supinate the forearm and perform daily activities such as brushing teeth or typing. It is capable to performing all of the clients original requests as well as providing ease of use and comfort to the user.

Materials, Components, and Assembly

The materials and components required include four feet of PVC pipe, three Velcro straps, four Bungee Cords, eight screws, nuts and washers which can all be obtained at any hardware store. Also required are four fastener traps (auto clamps), which can be obtained from any auto part shop , and a neoprene belt, which can be obtained from any clothing store. The tools required to construct it include sandpaper, a drill and screwdriver. It takes approximately an hour to build the orthosis. Instructions that are required include using sandpaper to sand the edges of the PVC pipe, to remove sharp edges and to make the device more adjusted to the user’s arm, another instruction that must be followed is to drill a hole on each side of the PVC pipe about one inch from the end, where the two pieces of PVC pipe will be placed into each other, so that the two pieces act as a hinge without colliding. No other special instructions are required.

Cost

The total cost for the Hamilton Hand Clinic to purchase the required parts is approximately $24.46 before tax. In order for the Hamilton Hand Clinic to be reimbursed for time to make the device and for total cost of the device the user would have to pay approximately $50.00 to $100.00.

User Acceptance and Compliance

While designing the Bungee Splint it was considered that for the user to comply with the splint that was designed, it would have to fulfill all of the objectives that the user was looking for in a splint. User independence was a big factor in the design as well due to the fact that the user has a trial and could possibly incarcerated and would need to be able to get the splint on and off singlehandedly. The splint fits the users arm and could be added for more comfort. The splint will not only increase the range of motion but also act as a functional splint. This allows the user perform everyday tasks using his fingers. Since the user suffers from an injury to the brachial plexus and only has movement in his fingers, the splint was designed so that the PVC pipe length goes up to the wrist to maximize finger movement. The splint is to be worn over the clothing and has a very sleek design that does not have any added bulk. The objectives set out by the user were met by the splints design. The splint is constructed from readily available materials and the total cost to construct is only around thirty dollars. It is also extremely lightweight and also helps to distribute the weight from the subluxed shoulder across the rest of the body eliminating a lot of safety hazards. It also is difficult to disassemble making it acceptable in general population allowing the user to use it should he be incarcerated. The Bungee Splint is an ideal splint for the user as it meets all of the objectives and user compliance is not an issue, this is a splint the user will want to wear.

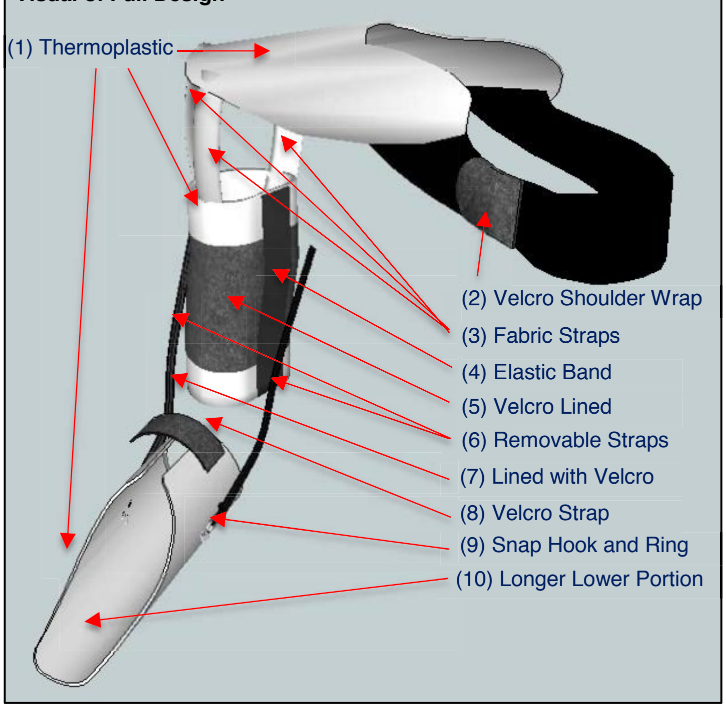
Benefits

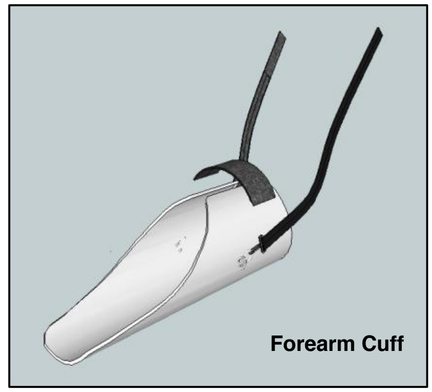
Compared to the other splints on the market, the Bungee Splint won’t put strain on the shoulder because it’s lightweight and it uses a belt to provide support to the shoulder. The splint uses materials that are much cheaper but just as efficient as the materials used in splints on the market. The Bungee Splint is simple to construct; all the materials can easily be found at any hardware store. The splint can be worn for long periods of time without getting uncomfortable and it is fairly use to put on and take off. It is also more likely to be allowed in general population if incarcerated compared to other splints.

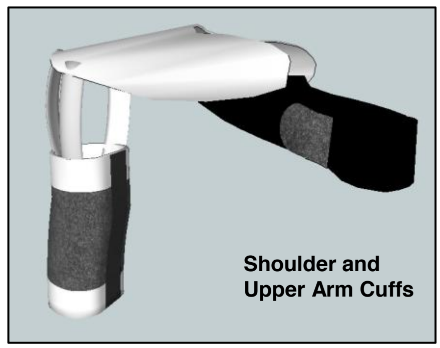
Elbow Orthosis

RASPBERRY
Raspberry
F09 - T01 – 2

Visual of Full Design




Forearm Cuff


Shoulder and Upper Arm Cuffs

Problem Description

Our proposed design is an elbow splint suitable for Mr B, a patient of Hamilton General Hospital's Hand Clinic.

Mr B has subluxed shoulder and is unable to control flexion and extension of his right elbow. Our design aim is to enable Mr B to use his right hand for functional activities and decrease stress caused by the weight of his arm on his shoulder.

Design

The design consists of three cuffs made from thermoplastic (1) (refer to visual), molded to fit the shoulder, upper arm and forearm of the user snugly.

The shoulder cuff is worn via a Velcro adjustable fabric wrap (2) about the user's chest and back, under the user's functional arm. The cuff is linked to the upper arm cuff by three fabric straps (3).

The thermoplastic of the upper arm cuff would be fixed onto an elastic band (4) which could slide up the user's arm and fit the upper arm comfortably. The cuff is lined with Velcro (loops portion) (5).

The forearm cuff could be tightened across the forearm, close to the elbow joint via Velcro (8). Two removable straps (6) are hooked onto rings (9) attached to the forearm cuff and lined with Velcro (7) (hooks portion). These straps would be attached to the upper arm cuff via Velcro.

The shape of the forearm cuff, i.e. longer lower portion (10), is designed to mini0mise the stress on the forearm caused by straps.

Functionality

The shoulder cuff relieves stress of user's right shoulder by distributing the weight of user's arm across the body.

The removable straps can lock the user's elbow into different angles by adjusting the length of the straps that are wrapped about the upper arm cuff. The straps also allow the user to dictate the horizontal direction (left to right) of his hand by similarly varying the length the straps are wrapped about the upper cuff.

Materials, Components, and Assembly

Materials:

1) 2 plastic/metal snap hooks (straps loop 0.6 inch wide)
2) 2-inch D or O metal/plastic ring
3) Thermoplastic (As required according to user's size)
4) 5-inch width elastic fabric band (length as required according to user's upper arm diameter)
5) Velcro
6) String and needles

Tools:

1) Glue Gun with glue
2) Scissors
3) Boiling water
4) Sewing machine/Needles & threads

Time required for assembly is 2 to 3 hours.

Assembly instructions:

1) Size the elastic band around the user's upper arm with appropriate tightness and sew the band together.
2) Mold thermoplastic over the elastic band, leaving a 1.5-inch gap under the arm as shown in visual.
3) Mold and fit thermoplastic to user's shoulder and forearm, shaped and sized as shown in the visual.
4) Measure the length of three fabric straps from the upper cuff to shoulder cuff to provide sufficient tension to user's upper arm cuff and affixed as shown in visual.
5) Adhere Velcro to two straps (0.8-inch width) with sufficient length to enable user to lock elbow to full extension and flexion. Loop and sew straps onto a snap hook each.
6) Use 2 strips of fabric to loop and adhere the 2 rings to the forearm cuff, about 1.2 inches from the elbow joint and angled as shown in visual.

Cost

Estimated cost is approximately CAD$ 100.

User Acceptance and Compliance

Instructions for user:
1) To wear the splint, slip upper arm cuff up to 1 inch below armpit. Place shoulder cuff over shoulder and strap across body snugly.
2) Clip the snap hook of the two removable straps to forearm cuff's rings and slide the forearm cuff on, tightening the Velcro strap for forearm.
3) To adjust angle of arm, rest arm on a surface at the required angle while adjusting straps to required length. Do not unstrap without support for forearm.

The splint is designed to be light-weight, easy to put on and remove. Short sleeves or a sleeveless shirt can be worn over shoulder and upper arm cuff. For short sleeves, right sleeve would have to be rolled up such that the two adjustable straps can be fixed to the upper arm cuff.

User can remove the two straps while still wearing the forearm and upper arm cuffs when the function of locking elbow is not required.

Benefits

There are designs which have similar shoulder support and designs that utilises straps and buckles for locking of elbow. However, our design incorporates both ideas and improves user friendliness with the use of Velcro.

Our design also allows for the rotation of the forearm such that functional activities can be done while the splint is in place.

Dynamic Elbow Orthosis

Maple Engineering Branch 78
F 09 - T 01 – 3

Problem Description

The problem presented to the Maple Engineering Branch 78 was the designing of a dynamic elbow orthosis that could assist a user, such as Mr. B who has no movement in his elbow and a dislocated shoulder, in his day-to-day activities. This design will be a support and positioning mechanism him to use. The first problem is how to take the weight off the shoulder. It was addressed by using a support system on over the back and across the chest. A secondary problem is how to lock the elbow in place. It was fixed by attaching a tension bar from the upper to the lower part of the arm. The third issue that was solved was the supination and pronation of the wrist. This was solved by locking in the lower wrist at different angles with the previously mentioned tension bar. The fourth and final issue is how do get his arm into adduction and safely back down. Uniquely we designed a pocket system that is easy to operate that holds the arm at different levels. These solutions are like no other and easy to achieve. This device is one of a kind and will completely change the way elbow orthotics are used.

Design

The brace has a modern futuristic appearance to it. It is made of bright white thermoplastic, giving a clean sleek look. The tension bars are made of chrome steel, adding to futuristic look that this brace gives. The brace is supported by a knapsack style chest belt you wear over your shoulders; this will be made of a dark black material so that it is hard to notice, however can be changed to the users liking. The device's size is approximately half of the users forearm and most of the user's upper arm. Generally, one would expect the device be made light. That request is not necessarily required. This device was not created with this intention; it is designed to take the weight off the shoulder so the user does not feel its true weight. Let it be known that even without the straps this brace is quite light.

Functionality

This device is able to provide the user with the ability to complete standard daily tasks with great ease. With it the user may put their elbow into both flexion and extension, the wrist into both pronation and supination and the shoulder into both abduction and adduction. The device locks the arm into the most useful positions that will allow the user to complete daily tasks. It is believed that anything someone would need to do on a normal day is totally covered.

Materials, Components, and Assembly

The materials used for this project are thermoplastic, steel/wood, shoulder straps, a utility strap, buckles, krazy glue and sponges. These materials are all available to the public at local stores such as Canadian Tire, and Home Depot. The only exception to this is the thermoplastic. This material is only available on special order. The brace takes minimal amount of tools to create; all you really need is a knife, pot, stovetop and glue. Although the material requires special order it provides the brace with the best possible **support**. The design will take approximately two hours to make; the hardest part of construction would be specifying it to each user. The instructions would include a simple explanation on how to manage the thermoplastic and what order to construct and attach each part of the brace.

Cost

The financial cost is about $66.00.This price includes four dollars on sponges, fifteen dollars on straps, five dollars on duct tape, five dollars on krazy glue and two dollars on the wooden/steel dowel. It also includes the price of thermoplastic which in whole is eighty dollars, but since the device uses only one third it would cost only twenty seven dollars per device. Since the device is easy to make and the materials can be easily acquired the total assembly should involve no more than two hours' worth of labour cost.

User Acceptance and Compliance

The user's compliance has been considered throughout the design process of this brace. The result of this is a fully functional and practical device that could be used for many tasks. The user will be able to un-strap the thermoplastic portion using their one free hand. As far as the back straps go, they will be able to simply slide on and off at the click of a buckle. The inside of the brace is lined with sponges; these act as a cushion making the brace extremely comfortable. Also the shoulder straps are to be padded so that irritation does not occur. Although wearing a brace is not ideal for anyone, the design created will provide a minimal amount of embarrassment or discomfort to the user. To ensure that this is the case, the colour scheme chosen makes it hard to see, however if someone were to want it is a certain colour it could be designed that way. The user has set requests that became our team goals. These goals were reached through the design of this brace in such a way that will satisfy the user and their needs. Our device does not have any hazardous or dangerous components to it. In other words, it would be challenging to find a way to cause harm with it. This makes the device created the ideal device.

Benefits

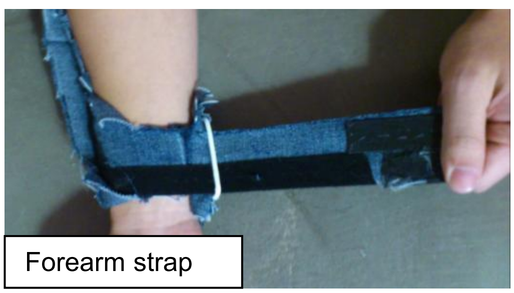
Our device is beneficial in comparison to existing devices because it is much more convenient when it comes to taking it on and off. It is truly a one handed device that is functional without the assistance of another fully abled person. Our device is one of the few products that address more than one problem to our user. It provides the greatest possible range of motion. The appearance of the device can also be easily altered, in reference to colour, upon the users request.

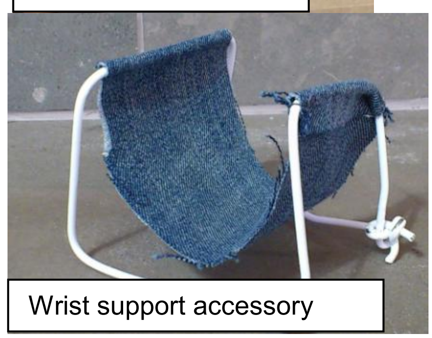
Static Progressive Elbow Forearm Orthosis

Physio-Tech Engineering
F09-T01-4


Front view of device


Back view of device


Forearm strap


Wrist support accessory

Problem Description

The problems that needed to be addressed were Mr. B.'s subluxed shoulder, adjustable pronation and supination for the forearm, adjustable angles of flexion and extension of the elbow, cost, ease of construction, availability of materials, and the matter of Mr. B. being incarcerated.

Design

The design is very lightweight and small, allowing transportation and storage of the device with ease. In the front and back view of the device you can see that it is completely fabric and can be folded. The forearm strap can be seen in the picture labeled forearm strap which shows how it is adjustable to fit different sizes of arms. The chest belt is adjustable to also fit people of different sizes and a custom chest belt can be made if the commercially available one is not appropriate. The wrist support accessory is simply something to help hold the angle of supination/pronation of the forearm by simply placing the forearm near the wrist into the accessory at the desired angle and the accessory will simply conform to the arm and hold it in the desired angle of supination/pronation.

Functionality

The Static Progressive Elbow-Forearm Orthosis can support the arm at different positions and fully allows flexion and extension of the arm by adjusting the length of the tension belt. Also it allows arm rotation at the wrist thus permitting supination and pronation movements. The device can support the wrist at different angles with wrist support. The shoulder will not bear any weight from the injured arm because of the chest band. The Static Progressive Elbow-Forearm Orthosis performs all the requirements the client requested.

Materials, Components, and Assembly

The materials our orthosis requires are denim (or a similarly strong fabric), a coat hanger (or store bought clothing loops), a back support belt and Velcro. These materials are common items and can all be easily found in stores or ordered online to be delivered directly to the Hand Clinic. Tools to create our orthosis include scissors, a sewing kit and wire cutters/pliers. To construct for the first time it may take several hours (no more than 5 hours) but as the manufacturer becomes more experienced, time of manufacturing should decrease. Construction time can also be reduced if the Hand Clinic has access to a sewing machine. Simple instructions may be needed if building the orthosis without the prototype as a guide but if the manufacturer has the prototype, it should be enough to create another one.

Cost

For the clinic there will be a capital investment of about $60 for all the materials, but the subsequent orthoses should cost around $50 or less each. The cost depends on whether the chest belt will be handmade or store bought. If the chest belt is handmade with a similar stretchy cloth such as nylon, the cost will go down by approximately $35 per orthosis, however it will increase time of manufacturing.

For the user, the orthosis could be at cost, in which case any cost from the clinic would be passed onto the client (about $25-$60). To cover any other costs the clinic can choose to increase the price.

User Acceptance and Compliance

User compliance has been considered by making the orthosis have customizable looks and making it as comfortable as possible. It was made with soft but materials with wide bands to reduce any potential sensitivity from pressure or irritation from friction between skin and fabric. In terms of customization, different fabrics and colours can be used to get different looks. Designs can also be made on the device itself using markers, fabric patches or even paint if the client desires those modifications, it can truly be the client's canvas as well as orthosis.

The user will get it on and off by sitting down on something and using the back of the seat to pin the chest belt and put it on. The rest of the orthosis should be able to be put on without much difficulty. To adjust the orthosis, they simply pull the tension band farther across their chest to lift their arm up.

PTE's device is incredibly safe and should be allowed into incarceration. It is mostly fabric with very minimal amounts of metal where rigid strength is needed, however if need be, that can also be replaced by strong plastic or even cloth.

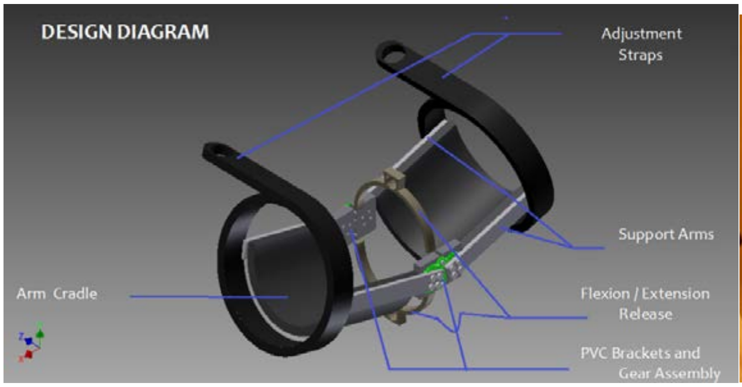
Objectives were met by designing and creating with the objectives at the forefront of the design team's mind. The design was created specifically so it would fulfill the objectives.

Benefits

What makes PTE's design better current designs is the lightweight, low cost simplicity that it brings. There is a wide range of devices that have already been designed for situations such as Mr. B.'s, however this device meets Mr. B.'s unique set of needs. Some of the devices do meet what the client needs, but may not meet what the client would prefer. Some designs put too much strain on Mr. B.'s subluxed shoulder, some were much too complicated to build by the hand clinic and some were simply too expensive to implement in these cases. These tests against our constraints and metrics and other similar ones lead PTE's design team to believe that this device is the best choice for Mr. B. and the Hand Clinic.

Elbow Orthosis

The BMO Firm
0 9 - T 0 1 - 5



Problem Description

The BMO firm would like to design an elbow orthosis for Mr. F who has previously had heterotrophic ossification. The proposed device should support the elbow, while not irritating his burned skin. Furthermore, it should promote mobility and a gradual recovery to a full range of motion. In consideration of the practicality component, the device should minimize the relative cost and manufacturing time, ensuring an easy and safe solution to the problem. The design must not only be reusable, but also adjustable for future patients. In particular to Mr. F's situation, ease of application should be the primary focus of the final product to promote portability and make use of our client's minimal finger dexterity. The materials used must be soft in texture and must not irritate the already damaged area of application.

Design

The design consists of a gear matrix supported by PVC brackets. With relative ease of use, the user needs to lift an elastic alleviating apposing gears and allowing for adjustments in the range of motion. The device consists of adjustable mechanisms allocated to the top and bottom of the device; one in the direction of the palm facing the floor, and the other one up in the direction of the back. The elastics have been carefully chosen in relation to Mr. F's minimal finger dexterity, and have been designed to promote his independence without asking others for help. The product weighs around 18 ounces, eliminating any distress or discomfort on the user's arm. While it is easily adjustable and compact, it can be conveniently folded for storage.

Functionality

This lightweight, low profile product provides the user with a range of motion control, which can be locked at any angle. The BMO Elbow Orthosis is an ideal solution to Mr. F's medical condition, as it rehabilitates the flexion and extension motion of his injured elbow. With its strap-wrap bicep and forearm cuffs, it provides a lightweight, soft solution to fastening the device onto the user's arm. These straps prevent the brace from migrating, maximizing the product's effectiveness. The BMO elbow orthosis, a static progressive splint, is universally adjustable and capable of fitting any user.

Materials, Components, and Assembly

The list of materials includes PVC, Elastic Bands, Steel, Plastic Spur Gears, Metal Hardware, Custom Strapping, Foam Padding and Velcro. They are obtainable at any hardware or hobby store. The product can be assembled in an ordinary fashion, assuming that the hand clinic pre-orders all components to custom specifications. To simplify the assembly, the hand clinic is advised to order pre-fabricated materials to ensure proper sizing and to eliminate the use of machinery. Having ordered the components, the assembly is rather simple and requires minimal experience. At first, the support arms are attached to the spur gears, using simple metal hardware. The pre-fabricated gear matrix is then connected to the support arms by the PVC brackets. To ensure ultimate comfort, foam padding is utilized on the support arms. Having assembled the main components of the device, the last step includes the attachment of Velcro straps. The Hand Clinic will receive a detailed set of technical guidelines and assembly instructions.

Cost

PVC	(3.50)	Elastic
Bands	(0.40)	
Steel	(4.00)	Plastic
Spur Gears	(4.40)	
Metal Hardware	(2.40)	
Custom Strapping	(0.60)	
Foam Padding	(0.40)	Velcro
	(0.80)	
Total Cost/Unit 16.50		

User Acceptance/ Compliance

The foam lining of the orhosis is soft and absorbent, creating a rigid yet comfortable fit to users of any skin condition. The BMO Elbow Orthosis is easy to apply and remove, maximizing the minimal capabilities of the user. All prior knowledge, pertaining to Mr. F's condition, have been considered and taken into account. The product is designed to promote the user's independence through an easy-to-use product. Since its discrete nature allows the user to wear it underneath any clothing item, the design supports a non-restrictive and user-friendly approach to the problem. The BMO firm has designed a product, which would be easy to admire aesthetically and be capable of all designated objectives. While the objectives are primarily envisioned for Mr. F's specific medical condition, the design team is determined to publicize the product to future patients, as it is seen to be beneficial to other medical cases. The safety component of the design was measured through a set of carefully chosen metrics, which assessed the product to be safe and applicable.

Benefits

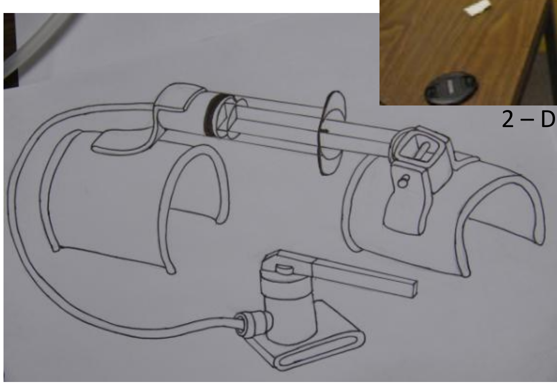
This unique design has many advantages, since the locking system is designed to achieve almost any possible angle in the flexion and extension motion of the elbow; it is capable of achieving almost a full 360 degrees. By simply lifting the top release strap to decrease the angle, or vice versa, by pulling the bottom release to increase the angle, its simplicity and easy adjustment mechanism is the ultimate benefit of the design. The entire process requires very little effort and can be completely done without the aid of another person. Additionally, the BMO elbow orthosis is compact and light in comparison to many commercial products. Since it is proven that even a moderately heavy product can cause strain on the arm and shoulder of the user, the associated weight of the product is a huge component of compliance. Many people are hesitant to wear medical devices in a public setting, and choose to remove the aid for that reason. As a result, this discrete, aesthetically pleasing product will increase user compliance, as it can be worn and adjusted beneath many types of clothing. Having carefully analyzed Mr. F's skin condition, the materials have been carefully chosen to reduce any possible skin irritation. In conclusion, the reusability and user-friendliness are the ultimate selling points of the BMO design.

Air Infinity

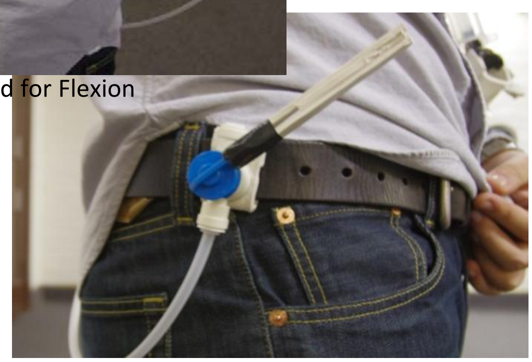
LIMBEDLESS™

Limbedless
F 09 – T07 - 1

2 – Device being used for Flexion



1 - Sketch of the Design



3 – The Angle Adjustment Valve

Problem Description

Tara Packham, an occupational therapist at Hamilton Health Sciences, came to our engineering team with a case of a patient, Mr. F. The patient's severe burns and heterotrophic ossification prevents him from leading a normal life. The excessive calcium buildup inhibits movement of the patient's arm. To recover his movement, the patient requires a device that can aid in redeveloping his full range of motion. Current devices are unacceptable because they do not fulfill the patient's health requirements, specifically, they are hard to put, difficult to adjust, and uncomfortable on the patient's sensitive skin. Tara Packham, on behalf of Mr. F, would like a device that can help Mr. F regain his range of motion, is easy to use, and produces a minimal number of negative health effects

Design

. The air infinity works through the use of a pressure sealed syringe system. As seen in the visuals, the syringe (which is free to rotate) connects the lower and upper arm cuffs. Tubing extends from the end of the syringe to a valve that attaches to the user's belt (see image). By opening the valve, the user is able to move their elbow to any desired angle and the syringe compress or extend along with the user's movement. By simply closing the valve, the syringe is sealed and the elbow position is locked. This easy to use mechanism allows the user to easily adjust the orthosis to any angle and securely lock the elbow in either flexion or extension. The design is both compact and lightweight, and weighs less than 300 grams.

Functionality

Functionally speaking, it can hold the elbow at various angles. It supports the upper and lower arm and is extremely simple to alter the degree. The user will also find it extremely easy to take on and off. The orthosis is able to be adjusted using nofine motor skills, so patients who have trouble handling small things with their fingers will still be able to easily control this elbow orthosis. It does not, however, address the client's request for pronation and supination, but the design time predicts that this can be easily implemented with more time.

Materials, Components, and Assembly

The Air Infinity is made from a variety of different materials. The upper and lower cuffs, as well as the rotation mechanisms are formed from thermoplastic. A 1-inch nail is attached to the syringe to allow rotation when the user moves their arm. A 60 cc syringe is used as a pneumatic system that seals the air. It also allows the adjustability to be performed hands free. The ¼ inch straight valve, attached through plastic tubing, is used as a shut off valve to allow air into and out of the pneumatic system. We used an aloe infused padded dish drying mat form around the user's arm and to act as a barrier between the arm and thermoplastic. The mat is attached by velcro and is easy to remove for washing. Velcro is used to help prevent unwanted motion by fastening the orthosis together and creating a tight, secure fit around the user's arm. All these materials are easily attainable from a department store, and the clinic has access to thermoplastic. Assembly of the device does not require any specialized equipment, and the client should have easy access to all the necessary tools. However, some special instructions may be needed in order to specify how to create the small components used in the design and to ensure overall accuracy of the final product. These instructions have been created by the Limbedless design team and are ready to distribute to the client. Total assembly time for the design will be around 2 hours.

Cost

In total the cost to the user and clinic will be $32.00.

User Acceptance and Compliance

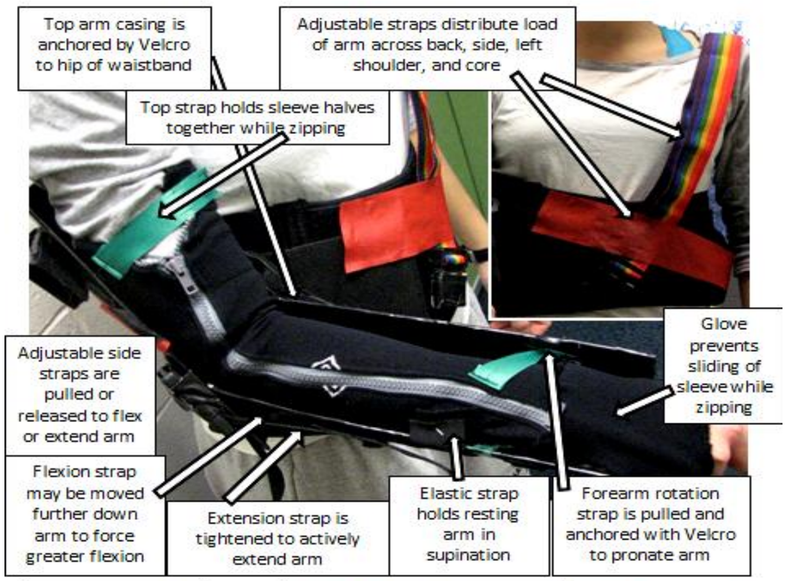
User compliance of the device is encouraged through simplicity. Every detail ranging from placing the device on the arm to adjusting the angle was designed with the user in mind. The soft, non-abrasive material inside the cuffs can be easily removed, allowing them to be cleaned. In addition, the cuffs are securely attached to the arm so they undergo virtually no movement. The cuffs attachments also feature soft handles which allow the user to attach and remove the Velcro (c) without the need for any fine motor skills. Special consideration was also placed on the adjustment mechanism. It attaches to the belt next to the users right arm. A simple movement closes or locks the valve and secures the orthotic into the desired angle. All these considerations result in an orthotic device that promotes user compliance by virtue of the fact that it is comfortable, intuitive and effective. The objectives were all surpassed in the final design.

Benefits

The *Air Infinity* allows the user, Mr. F to easily adjust the angle of flexion and extension without the use of fine motor control movements from his hands. By eliminating the pin and lock hinge angle adjustment and replacing it with a pneumatic system using a syringe and a valve, Mr. F is now able to comfortably and safely adjust his arm into different angles without further injuring his hands. In addition, the aloe infused material protects Mr. F's fragile skin. Other beneficial features include easy fastening straps allowing for simple application and removal, portable, lightweight, water resistant, safe, can wear with everyday clothing, non-abrasive and sturdy arm cuffs, and lastly it meets Mr. F's requirement for independence.

Aspire Dynamic Elbow Orthisis

Zero G
F 09 - T 07 -2



Problem Description

After sustaining a subluxed shoulder, extensive nerve damage, and a compound wrist fracture, Mr. B was left unable to use his right arm, elbow, shoulder, or wrist. He has since regained functionality of his hand and wrist; however, he lacks the arm function to enable him to position his hand and wrist for use. The Hamilton General Hospital Hand Clinic has asked Zero G to create a device that may be built in the Clinic workshop that may allow Mr. B to change and lock is arm in different degrees of flexion, extension, and forearm rotation. In addition, the device should reduce the load of his arm on his subluxed shoulder and allow him to complete range of motion activities. Finally, the final device should be customizable for use within general population of a prison.

Design

The Aspire features two solid casts that will separately cover the posterior face of the upper arm, from armpit to elbow, and the posterior face of the forearm from elbow to wrist. The arm compression sleeve covers the length of the arm from armpit to wrist, and the upper arm portion is attached by Velcro to the inside of the upper arm casing. The shoulder straps, seen above crossing from the left shoulder, will span from the top of the upper arm casing across the back, either under or over the left shoulder, and to the front. An elastic belt will be wrapped around the waist to anchor the straps. The arm portion of the device, excluding shoulder straps and waist band, will weigh approximately 320g, while the entire device will weigh approximately 600g.

Functionality

By pulling or releasing the adjustable flexion straps, seen in the image at either side of the elbow, the arm may be actively flexed, or passively extended. An elastic strap attaching the lateral side of the arm sleeve to the lateral forearm casing face places the resting arm in supination, while a forearm rotation strap, shown in the diagram attached to the medial side of the arm sleeve, may be pulled to force pronation, then locked in place by Velcro. To force a greater degree of active assisted extension, the fully tightened flexion strap may be attached by Velcro further to the distal end of the forearm casing. To force active assisted extension, the extension strap, seen in the above image attaching the posterior faces of the upper and lower arm casings, may be tightened. This incrementally increases the angle between the upper and lower arm, thereby forcing extension. To reduce the load of the arm on the shoulder, one adjustable strap runs from the posterior face of the upper arm casing, runs across the back, over the left shoulder, and is anchored at the front of the waist band. A second strap originates at the same location, runs under the left arm, rather than over the shoulder, and attaches at the front of the waist band. Finally, pieces of Velcro attach the medial side of the upper arm cast to the lateral side of the waist band. These features spread the load of the arm away from the shoulder, and over the hip, back, left shoulder, and core of the user.

Materials, Components, and Assembly

The Aspire requires medium-density thermoplastic, and rivets, which are obtainable from the Hand Clinic's supplier. Additionally, thin and thick adjustable straps, thin and thick non-adjustable straps, Velcro tape, and an elastic back support belt, which may be purchased from a hardware store, are required. Finally, the required arm compression sleeve and zipper may be purchased from a fabric supply store. To construct the Aspire, a sewing machine, rivet gun, and knife or scissors are required. Special instructions are required to specify the exact placement of Velcro pieces, rivets, and slits cut in the thermoplastic casing. Assembly of the device may be divided into assembly prior to the patient meeting, which is approximated to take 1 hour, and assembly during the patient meeting, which is approximated to take 20 minutes.

Cost

The estimated cost of all materials is $78; however, all straps, the arm sleeve, and the waist band may be washed and reused for multiple clients; thereby reducing patient cost to $40, including a $7 rental fee for reusable parts.

User Acceptance and Compliance

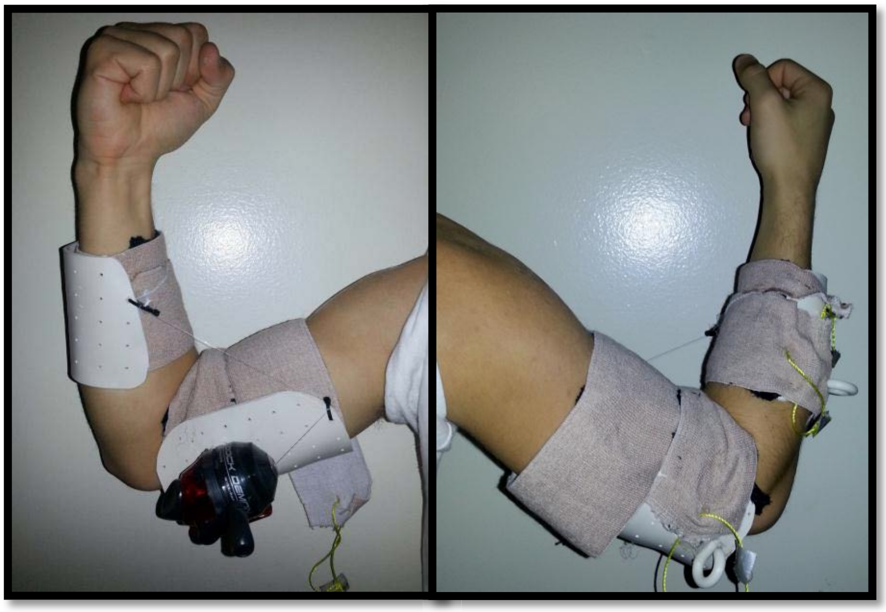
The Aspire is easily put on with one hand due to a zippered arm sleeve with a top strap, that can be fastened to hold the straps together as they are zipped, and a fingerless glove that provides a counterforce against the upwards zipping force. The shoulder strap is pre-anchored at full length to the waist band, such that it may be slipped over the left shoulder with one hand, then adjusted to proper tension. The Aspire may be worn over a variety of clothing due to the elastic nature of the compression sleeve. Many components of the Aspire are customizable to meet the individual colour preferences of each user, and the design is fairly tight to the body, ensuring that its appearance is inoffensive.
The Aspire does not pose a threat of furthering the injury to Mr. B's subluxed shoulder, as it is extremely lightweight, due to the composition of fabric and thermoplastic components, and is well-supported due to the three support features used. The device is also very easy to adjust, as it operates on the simple pull and release of adjustable straps. The Aspire may be used outdoors, as it is durable and features no easily breakable parts, or parts that may be damaged by water. Finally, if long straps are removed, and the device is supported only by the direct arm to hip support, the Aspire would be allowable within prison general population.

Benefits

The Aspire is the best choice of device for use by Mr. B. It meets all functional requirements fully, and is incredibly user-friendly, with simple methods for adjustment, and components designed specifically to be put on with one hand. The Aspire could also be implemented seamlessly by the Hand Clinic, due to its low cost and quick assembly, much of which may be done in advance of a patient visit, easily-attainable materials, and use only of tools available in the workshop.

Reel Comfy Elbow Orthosis

Logical Engineering Designers
F 0 9- T 0 7 - 3



Problem Description

The patient we are designing the "Reel Comfy Elbow Orthosis" for is Mr. F. He is a 29 year old male who was a victim in a house fire. He suffers from poor skin quality, limited hand dexterity, and weakened muscles. The staff at Hamilton General Hospital has asked the team to design an orthosis that would help stretch and mobilize his arms with minimal effort required while causing minimal irritation to his skin. Our design recognizes every part of the problem with the use of our materials, ideas, and assembly.

Design

Our design for the elbow orthosis involves mainly two moulded cuffs for the upper and lower arm, a reel wound with high strength string, and straps that are elastic bandages lined with micro fibre plush providing for a very comfortable experience for the user. The orthosis is relatively light, weighing in at an approximate 3 pounds. It also takes up only half of the bicep area and a third of the forearm leaving many areas for the skin to breathe. The user should also be able to support the orthosis for long periods of time no matter what their sustained injuries are.

Functionality

The main functionality of our orthosis is to provide both flexion and extension for the arm. Also, it provides protection against bacteria and debris from the air and surfaces while keeping the arm in a stable position to stretch the muscles.

Materials, Components, and Assembly

The “Reel Comfy Elbow Orthosis” consists of two thermoplastic moulds for the upper and lower arm components. These were moulded using hot water and the arm of one of our group members. The upper arm has a reel attached on the left side of the bicep and is lined with elastic bandages and a micro fibre plush. The upper reel and micro fibre plush was hot glued, and the elastic bandages were attached using Velcro. Each elastic bandage is used as a strap and has string hoops at the end of each, allowing for a simple tightening method. Along the lower right bicep of the upper arm mould and the upper right side of the forearm mould rests a plastic hook for the string to be fed through. The string is also fed through zip ties that are located at the top of the bicep mould and the bottom of the forearm mould. The string is permanently attached to the bottom zip tie and moves fluidly through the top zip tie. The time of assembly took the team approximately two hours and all materials could be purchased at either the local hardware store or drug store. The only special requirement is to buy a string for the reel that is of appropriate tension to support an arm that is of the client’s personal weight.

Cost

All the materials that were used for the creation of our orthosis amounted to approximately 50 dollars. We used about 20 dollars of thermoplastic, the reel was 10 dollars and the rest of miscellaneous items were three to five dollars each.

User Acceptance and Compliance

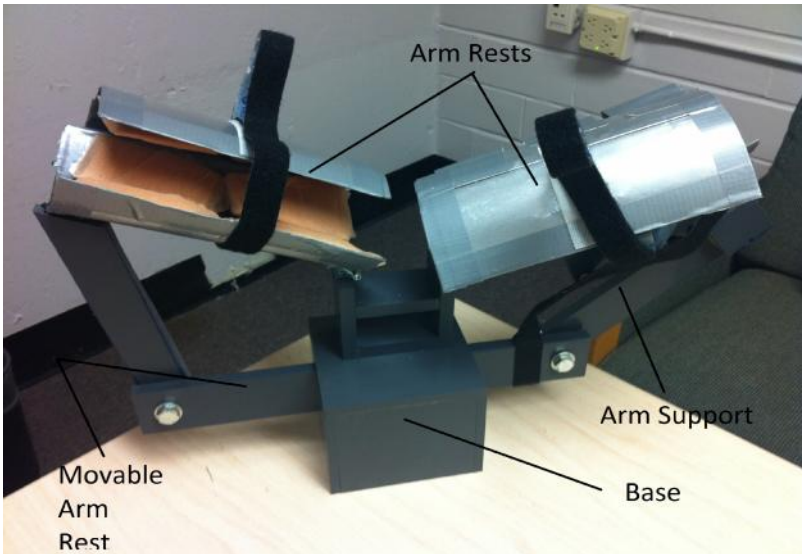
Our design team has taken all of our user’s needs into consideration. Mr. F should be able to put the orthosis on simply by placing it onto a table and dropping his forearm or upper arm into the mould depending on which he would like to put on first. We have left enough space for his arm to drop into that mould without touching any of the thermoplastic. And the edges are lined with a soft microfiber plush in the case that he does touch the edge. Therefore this should minimize the occurrence of any blisters or bruising. The straps are also lined with this micro fibre plush and have hoops made out of string attached to the ends so that tightening could involve as little dexterity as possible. All Mr. F has to do is slip his hand or a couple of fingers through the hoop and pull to a preferable tightness. The reel also has a string hoop so that he does not have to use his fingers to turn the handle. Instead he can slip his hand through and rotate it in a circular motion. In order for Mr. F to perform flexion, all he has to do is leave the orthosis as is, push the button located at the bottom of the reel, and rotate the handle. The reel locks automatically so that when he reaches the preferred adjustment he just has to stop rotating. In order to perform extension, he just has to move the string under the moulds and place it into the hooks located on the right under side of the upper and lower arm cuffs. The natural position of the orthosis places the reel in a position that is unseen from the front, so that all that will be seen on Mr. F is the thermoplastic. Our design can also fit comfortably over clothes and is very easy to be cleaned because the elastic bandages are only attached using Velcro so they can simply be removed and replaced on an appropriate basis.

Benefits

Our design has a multitude of benefits which makes its better than any typical orthosis on the market. Our orthosis is relatively cheap, costing about 50 dollars. Additionally, the material used in making it, mainly the micro plush, provides a soft surface that is sensitive enough for his burned skin. With a minimal amount of material used, the orthosis is light in weight, approximately 3 pounds, which doesn’t cause a lot of strain to on the user’s arm. Furthermore, our orthosis is very simple and easy to put on and take off. With the help from the reel, it provides both flexion and extension, which will help rehabilitate his muscles over time.

FX2-Orthosis

MAVZ Engineering
F09 - T07 - 4



Problem Description

The problem presented to the MAVZ teams originates from the Hamilton general Hospital, in specific regard to Mr.F, a burn victim. Mr.F suffered second and third degree burns across 20% of his body area in an accidental home fire. In addition to the burns, he was also left with heterotopic ossification. Through the long recovery time needed for the above conditions, Mr.F's muscle deteriorated and atrophied. A device had to be utilized to allow compression and flexing of the arm in order to regain flexibility for Mr.F. While designing the device, it was important to note that Mr.F had extensive damage done to his skin and found many surfaces to be irritating. In addition, prolonged contact with a surface could lead to bacterial infection which was also a concern. Furthermore, Mr.F has expressed that he would like to be able to use the device designed without any assistance. The Hamilton General Hospital has also expressed their wishes to be able to construct it in their own workshop and, optimally, having it operational for uses in situations similar to that of Mr.F.

Design

The design of this device consists of several smaller assemblies put into one functional device, the first of which is the support box; it is the base that supports the rest of the device. Secondly, there are the two arm supports, one of which is completely stationary while the other one is movable. Third, there are two armrests, they are the half-pipe objects seen in the image and they are meant to hold the arm. One armrest is attached to the base by a hinge, in conjunction with the movable arm support. This allows the user to both flex and compress his muscles. In regards to the size of this device, the lower box will measure 3 inches for all dimensions, the armrests extends 4.5 inches while the arm support is 2.5 inches. In comparison to the arm, the device's maximum length measures at about 75% of the length while the height is a stationary 3.5 inches from the box and support in addition to 75% the length of the forearm.

Functionality

In terms of using the device, the primary function of being to compress and flex the arm is fully met. The device is able to be easily oriented into a desired position which will provide 30 degrees of compression or 150 degrees of flexion. Furthermore, the device has been tested to have easy single handed operation, with no additional assistance. The sanitary problem has also been fully addressed, this was done with padding that is completely removable and easy to construct. This allows the padding to be rinsed or easily replaced. In addressing the needs of the hospital, the device is not material intensive and can be built with relative ease with the necessary materials and instructions.

Materials, Components, and Assembly

The device has been fully assembled by group members in the MAVZ team. The materials used consist of one sheet of polyvinyl chloride (PVC), a PVC pipe, a hinge, PVC glue and a strap of Velcro. The only tool used in the construction was a saw and scissors that were respectively used to cut the PVC plastics and Velcro. The materials used can be easily obtained in a department store. PVC pipe and glue can be acquired at most hardware shops, while PVC sheets are available from the professional plastics online shop. The hinge and Velcro was obtained from a department store (Wal-Mart). The hinge was very similar to a door hinge which can be easily obtained. In construction, the aforementioned smaller assemblies were made singularly and they were eventually pieced together to obtain the full device. The addition of all construction times arrived at 3 hours. The box and arm supports can be made without specific tailoring and, later, when the customer requires, the length of the arm rest can be determine the made. If the entire box and arm support was already made, the assembly of the arm rest will only take an estimated 25 minutes.

Cost

The cost of the materials, as mentioned above ranges from $23-27, including 3 hours of labour, the cost to the clinic would not be significant and should not surpass 70 in labour if included. If the clinic were to sell on par to the cost, it would not cost the user more than $70 as well. In comparison to current alternatives, it is significantly less expensive, in the group’s research; it was found that common alternatives cost, on average, $200.

User Acceptance and Compliance

The use of this device, in itself, is very comfortable in it self, furthermore, the device can be designed to the user’s likings. Due to the material used, the device can be made in different colors, written upon or decorated in other means. The device is made with rounded and full edges this means that the user will have one less problem in operation.

Benefits

The device designed provides significant benefits over the current available alternatives. Firstly, the device is provides support and stabilization directly from an inanimate object, where many devices focus on portability and lose the fact that both support and stability is essential. Secondly, the device is meant to wrap around all parts of the arm, usable with or without sleeves. The large contact areas relieve pressure from pinpointed parts and alleviate much of stress, making use very comfortable. Lastly, due to the comfort of the padding, there is little that can irritate the burns on Mr.F’s arm. These are three of many factors that present this design as an improved alternative to many current designs.

The OrthoGenius Brace

Team Name
F 10 - T 02 – 6

Problem Description

Tara Packham, an Occupational Therapist at the Hamilton Hand Clinic at Hamilton General Hospital, has a patient, Mr. B, involved in a motorcycle accident that resulted in a compound fracture and degloving of his right wrist, and a brachial plexus injury on the same side. His shoulder is already subluxed from the weight of his arm. This patient's finger and wrist muscles are functional but his shoulder injury restricts his movement. The patient is right-hand dominant and is unable to perform basic household tasks such as turning a doorknob. The client, Mrs. Packham, desires a device that is easy to use, inexpensive and comfortable.

Design

With respect to an average male arm, the OrthoGenius Brace will cover the area underneath the shoulder to the base of the hand. This will cover about 50% of the surface area of the arm and have four main arm straps, each about 1 cm in thickness. The straps will be located on the wrist, just below and above the elbow, and one just under the shoulder. When the device is encouraging flexion of the arm, there is a cord running from the top strap near the shoulder to the bottom strap on the wrist. When the device is encouraging extension of the arm, there is a cord running from the wrist strap to the strap located just beneath the elbow. Velcro strips will be located on the shirt covering the right lateral torso. Due to the light material, the OrthoGenius Brace weighs less than half a pound.

Functionality

Functionally speaking, the OrthoGenius Brace can perform each of the functions that our client Tara Packham had requested. These functions include: Locking the elbow in a flexed position, locking the elbow in an extended position, allowing full range of motion in the arm, allowing the user the ability to perform supination and pronation and providing support for the users injured shoulder.

Materials, Components, and Assembly

The materials required for the OrthoGenius Brace consist of four Velcro strips, four Velcro straps, black thread, eight plastic hooks, two plastic rectangles, four pieces of pipe insulation, five sleeves of fabric, one bungee cord and a light shirt for support. All the materials listed can be obtained at a local Canadian Tire store. In order to construct the OrthoGenius Brace, basic tools such as a sewing machine, thread, a needle, scissors and fabric are needed. The time needed to construct the OrthoGenius Brace with a sewing machine is no longer than one hour. In contrast, using a thread and needle would increase the time needed to make the OrthoGenius Brace by a couple of hours. Although the design is uncomplicated and easy to make based off of a provided picture, a set of instructions on how to sew the Velcro to the fabric and hooks may be needed. Also, instructions on where the hooks should be placed may be included in the assembly, which consists of a hook at the top of the highest arm strap below the shoulder, a hook on the top of the two straps above and below the elbow, and three hooks on the strap around the wrist which are located at the top, left side and bottom of the strap. Instructions on where to position the Velcro strips on the shirt may be needed as well.

Cost

The cost of the design for the clinic has come to an approximated price of $45. This price will decrease if the clinic buys Velcro strips in bulk.

User Acceptance and Compliance

Each of the four cuffs of the OrthoGenius Brace has a Velcro strap attached to it. To put it on, the user must first put these parts on the appropriate positions of the arm: two on the upper arm and two on the forearm. Likewise, to tighten the OrthoGenius Brace the user may simply adjust the Velcro strap surrounding the cuffs. To get it off, the user can simply loosen the Velcro and pull off each cuff. All four of the cuffs contain foam between velcro belts and the user's arm. The foam can evenly distribute forces from hooks and Velcro straps to the user's arm, thus avoiding pain due to excessive force. In addition, softness of foam also provides a comfortable experience for the user. To assist arm movements, the user can put an elastic band on the hooks corresponding to the type of movement desired. The OrthoGenius Brace has a simple appearance, and the covering fabric is customizable to the preference of the user. The design mainly consists of flexible components and has no sharp edges that may hurt the user. The rigid components are small in size and have round edges. Overall, the design has a lower probability to injure users than common orthoses with large, solid structures.

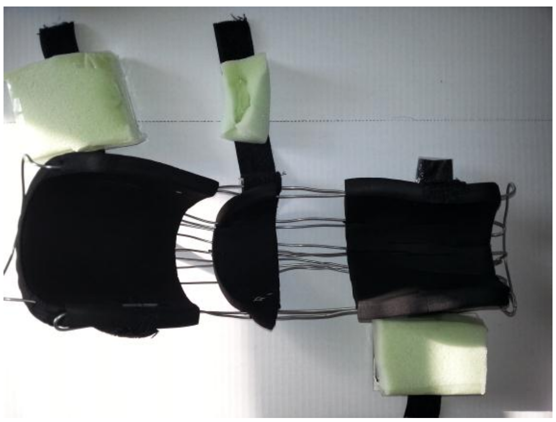
Benefits

Despite the various elbow orthoses in existence, none of them can perform the functions that Mr. B is in need of. The OrthoGenius Brace is cheaper than existing, mass-produced, orthoses. The OrthoGenius Brace reduces the load on the shoulder better than existing orthoses because it is constructed out of light materials and attaches to a shirt to reduce load. Finally, the OrthoGenius Brace can be easily constructed at the Hamilton Hand Clinic with locally found materials.

Dynamic Elbow Orthosis

Trust us we're *S.A.N.E.*

S.A.N.E.
F10 – T02 - 7



Problem Description

Due to Mr. F's current medical condition, Tara Packham, our client, and the hand clinic requested an orthosis that is comfortable, and sensitive to his skin burns to avoid irritation and infection of his left arm. In addition to this, the heterotopic ossification in his elbow requires that the orthosis is rigid around the hinge on the elbow so that enough support is provided to maintain the position of his arm. Mr. F personally requested an orthosis that allows him to independently complete daily tasks. For this to be achieved, the angle mechanism must be easily adjustable and locked so that a variety of positions can be sustained to complete a variety of tasks.

Design

The completed prototype will consist of three arm supports; one located at the top of the bicep, one at the elbow, and one near the wrist. Each support, which lies under the arm, will be accompanied by a strap that will wrap over both sides of the support to secure the arm in place. Malleable steel rods penetrate each arm support along the underneath the arms designated resting place. Upon completion, the prototype will weigh approximately one pound (slightly under). The design itself is very sleek. It does not consist of many material components; it merely just spans a large portion of the users arm for additional support.

Functionality

The orthosis allows Mr. F to change and maintain a variety of angles independently. The design, though large relative to his arm, encompasses a very small portion of the surface area of his arm. The material used in the prototype is also sensitive to his skin condition, which means the major functions that the client and user requested were accounted for in the design.

Materials, Components, and Assembly

The required materials to produce the prototype are: 2 foam kneepads, 8-12 steel twist ties (depending on weight of arm), and three clasp straps. All of the above materials can be obtained in a variety of stores such as Dollar-Rama or Walmart. The only tools required to construct the prototype is a pair of scissors. For convenience a heat source could be used to allow the rods to cut through the foam easier. The approximate construction time of the design is one hour.

Instructions: Cut the curved end of the kneepads (one of the removed parts is used to make the elbow piece). Heat the ends of the rods. With the tips heated and the pads flipped open end up, pierce through the middle of each of the kneepads and fold the tips of the rod under the pads to secure them. Once the all of the required rods are in place, cut holes on the left and right side of each of the foam pieces to provide a space for each strap. With the straps through their respective holes, the design is then completed.

Cost

The total cost of materials required to complete the prototype is approximately $10. No special tools aside from scissors are required to assemble to design. This means that the total cost of construction is very low. Considering the time of construction is only one hour, the total cost including construction will be no more than $15

User Acceptance and Compliance

Mr. F's condition does not allow him to extend or extract his elbow, so the elbow orthosis that we design and prototyped tries to help him move his elbow comfortably. Putting it on and taking it off is fairly easy considering he can only use one hand which is still not 100% working, there are 3 straps which hold his arm in place. Our primary focus was to help him bend his arm and keeping the orthosis user friendly but we have made the orthosis with foam padding which provides some comfort. The user can change the angle by basically exerting force on the forearm part of the orthosis, considering the material it is made of angle changing is easy. Since the device is light and completes the required functions, it allows him to do his daily tasks, therefore it is likely the user will want to wear it. The steel rods are pierced through the pads which makes the orthosis look sleek. Overall the device meets the main objectives that we found most important considering the constraints <>. There are no sharp ends and the main components of the device are pads so his skin is safe.

Benefits

Our device is most likely the cheapest way to meet the required objectives of the user. Also our device is specifically made for Mr. F, he can easily put it on and take it off, and the device easily helps him change the angle of his elbow.

Dynamic Elbow Orthosis

Intrepid Biomedical Innovation
F 1 0 - T 0 2 - 8

Problem Description

Vehicle accidents can cause severe injury, some life threatening and /or permanent, fortunately, some injuries can be rehabilitated. We at Intrepid Biomedical Innovation have been asked by our client (Tara Packham and Occupational Therapist from the Hamilton Hand Clinic) to design an elbow orthosis for her client, Mr.B.

Mr.B is a 23 year old single male that was in a motorcycle accident, he has a compound fracture and degloving of nerves in his right wrist. During the accident he also managed to severely damage his brachial plexus and partially dislocate his shoulder meaning any weight on his arm would probably cause further damage.

The objectives for this orthosis is to create a design that allows for an adjustable range of motion in the flection/extension of the elbow, provide support for the elbow and avoid putting strain on the shoulder, and to make something that is user friendly and simple.

Design

The orthosis has been designed in a way such that it allows for the arm to breathe, is comfortable, and performs most of the desired functions. The orthosis body is made of thermoplastic that only covers the tricep and underside of the forearm. To keep the arm in place are three Velcro straps (with a smooth nylon surface), one over the forearm and two going over the bicep. Instead of the typical hinge, this orthosis has metals rods on either side of the elbow that can very easily be changed in length through the use of a pin. This allows the user to adjust the angle at which their elbow is fixed. What makes this orthosis unique is the other piece.

The other piece of the orthosis is a “U-Shaped Cup” that the elbow splint rests in while the user is wearing it. The cup is attached to the belt (possibly more than one belt for more stability) but is also removable if the user prefers to let their arm hang. The purpose this cup serves is eliminating the strain on the shoulder due to the weight of the users arm. Since the majority of the splint and the cup are made of thermoplastic, it is quite light—causing very minimal (if any) strain anywhere on the body.

Functionality

Our design is able to accomplish many if not all of the needs of the client/user. It serves its main purpose as a device which makes it easier to live with the problems the user suffers from. First off, by use of the belt and the support device attached, the stress the shoulder of the client has to endure is either limited or removed entirely. Furthermore, the Velcro straps and cushioning insure that the arm is secured and locked in place, unable to move on its own and cause unneeded stress. The most intricate and useful section of our design is the locking hinge mechanism. The hinge is located at the elbow and allows the user to lock the forearm at different angles in respect to the upper arm. There are a variety of angles, much of which are useful for several everyday activities such as typing. The hinge also, allows a small range of motion meaning it is not completely locked as not to be in an unnatural position but can still be moved to some degree. Our design accomplishes almost of the desired functions of the client with the ability to take weight off of the shoulder using a belt and locking the forearm and arm in different angles when required.

Materials, Components, and Assembly

When we designed our elbow orthosis, we tried to limit the complexity of our design to help the user to assemble and dissemble the device. This led us to our design consisting of two main parts. One part being the belt that will ultimately provide the user’s arm with support and then the second part being the actual arm brace. The belt is a very simple design, very similar to a normal belt but with a piece of firm padding on the side of the injury. In our prototype we used a hip pad that football players’ use but there are many alternate materials. For the brace we simply had a cuff around the top part of the user’s forearm and a cuff around his bicep. The cuffs are made out of thermal plastic, very makeable for the clinic. The two cuffs are attached by a metal bracket, allowing the position of the arm to lock into three beneficiary positions for the everyday life. The bracket can be simply purchased at the local hardware store along with the nuts and bolts to assemble the brackets for a low cost. The straps that hold the arm securely are just a comfortable material with velcro attached onto it. Our prototype took our team roughly an hour to construct and assemble, which could be cut down over time and becoming more familiar with the design. The only tools needed are a drill, drill bits, glue and something to cut and heat up the thermo plastic. The steps to creating our orthosis are very simple and would not need any special instructions. From looking at our prototype, you could re-create the design with little instructions.

Cost

Our device could be constructed for the low cost of fifty dollars. The piece of padding is very low costing and could be made to attach onto the user’s belt. The material that brings up the cost is the thermoplastic. Thermoplastic works great with our design because it is lightweight and comfortable for the user. The amount of thermoplastic is small and would cost around thirty dollars. All of the hardware, straps, side protection/support and velcro would not cost more than twenty dollars. This is an estimate considering many of the materials could be found from old devices or recycled parts.

User Acceptance and Compliance

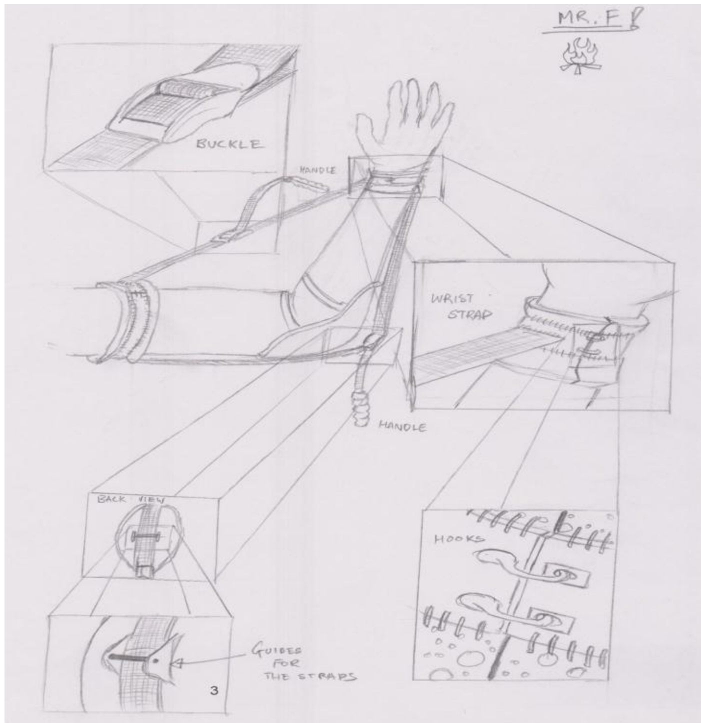
Acceptance and compliance by the user was taken into consideration during the design process of this product. It was very important to incorporate user acceptance as the elbow product was likely to be used for long periods of each day and for multiple months. This dynamic elbow orthosis' design has been specifically created to be easy for users to use. The first user-friendly feature is the adjustable straps used in the design to make the product easy to put on and remove. This can be accomplished easily with only one hand. The final product will be easy to manipulate. The part that wraps around the waist in the design is detachable from the elbow attachment. This allows for easy use of the products in multiple environments, the waist attachment used for simple support of the shoulder and the elbow hinge used for elbow support. The comfort of the product has been refined by the use of padding on the adjustable straps and smooth thermoplastic form-fitted to each user. No part of the arm comes in contact with a surface that could cause a rash or chafing to occur. For added comfort, an arm sleeve can be worn underneath the product. The aesthetics have also been taken to account since they will affect whether or not the user will want to wear the product. The thermo plastic has a sleek look to it and comes in a variety of colours, while the low number of parts makes it look simple rather than complicated. This also adds to the safety of the design by limiting the chance of parts malfunctioning. The comfort of all the parts are actually side effects of safety measures made on the design. The overall weight of the design is made to ensure that an elbow injury cannot be sustained from a malfunction. This safety feature is due to the lightness of the elbow splint so it cannot cause "wear and tear" on the shoulder or elbow, in cases of failure. All rough edges are filed down to make sure the user does not get injured or injure any other person. The design team's objectives were met by designing a product that is simple, functional, provides good support and is lightweight. These were achieved by a simple deign made up of light, strong parts and extra support was provided by the waist attachment.

Benefits

The industry for this type of treatment is competitive with almost all products being identical to each other in most aspects. Our device is different as we essentially took several different designs and incorporated their most useful components to form our design. One of the main issues with most products is the fact that they are either extremely light and don't work as well as they should or they work extremely well but are too heavy and will most likely cause the user unneeded pain and discomfort. Our design combats this by finding a middle ground by using lighter components in place of heavier ones wherever we could, for example the Velcro provides an essentially weightless method of attaching the device to the users arm. Furthermore, one of the main things that set our design apart from all the others is the fact that our design incorporates a adjustable locking mechanism. Most devices have a locking mechanism but it only locks in one angle, our design allows for several predetermined angles which make daily tasks easier to accomplish. Lastly, the belt and its attachment take off almost all the weight off of the shoulder when the user is not using the arm. This means that the device can be worn for longer periods of time and provides relief to the shoulder. Once again this is another mechanism lacking in most devices.

Dynamic Elbow Orthosis

Orthotix Engineering Ltd.
F 10 - T 06 - 1



Problem Description

The problem presented to the team involves Mr. F, an individual who was recently severely injured in a house fire. He suffered significant burns to 20% of his body surface area and is currently suffering from heterotrophic ossification of the left elbow. This significantly reduced range of motion in Mr. F's left arm. Surgery was performed and Mr. F was given a hinged elbow splint to attempt to restore range of motion. Due to Mr. F's burns, he has limited functionality in both of his hands. This causes the angle mechanism to be difficult to adjust and the Velcro straps challenging to fasten. The straps on the splint also cause blisters which pose a risk of infection due to his poor skin quality. The team has been tasked with designing a functionally equivalent device to replace the hinged elbow splint by the Hamilton Hospital Hand Clinic. The device should be easy to adjust, making Mr. F more independent. It should be as comfortable as possible to reduce the chance of infection from blistering. Overall, the device will assist Mr. F in restoring the range of motion in his left elbow, enabling him to eventually regain full use of his arm.

Design

While designing the elbow orthosis, careful attention was paid to fulfilling the client's requests. Due to the users condition it was crucial that the orthosis be adjustable. As the team was uncertain of Mr. F's true arm length and width, the orthosis was modelled with the average male's physique in mind. Comfort was paramount as the user suffered major injuries to his left arm and so the orthosis' surfaces are smooth. The upper arm straps can be adjusted from a diameter of 4" to 5.5" and the strap has a width of 4.5". The wrist strap can be adjusted between diameters of 3" to one of 5" and has a width of 4". The entire orthosis without being stretched runs a length of 20.5" and can be easily shortened to an ideal length. The orthosis is designed to be secured around the arm at three locations. The buckles located proximal to the shoulder and wrist straps allow for the orthosis to be set in a flexion or extension position while the elbow strap holds the orthosis in place and prevents the straps from rubbing against any exposed skin.

Functionality

The device is a fully functional elbow orthosis capable of adjustable flexion and extension. The functionality is implemented within the constraints of minimal skin surface area contact and comfortable materials. The objective of being easily adjustable was met through the use of backpack style straps and a ring grip mechanism, enabling the client to set the orthosis to the desired position without any external assistance.

Materials, Components, and Assembly

This project requires a variety of materials. The padding on the arm was cut out of a yoga mat. The material holding the padding down is a simple strap. The strap is sown onto the padding. The two ends of the strap are connected by a backpack clip. The clips are slid into each other, and then the strap is tightened to supply sufficient pressure to the arm. There are two of these arm bands, one on the forearm and one on the upper bicep. Two backpack straps are attached to each armband, one on the top of the armband, and one on the bottom. These backpack straps are connected by two buckles which are used to tighten the backpack strap. When the free end of the backpack strap is pulled, it forces the arm into extension or flexion. The one strap runs under the elbow, and risks skin being pulled off. To protect against this, a rollerblade elbow pad is placed on the elbow. This keeps the strap in the proper position and keeps the skin safe. Most of these materials can be purchased at the local fabric store. The elbow pad needs to be purchased at a sport store. Only three main tools were needed to construct this orthotic: a lighter, scissors and a sewing machine. After the strap was cut with the scissors, the lighter melted the ends to keep the strap together. The sewing machine was used to sew the strapping to the yoga pad. The construction of this orthotic will take about an hour, as long as the constructor is skilled with a sewing machine.

Cost

Material	Price	Qty.	Final Price
Yoga Mat	$4.00	1	$4.00
Arm Strap	$0.98	2	$1.96
Backpack Clip	$3.75	2	$7.50
Backpack Strap	$0.63	4	$2.52
Buckles	$1.80	2	$3.60
Elbow Pad	$6.75	1	$6.75
		Total Price:	$26.33

User Acceptance and Compliance

The user would prefer our design as it meets all of his requirements. The design permits him to put on the orthosis independently due to its buckle mechanism. The design is relatively appealing cosmetically and does not possess any of the big steel hinges that are so common in commercially available splints. The design is extremely comfortable to wear since it is both light weight and padded. By trying to keep costs at minimum, the resulting design was cheap to construct and thus the user can possess multiple copies of the orthosis if necessary. The addition of an elbow pad helps to prevent the straps from rubbing against the user's skin and so also adds to the users comfort and safety. The adjusting mechanism is easy to understand and use with none of the complexities of hinges or dials.

Benefits

The designers were extremely careful with the type of materials used in their design. Minimizing the surface area of the orthosis was a major objective as the user suffers from blisters. Three foam straps was the solution suggested to solve both these problems. Likewise the users request to be able to put on his splint independently was easily satisfied with buckles that "click" into place. All commercial splints tend to either have hard plastic or metal components that weigh down the arm and over time grow relatively uncomfortable but the use of lightweight yet strong material allowed for the orthosis to meet all its functions. The wide range of available length and width adjustments for the orthosis permits the user to wear the orthosis even with severe swelling and thick clothing.

Light Weight Elbow Orthotic

MEOO
F10 - T06 - 2

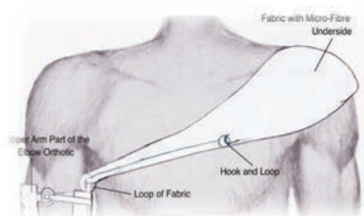


Figure i: Shoulder Accessory

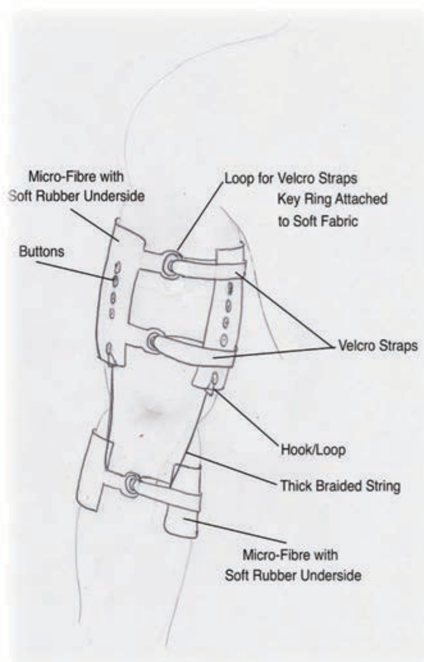


Figure ii: Top view sketch of the device

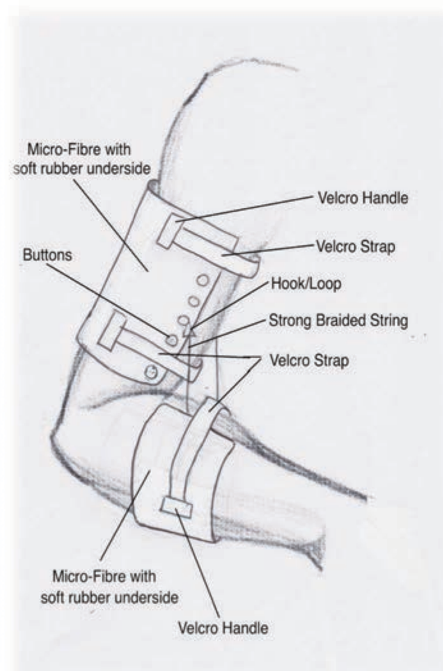


Figure iii: Sketch of device at 90 degrees

Problem Description

The client, the hand clinic is looking for a device to help their patent Mr. B. The user sustained injuries in a motorcycle accident that left physical injuries specifically to his right arm. Due to a brachial plexus injury, he has very little working muscle in his right shoulder and none at the elbow. Mr. B cannot flex or extend his arm; he would like to be able to do simple day-to-day activities that his current state does not allow. Mr. B has not lost all movement of his arm; he is still capable of using his hand and can rotate his forearm to a certain degree and wants to maintain this ability. The device must be as light as possible in order to prevent further injury to his shoulder. Mr. B is also on trial and would like the brace to be able to go into general incarceration with him. This means the brace cannot be used as a weapon in anyway.

Design

The design consists of three major components; the forearm component, the upper arm component, and the shoulder accessory. The upper arm component – goes around the bicep – has a set of buttons on each side so that loops can be placed around them to keep the elbow locked at the desired location as seen in figure iii. The forearm component – goes around the upper part of the forearm – has two thick braided strings attached with loops on the end so that they can connect with the buttons on the upper arm component. There are Velcro straps in order to tighten the device around the arm on both components. Comfortable, soft rubber is under the micro-fibre material to stop the device from slipping down the arm while on. The shoulder accessory – seen in figure i – connects with the upper arm component so that the tension of his injured right arm goes to the functional left arm. The device can be put on using only one hand. The design basically consists of fabric, soft rubber, string and other various small components making it extremely lightweight and easily portable. The device can fit over tight clothing as well as under baggy clothing.

Functionality

The device can place his arm in various angles that he can adjust to do daily activities. It still allows Mr. B to rotate his forearm freely to do activities with his injured right arm. The shoulder accessory takes the tension on the right arm and distributes it to his left arm. As Mr. B's shoulder heals the shoulder accessory will become unnecessary so it can be removed when his shoulder can support more weight. The device can also be allowed in a jail setting since it does not have any parts that can be used as a weapon.

Materials, Components, and Assembly

The elbow brace requires very simple parts, like Micro Fibre – towel material with a thin sponge inside – Velcro, buttons, key rings, string, paper clamps, staples and a non-skid rubber (seen in the figures above). All of these components can be purchased at almost any dollar store. The tools required for construction are also very simple like: a sewing needle, scissors, glue gun, and a stapler. A sewing machine can be used to increase productivity. The brace can be constructed in less than an hour and because of the simplicity of the design minimal instructions are needed. The only instructions needed are the placement of the straps and buttons that allow for the maximum ROM. There are also no internal parts meaning, only using a prototype as reference it could easily be duplicated.

Cost

The total cost of the materials to create one brace is under $15 but there are large amounts of excess material. If the clinic wanted to build multiple braces all you would have to buy is additional Micro Fibre. At a minimum five additional elbow orthotics could be made with the excess. A lot of the items can be easily found in an office environment, which could decrease costs further. The only expense to the user is the cost of the materials and possibly the labour to build the device.

User Acceptance and Compliance

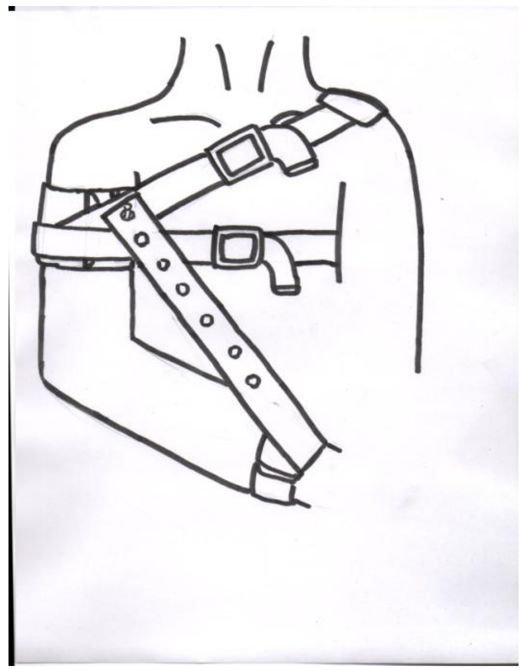
The device has been designed to encourage user compliance. The device does what Mr. B wants it to do – improve his day-to-day life. The device will lock the elbow at his desired angle while still allowing forearm rotation. The user can get it on and off by simply slipping it up the arm and tightening the Velcro straps. The shoulder accessory can be easily tightened and taken completely off. To lock the device at the desired angle take the loops and place them around the appropriate buttons – the higher the button the smaller the arm angle. The whole device is extremely light and only soft fabric touches the skin providing comfort and safety for the user. The device can be made any colour as the micro-foam comes in multiple colours. All of Mr. B's desires are met within reason. His elbow cannot be locked at every angle but can be locked into five different angles – which is more then he had before. The device can work on Actively Assisted ROM for flexion only.

Benefits

The device has many advantages: the weight, the cost and the manufacturing ease for the hand clinic. We took all of these factors to an extreme. All of the materials are very cheap and could be found at almost any dollar store – costing less then $15 – and can be put together relatively quickly with a glue gun, a stapler and a little bit of sewing. The brace is extremely lightweight and hardly puts any load on the shoulder – weighing approximately under 0.5kg. Being able to lock the elbow at different angles makes it possible for Mr. B to do day-to-day activities independently. The simplicity of this device makes it affordable and easy to construct at the hand clinic. The device is not only limited to Mr. B, other patients at the hand clinic can benefit from its simplicity, lightweight and low price!

Dynamic Elbow Orthosis

ACME corp.
F10 - T06-3



Problem Description
Our group has decided to address the problem of Mr.B. The patient suffered a compound fracture/dislocation of his left shoulder and degloving of his left wrist. His injury was severe and his shoulder cannot hold heavy load. The device we built is to help client to have regular range of motion for elbow and shoulder, achieved by a lockable orthotic which eases his forearm rotation.

Design
The orthotic is designed as two loops one for forearm, connected with aholeystrap and one loop forupperarm with a hook tightly attached. Loops are closed with strong Velcro to prevent from slipping. According which hole one the strap hook goes in will change the angle between forearm and upper arm and lock them in place. Straps that go around the chest and over the user's healthy shoulder are both designed as length adjustable.Pull the just will force user's arm get close to body and loose the strap will free them.
The device is going to be big in size since it will go around client's body; however it is going to be extreme light because it is mainly made of fiber materials.

Functionality
The orthotic perform mainly 3 functions: allow arm keeps in certain angle and lock them, provide support to arm's own weight, and force arm always beside body.
The orthotic allows flexion of the arm to various positionsand lock the arm beside user's body to prevent arm from random swing that might happen while allows forearm ortation, and hold

up the arm as a lifter. The design also fulfill most of user's request in term of cost, assembly compliance etc, which makes it affordable and simple which meets the needs of both the client and the user.

Materials, Components, and Assembly

In order to allow minimum cost to build the orthotic, our team has carefully chosen to build the project within materials that are easily accessable in a hand clinic. Our project uses Velcro strips, two body straps with padding to tighten around the body, hook, two cuff strap to go round the forearm and strap with holes to hook on the hook. Most of the materials are available in the hand clinic but some need to be outsourced. The orthotic can be built within 2 hours approximately with the help of a sewing machine or a sewing kit without any special instruction. The only instruction needed is during assembly of the orthotic.

Cost

Because most of the materials are available in hand clinic already, and outsourced material are common, the device is going to be low in price. Twojoint protectors can be found in sports sections of most supermarkets, the estimation is they will cost around $15. The straps with padding to tighten orthotic around body can be found in camp sections, the price is going to be $7 for around 2 meters.The hook is available in any home hardware shop or even dollar shop which should not cost over $2. Therefore sum is $30 for now, plus some extra cost generated during assemble, the total budget should not go over $35, which is relative cheap to already existing commercial product.

User Acceptance and Compliance

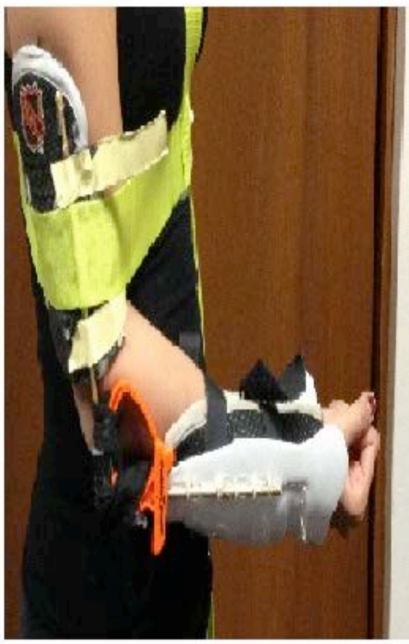
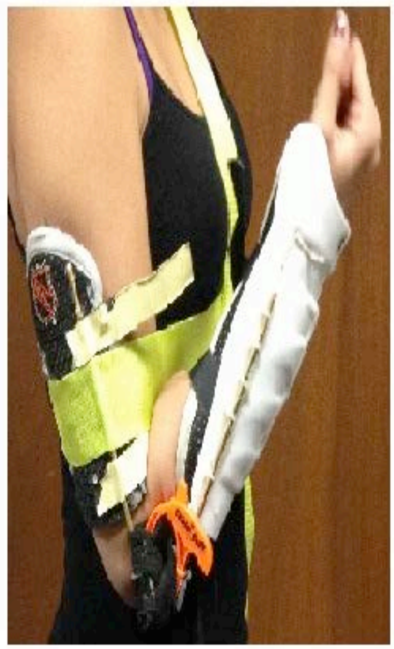
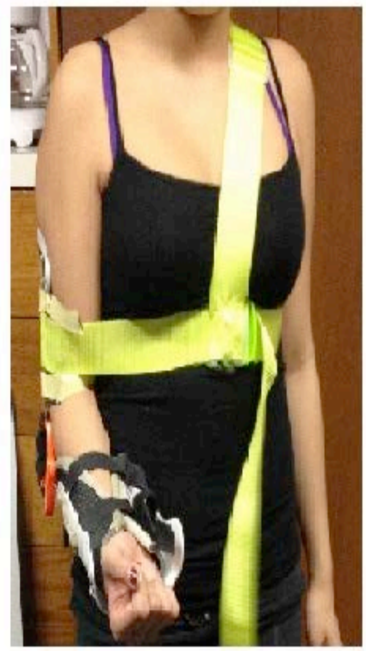
Since has only one hand available, the design team made the orthotic extremely easy for user to put on, everything can be done with single hand without help from another person.
User can put on/remove the orthotic with the use of Velcro, making this process easy to handle. Adjustable straps are also easy enough to tighten and loose. User's heath shoulder has to took the weight of his broken arm to prevent further injury on the broken one, so the pressure will be big and bring discomfort. To solve that padding is placed on pressure points to reduce the discomfort.
There are two steps to put on/remove the orthotic, step 1: stick the Velcro on the arm, one with hook for upper arm and the other for forearm. They need to be tight enough so no slip. User will put hook on a certain hole; this will decide the angle between 2 parts of the arm and lock them there, like a lifting bridge. Step 2: One strap will goes around the chest and another one goes over head and be placed on user's healthy should with padding. Tight them make sure the orthotic does not drop. If user want to remove orthotic, he can repeat these two steps in opposite direction.
The orthotic is made of mainly fibber, which makes it extremely simple and lowing weight, user can barely feel it. And it is all black which make the orthotic harmonious in not only functional but also cosmetic design, so user just cannot find a reason refuse to wear it.

Benefits

The biggest problem current existing they are usually too heavy, expensive and hard to build. So design group focus on solve these three disadvantages.
This product is mainly made of fibre which is obvious going to be much lighter than the other product which used plenty of metal parts, which will cause further injury to the patient In this case. Another advantage is made of easy accessible materials which mean it will not be costly and hard to make, which the design group believe is extremely important for clinic staff and user. Tool that needs to build this orthotic are just screwdriver and sowing tools.

Dynamocuff

CIEFA & Associates
F10 - T06 – 5

Problem Description

Your problem statement should go here. Discuss only those parts of the problem that you have chosen to address in your design.

Design

The Dynamocuff is lightweight and easily assembled. The design fits snugly on Mr.'s forearm with the bottom half covering the area from his elbow to his wrist and the top half the size of a wristband. For the user's convenience the orthosis is easily adjusted allowing for independence and maximum comfort.

Functionality

The Dynamocuff allows Mr.B to lock his right arm at various angles without placing stress on his dislocated shoulder. Since the arm is secure Mr.B can now use the fine motor skills he maintained in his digits. The "name of design" can be used independently allowing Mr.B to adjust the angle and therefore the position his arm is locked in.

Materials, Components, and Assembly

The design requires 2 metal float rods, 1 child's standard hockey shin pad, 1 cable cuff, and fabric. The device can be constructed using a glue gun, superglue, and zip ties. The assembly should take no longer than an hour. The float rods attached to the cable cuff with zip ties, and the rods attach to the shin pad using glue.

Cost

The orthosis should cost between $20-$50.Shin pads can be donated thus creating a lower cost range. The cable cuff, fabric, zip ties, and float rods can be purchased for under $5 at a local hardware store.

User Acceptance and Compliance

The orthosis was designed to be user-friendly. The Velcro straps and easily adjustable sling strap allow Mr.B to get the orthosis on and off without difficultly. The cable cuff can be adjusted with ease thus fulfilling Mr.B's desire to be independent. The orthosis was covered in aesthically pleasing fabric which also enhances its comfort level. By positioning his right arm with his left arm the cable cuff locks the orthosis at different angles. The release knob at the top of the cable cuff is easily accessible and requires little force allowing for easy adjustability. Safety was considered in the design since all sharp edges and raw material were covered with fabric for protection and comfort.

Benefits

The Dynamocuff is much better than existing solutions since it is cost-effective, user-friendly, safe, and it solves Mr.B's major issues. The dynamocuff is almost one quarter the price of commercial elbow splints and since thermoplastic isn't necessary the cost is reduced significantly. The dynamocuff is ideal for the hand clinic and their clients since it is easy to assemble and doesn't cost much. The cable cuff is a simple mechanism and allows all users to adjust the orthosis without difficulty or much effort.