Final Report

Project #3: Specialized Seat and Activity Tray for Sean Munzer

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1. **Introduction:**

1.1 **Background**

Cerebral Palsy describes a wide range of movement disorders that typically become apparent during the second or third year of a child's life. It is usually caused by abnormal growth or injury to a developing brain of a fetus, and results in a multitude of muscle and coordination related problems. Afflicted patients may display decreased motor control, muscle tone, and abnormal posture. Furthermore, movements are usually described as spastic, unusually rigid and are often involuntary. Also, as a result of the brain trauma or abnormal development of the brain, there may be associated mental disabilities; it is common for an individual to have learning disabilities, auditory or visual problems, and seizures.

Sean Munzer is an active, perfectly happy eleven-year-old boy with Cerebral Palsy. However, due to his condition he is non-verbal and has decreased musculoskeletal control of his body. He also has the decreased learning capabilities that are associated with Cerebral Palsy. Sean lacks fine motor control, is fed via a G-tube, and has caretakers administer his medicine, bathe him, dress him, play with him, and provide other general care. Despite this, he is very active and displays joy by smiling and kicking his legs. He finds great pleasure in music and auditory stimuli, along with his other toys. Sean does have some degree of motor control and muscle strength, though. He can push himself into a sitting position and remain upright for a few seconds. However, he tends to fall over sideways, and requires supports to prevent injury. He also needs a support system to keep his legs safely positioned despite his kicking.

1.2 **Purpose**

The purpose of the projects are to contribute to a more comfortable life for Sean, the Munzer family, and Sean’s aides and loved ones. In order to accomplish this, a comfortable alternative chair will be designed for Sean. It will allow for Sean to be out of his wheelchair for a longer amount of time each day, which will hopefully provide greater comfort. Currently, Sean remains in his wheelchair almost all day, except for an hour or two a day, when he is given “floor time” and is out of his wheelchair. However, Sean’s parents are looking for an alternative seat that will provide a safe and comfortable place for Sean instead of the floor where he could be injured. He currently has a reclining chair that was purchased for just this reason, but it lacks some of the necessary features to make it practical.

The alternative chair must have a harness for Sean to remain in place, and a support system for his sides to keep him upright. He is very active and known to move about quite a bit, so this is an important aspect of the chair, to ensure the necessary safety for Sean. He also requires a soft, yet resilient footpad for his seat.
Sean likes to express joy by kicking, and will sometimes continue to kick even past the point of pain. The chair must be built to withstand the greater wear that Sean will put on it.

The purpose of the activity tray table is to provide Sean stimulating activities that are suited to his personal needs. Sean currently has multiple toys that he enjoys playing with, but he requires more personalized toys than those that can easily be purchased. In order for the tray table to be best for Sean, it needs to have auditory features, which he seems to enjoy most. As an example of this, one of Sean's favorite toys plays music and different sounds when different buttons are pushed. The activity tabletop will provide Sean the same type of enjoyment, but with better features. It will have built in speakers that will play music from different components such as a radio or other music player. It will also have a children's piano keyboard built in, which will produce the sounds that Sean plays, since he greatly enjoys similar toys. A workspace will also be a feature of this project so it can be used when not providing auditory stimulation.

The activity table will not have any sharp edges or dangerous aspects that could result in injury. This also means that the electrical components of the table must be completely enclosed, with the enclosure fully waterproof. It needs to be durable enough to withstand any increased abuse from Sean, and the extreme wear that would come with having a large piece of equipment being moved multiple times daily (to and from school, and any time the table is attached or removed from his chair). It also must clip on to the pre-existing tray table or onto his chair directly.

1.3 Previous Work

1.3.1 Products

There are many pre-existing products that are aimed at giving physically and mentally disabled individuals comfortable alternatives to wheelchairs and other seating arrangements. One of the previous products that has been identified as being similar to what is desired is the Atlanta reclining chair that is built by O'Flynn Medical Limited (Figure 1). The chair is described as being best suited for patients with "challenging behavior." The chair is described as being strong and resilient, or robust. It also specializes in enhancing the posture of individuals who are at risk of falling or climbing out of more standardized chairs. Some of the key features are high arms and a
deep seat, which promotes the better posture and safe positioning for users that may climb out of other seats. There are also removable cushions, and swiveling castors for mobility.

Another product that is designed for the same purpose is the Drop Arm Convalescent Recliner, made by Winco. The product boasts dropping arms that allows for easier transferring of the patient into the chair. It also comes with swiveling and lockable castors, as well as a removable tray, headrest, and a resilient vinyl covering. The benefit of the Winco product is the removable tray that is not included on the O’Flynn chair. The Winco chair also has available side supports as an option.

A third pre-existing chair is made by Freedom Concepts Inc. (Figure 2). It is a much simpler design, which keeps patients seated and in place by having a deep v design which does not allow for individuals to easily climb out of position. The chair comes in different sizes, which is not available in the other seats, which is an important aspect when considering chairs for children. It also provides a footrest (as do the other chairs) as well as castors for mobility. An optional tray table can be added, and the foam is designed to reduce stress while conforming to the patient’s body.

Surprisingly, there were not many similar projects designed for the National Science Foundation. However, there were a number of reclining wheelchairs that were designed for participants in the program. One such chair was the Reclining Wheelchair with Detachable Canopy and Desk from the State University of New York at Buffalo, in 2009. The project addressed the common problem of uncomfortable wheelchairs, which patients spend most of their time in. After some research of the NSF archives, it was determined that a comfortable chair for Sean must include a reclining feature. The reclining wheelchair is shown in Figure 3.

Providing disabled individuals with suitable workspaces is a considerable problem, but one that has been dealt with numerous times. There are a great number of tables that are suited for people in wheelchairs, both separate from the chair and attached. There are also many options for activity tables for children. Many of these activity tables are aimed at young children, and provide them with activities that test eye-hand coordination while giving them hours of entertainment. However, after considerable research, there does not seem to be a publically available product that combines the two ideas into an activity tray table that connects to wheelchairs. There also does not seem to be any available product for
mentally and physically disabled children consisting of an activity tray table that connects directly to their chair but is also detachable.

There seems to be main types of workspaces that are widely available for individuals bound to a wheelchair: freestanding and attachable to the chair itself. Freestanding tables are a simple solution, because they often provide adjustable mechanisms to best meet an individual’s needs. These are widely available, one such example is the table made by AmTab. However, a tray table that attaches to a wheelchair is desired. There are also many attachable tray tables that are easily obtainable. For example, the wheelchair tray made by Duro-Med Industries is a simple design and can be purchased for fewer than thirty dollars (Figure 4).

The products so far examined have only provided part of the requirements of the design for Sean. These products are simple tables and work stations, and do not provide any sensory stimulation, or fun activities. There are many activity tables for young children which have a multitude of games to provide stimulus for the different senses. However, there are far fewer available products for wheelchair bound, mentally disabled children. One available product is a soft pad of enclosed gel, which just gives an individual a soft, malleable surface. The Gel-Top Sensory Stimulation Wheelchair Tray by Skil-Care (Figure 5) is a pad that fits on top of an existing tray table, and gives an individual a sensory stimulating addition to their chair.

The gel filled pad that is available for a wheelchair lacks the auditory stimulation that is required. A better pre-existing product to compare to the activity tray table is a child’s walker. The Sound’n Lights Discovery Walker by Safety 1st (Figure 6) provides a child with greater stimulation than that of the simple gel pad. It has activities that are more visually striking; more varied for the sense of feel, and more relevantly, has different sounds that it emits. This is the type of stimulation that would be desired for Sean’s wheelchair activity table.

There are also a multitude of similar devices engineered by contributors to the National Science Foundation, but none with the exact purpose of the tabletop for Sean Munzer. Two custom work stations were identified, one from Rochester Institute of
Technology in 2006, and another from Duke University in 2008. Both workstations were designed to provide users with a general work area, which is one of the many features of Sean’s tabletop. One of the workstations was designed as a simple quick-release top and can be seen in Figure 7. However, these desk designs do not incorporate different stimuli and educational activities for the user. Separate, specialized activity stations were identified, but none integrated into the desk as is proposed for Sean’s activity tray table.

1.3.2 Patent Search Results

The first product is a modification on a comfortable, reclining chair. The full mechanism for a reclining chair is given in a patent received by W. Clark Rogers, Jr. et al. in 1975, where the footrest is operated independently from the reclining feature of the chair. The design allows for four positions of the chair: upright, fully extended, and two intermediate positions. It also includes a rocking base in the design. A clear illustration of the set-up can be seen in Figure 8. There is another design from 1963 to the same company (La-Z-Boy Chair Company) that describes a similar mechanism, with a self locking feature which keeps the chair in the reclined position without any added force.

The basic design of the tray table is not a new concept. It requires a simple table top to attach to a chair, which is a concept from 1910, when inventor G. Etles patented his design of a tabletop that attached to a comfortable seat. However, a more up-to-date basis for this product can be traced to a patent from June 2nd, 1970. The patent describes an attachable tabletop to a basic wheelchair design, and the product can still be found for sale today, with little modification. An even more recent design of a wheelchair tray table was found to be patented by Daniel G. Diestel, and John M. Onnen in 1998. It describes a tray table that lies across a wheelchair and secures to the armrests. An image of the design is included in Figure 9.
However, the design of the tabletop itself is only a part of the design. The tabletop must include sensory stimulating toys and activities. One of the most influential designs was that of a child’s walker with an included activity table. A design was patented by Peter D. Jackson et al. on March 24th, 2009, and describes a walker with a connected table that has attached toys. A diagram of the product can be seen Figure 10.

1.4 Report Map

The approach and details of engineering a comfortable alternative chair and an activity tray table are presented in the following sections. A major aspect of the engineering process was proposing a number of alternate designs for both projects. Doing this provided better understanding to how ambitious the designs could be, while remaining feasible. Ultimately, the knowledge gained from the research into previous works and patents, along with new ideas, was combined to form a single, optimal design, which would become the proposed outline of the project. After identifying the optimal design, the realistic constraints of both projects will detailed, with emphasis on special considerations of the project. For example, the sustainability of each project, as well as any environmental factors will be discussed, along with other areas that will effect, and will be influenced by the successful completion of the designs. Special emphasis will be given to detail the different safety features and concerns of each project, and be in a separate section. Next, the impact of the engineering process will be presented, as well as the life-long lessons that have been learned during the independent design of the projects. Budgetary details and figures will be included in the following section, along with a timeline of the work. Specific contributions of each team members time and work will be outlined, and the overall content of the report will be reiterated in a brief conclusion. References to any cited works and relevant information, acknowledgements to all the people and organizations that helped with the projects, and an appendix section will be close the report.
2 Project Design

2.1 Introduction

There are two main projects for aiding Sean and the Munzer family. The first project for Sean involves creating an activity tray tabletop. It has been requested that the activity center provide auditory stimuli. To this end, the tabletop will be activated by Sean, and will provide different sounds and music. A connectable music player and integrated radio will provide some of the audio for Sean. The user interface will be suitable for Sean to use, with large, easy to press buttons. A keyboard toy will also be a key feature of the tabletop, so that Sean can have an interactive toy in keeping with the audio theme. There must be built in speakers, as well and other toys may be incorporated into the design. Other features of the tabletop include a lip around the edge to prevent items dropping off, and it would be completely waterproof and easy to clean. It also will fit directly over his existing tray table.

The second project involves designing a comfortable chair that Sean can use as a break from his wheelchair, which he currently stays in almost all day. Sean’s family expressed interest in having a recliner, but one that would better suit Sean’s needs. The alternative chair must be practical, comfortable, but above all else, safe. He will require a harness, and side supports to keep him safely secured. Sean also requires a soft, yet resilient footpad for the seat. There must be pads on each side of the footrest as well, to keep Sean’s legs safely oriented. To maximize the use of this chair, it should also have adjustable features to allow for growth. The new design must also be light enough to be easily moved, and it would be a positive for the chair to roll for further mobility. All aspects of the new chair must not interfere with the daily care for Sean, and it needs to be easily maintainable.

In order to fulfill the parameters and constraints of the project, a number of different designs were produced, each with different benefits and drawbacks. The proposed ideas for the activity tray table and recliner are presented below.

Alternate Designs for the Activity Tray-Table #1:

The first proposed design idea for Sean’s Activity tray table is a simple design expected to maximize the usable area of the table. The basic shape of the table will be rectangular, and completely symmetrical in shape, both along the width and length of the top. However, it is anticipated that Sean may have a hard time accessing the far side of the table’s surface, especially while buckled into place. To correct for this, the table will be reversible, allowing any caretaker of Sean to simply turn the table around to give Sean access to the other aspects of the desk. It is proposed that one side of the tabletop have user-friendly controls to an audio device, and a keyboard toy for Sean to play with. The audio device will be a
combined mp3 and radio player, so that it will be programmable, but have a the radio for new entertainment. The audio controls accessible to Sean will be a play, stop, and fast forward button, as well as buttons that can transfer between the radio and mp3 source. There would also be buttons to control the radio station. The other side of the table will have a workspace with a pop-up easel so that the table can have a serious function. For the audio equipment, built in speakers are necessary, and a power source is required for the table's electric components. A switch would alternate between the audio components. All curves of the table would be smooth and there would be a lip to prevent things falling off. The speakers would be set into the sides of the table and would project outwards. Also, the volume control, and power button would be accessible on the side of the table, although not in a place accessible to Sean. The general shape can be seen below, in Figure 1.

![Figure 1: Symmetrical Activity Desk Design: Top View (left), Bottom Angled View (right)](image)

**Alternate Designs for the Activity Tray-Table #2:**

An alternate design for the activity tray-table involves a different way of allowing Sean to access the far side of the tray. To allow for the activity tabletop to attach to Sean’s existing wheelchair, the table will slide onto his armrests, similar to how his desk attaches now. For the desktop however, there will be a revolving surface similar to a “lazy-Susan” that will have the auditory stimulating components that Sean requires. The keyboard toy and audio controls would be built into the revolving surface, and could be moved by Sean to give him a choice over what he wants to use. The output of these components would be through enclosed speakers. The benefit of this design is that it gives Sean an independent choice in what he wants to play with no outside help. However, the wiring of the components would have to revolve along with the table’s surface. The table would also be shaped to better support Sean. The surface of the table would have armrests, all chamfered corners, and a lip to prevent things falling off. As with the other designs, Sean would
have access to both a programmable mp3 player and radio. He would have a play, stop, and fast forward button, as well as buttons that would control the preset radio stations. Instead of a source button, the source of the audio stimulation would be whatever audio component was in the position facing Sean, or his chair. The speakers would face outwards from the sides of the table, and the volume control, and power button would be placed on the side as well, although in a place inaccessible to Sean. This alternative design can be seen in Figure 2.

![Figure 2: Activity Tray Table Base with Revolving Surface: Top Angled View (left), Bottom Angled View (right)](image)

**Alternate Designs for the Activity Tray-Table #3:**

The third design for Sean's activity table goes for simplicity, which may also translate into a decreased cost. The tray table will be modeled after the simple, widely available tabletops that already exist for many wheelchairs. The workspace will be a rectangular shape, although there will be curved armrests for added space and support. All edges would be smoothed for safety. The difference with this design, however, is that the audio components of the table will be set into the tabletop nearest to Sean's seat. This design is the simplest and can be completely modeled after his existing desk, even with the same measurements. However, this comes at the cost of less access to the far side of the table. The other major difference is that the tray would not connect to the wheelchair. This is less desirable, but makes for a simpler design. The table would be on a free standing structure that would then sit at the correct height and move in close to the wheelchair seat. The same auditory stimulations would be incorporated into the table, and Sean would have the same buttons and controls as in the other proposed project ideas. Because Sean would not easily be able to access the far side of the tray table, the desk would also be shorter, costing less in materials. Also the speakers could be housed at this side of the desk and set upwards, for enhanced sound projection. A simple workspace that does not have any audio components involved would be sacrificed in this design. The simple design can be seen below, in Figure 3.
Alternate Designs for the “Floor-Time Chair” #1:

The first proposal for a comfortable alternative to Sean’s wheelchair is to improve on the design of a basic recliner. Sean’s family described what they had in mind as a fully functional recliner that was simply scaled down, but had a few added features for Sean’s specific needs. However, available children’s models are simple and lack the necessary features to make them useful for Sean. If using the already constructed frame, additions to the reclining mechanism must be made. The seat must stay reclined, and the footrest must stay extended. A safety harness must be added to keep Sean well back in the seat, although this can be accomplished using a lap belt, in order for Sean to have the most freedom possible while still remaining safe. He requires bolstered cushioning in the footrest, which can be added to the pre-existing chair, and supports, both for his legs and sides. Two adjustable clamps, each with cushions on the end, will be added at his feet and just above his waist, for stability. Also, the chair will rock slightly, along with the reclining feature. An option would be to place it on castors, making it more mobile, and even rotatable. As seen in previous designs, a Lay-Z-Boy reclining seat with additions for Sean’s specific needs would be very suitable. As an added feature, Sean’s new activity tray table can attach to the chair. The recliner can be seen below, in Figure 4.
Alternate Designs for the “Floor-Time Chair” #2:

Another proposed idea is to make a chair that has a very low center of gravity, to add stability and safety to the floor-time chair. The seat itself will be on the floor, and it will have a high seat back that will be one continuous part. The seat will be heavily weighed down to ensure the low center of gravity for stability. The seat will have a deep bucket shape, in order to safely secure Sean in place, along with a lap belt to keep him positioned far back in the seat. There will also be higher sides where Sean’s legs will go, to give him the support that he requires. A side support will be added above his waist as well, to prevent him from falling sideways out of a safe position. The length of the chair must be longer than the models that already exist, because Sean requires a footrest that he can kick, as well. Also, by making a rounded, but wide bottom to the chair, the chair will be able to rock forward and backward to a large degree. The chair will also have high armrests to keep Sean secure, and his activity tray may be able attach to these. The general shape and design can be seen below, in Figure 5.
Alternate Designs for the “Floor-Time Chair” #3:

A third proposed idea for Sean’s floor-time chair involves incorporating much of the previous design, but lifting it off the floor and adding a reclining mechanism. Instead of having the seat itself on the floor, with a freely rocking mechanism, the seat will be lifted, onto a frame, more like a traditional chair. This design takes advantage of the natural curves of the chair to provide Sean stability while giving it more of the reclining features that would make for a more comfortable chair. There would be a deep bucket seat, which would naturally keep Sean well positioned in it, and there would be an added lap belt to ensure his safety. The high sides and armrests would provide him with side support, and adjustable supports will be added to the chair, similar to those in design idea 1. The benefit of this design is that an extending footrest can be added to the chair, which will give Sean the kicking pad that is desired. This would have the bolstered cushioning that he would need. The back would also recline, controlled by a lever on the side of the chair that would not be accessible to Sean. However, Sean’s parents or any caretaker would set him into the reclined position for safety. This design would also rock forward and backward, and by putting the frame on locking castors, it could be more mobile, and even revolve. This design is illustrated below.

Figure 5: Pre-existing Rocking Chairs with Deep Bucket Shape

Figure 6: Elevated Bucket Seats, with Recliner Option (right)
2.2 Optimal Design

2.2.1 Objective

Reclining Chair:

The optimal design of the chair will be based on existing recliner designs, but it will be altered to fit Sean’s specific requirements. The basic structure of the chair and reclining mechanism were going to be purchased, in order to cut down on engineering time and costs of materials. However, the affordable recliner options for children do not have fully functional reclining mechanisms. As a solution, an electric reclining chair has been obtained and modified. This is different from the proposed idea of purchasing a child-sized chair and adding a functioning reclining mechanism because of the availability of a fully electric recliner. A remote control will operate the incline of the seatback, and extend the footrest of the chair. Additionally, the footrest will have improved cushioning to allow Sean to kick it. There will be adjustable side supports for Sean, which will stabilize him just above his waist, and prevent him from tipping out of his chair sideways, or positioning himself in an unsafe manner. These pads operate using a simple push-button sliding mechanism, which will be explained in the following sections. Leg supports will also be included in order to keep his feet and legs safely on the chair at all times, while still giving Sean the freedom to kick his legs. He also must remain properly secured in the seat. A lap belt will restrain Sean, and keep his pelvis far back in the seat, to minimize chance of injury or discomfort. Furthermore, the surface of the chair will be an easy-to-clean vinyl covering supportive foam inside.

Activity Tray-Table:

The second project for Sean involves creating an activity tray tabletop. The optimal design of the activity tray-table has changed significantly between semesters of senior design, though the general design has stayed the same. It has been requested that the activity center provide auditory stimuli. To this end, the tabletop will have components that can be activated by Sean, and will provide different sounds and music. A connectable music player and integrated radio will provide some of the audio for Sean. Originally, it was desired that the user interface would be suitable for Sean to use, with large, easy to press buttons. This design was meant to be accomplished by purchasing a combined mp3 and radio player, and rerouting the buttons to the more user-friendly controls that Sean will have access to. This was not considered possible after seeing the options available for purchase (more on that is elaborated in the subunits and prototype testing sections). A keyboard toy will also be a major feature of the tabletop, so that Sean can have an interactive toy in keeping with the audio theme. There must be built in speakers, as well, and other toys will be incorporated into the design. Other features of the tabletop included a lip around the edge to prevent items dropping off, and it will be
completely waterproof and easy to clean. These features are still incorporated into the final design. It also will slide directly onto Sean’s armrests and clamp on, similar to his current tray table.

The next focus of the project was drastically changed based on available parts. Sean’s positioning in the chair was considered in relation to the desk. Because he may not be able to comfortably reach the far side, the desk was originally meant to be a symmetrical rectangular shape, with curved edges. On the underside, the track was to have a similar symmetrical shape, which would have enabled Sean’s parents to take the tray table off, rotate it by 180° and replace it, giving Sean access to the other side of the desk. It was proposed that the other side would have a workspace and would tilt upward, giving Sean a functioning desktop and easel. Strips of Velcro will be placed on top of the table as well, to give Sean and his parents the option of securing other toys to the table. Instead of this design, the table was to have a u-shape that would attach over the armrests of Sean’s wheelchair and would slide right up to Sean. Holes in the back of the desktop allow for it to be tied around the back of his chair with a strap to help stabilize and hold it in place, similar to his other tray. Also, tilting mechanisms for another wheelchair desk was found at NEAT Marketplace, which made an easel for Sean unnecessary as the whole desktop could be inclined. Pictures and further details will be elaborated in the subunit sections and in the prototype testing section.

2.2.2 Subunits

Both projects, the reclining chair and activity tray-table, each have aspects of the designs that are best organized into specifically engineered subunits.

Reclining Chair:

Mechanical

Frame:

The frame of the reclining chair will be purchased as an already existing product. This will save on time spent designing and building a similar structure, most likely for a similar, if not greater cost. Wal-Mart and competing retailers offer a number of simple, children-sized recliners for less than one hundred dollars, but they do not function as needed. As a solution, a fully automatic recliner was purchased from the NEAT marketplace in Hartford, CT. For $100.00 the frame and reclining mechanism was obtained, which is cheaper and superior to the proposed idea of purchasing a child’s sized chair and altering it. The recliner that will serve as both the frame and the reclining mechanism for Sean’s chair, and can be seen below, in Figure 7.
**Basic Motion:**

The main goal of the chair is to give Sean a more comfortable alternative to his wheelchair. This will be mostly accomplished by having the chair recline. A fully functioning, automatic reclining mechanism will be added to the seat, which is a lacking feature of most children’s recliners (Figure 8). A remote control on the side of the chair will control the angle of the chair back and footrest. The remote is designed for use by Sean’s parents. The position of the chair will also lock into place as more pressure is added to the seat back, and the angle between the seat back and seat bottom increases. It will elevate back into the original position by pressing the “up” button on the remote. Also, by holding the “up” button for even longer, the chair will tip forward, which will allow for easy transport of Sean out of the chair.

**Safety Features:**

Most importantly, the proposed recliner will be safe for Sean, even with his energetic, and somewhat unpredictable motions. First of all, he must remain securely in the seat. This will simply be achieved by adding a lap belt to the design of the chair. The seat belt will keep Sean’s pelvis well back, in a safe position. The belt will have a clip that releases when a button is pressed, similar to a car seat belt’s release button. The belt will attached to the frame of the chair, and come out from under the seat cushion. It will extend upward and will be adjustable, similar to the
lap belt in Figure 4, but without the over the shoulder belt. By only having a lap belt, Sean will still have the freedom to move, which is important when making a seat that is about his comfort. A belt similar to what is needed can be purchased for about $30.00.

Sean also requires side supports to keep him upright. The chair will have an adjustable support, which will be mounted to the seat back, right above Sean’s waist. An existing side support for a wheelchair is pictured in Figure 5. The support can be purchased for approximately $75.00, but can be replicated for far cheaper. The design will be similar, but will be attached to the back of the chair and wrap around to the front. The pads will be attached to a thin steel frame and constructed of foam, covered in vinyl. They will be easily adjustable with two push-button adjustable pads (Figure 9, right)

![Figure 9: Side supports for a wheelchair (left) and adjusting pads (right)](image)

Supports are also required for Sean’s legs. Because of his kicking, he can easily dismount himself from a proper, safe position. To correct for this, there will be a system for restraining Sean’s legs, similar to the supports for his waist. The supports will be similar to those pictured above, in Figure 10, which will be extended up to keep Sean’s legs on the footrest. The pads will be very similar to the
previously designed side restraints, with a thin steel frame with the pads at the end. The pads will not have to be adjustable, and will simply extend upward from the sides of the footrest.

![Shredded foam filler and vinyl coverings](image)

**Figure 12:** Shredded foam filler (left) and vinyl coverings (right)

**Comfort and Care:**

The filling of the chair will consist of shredded foam fill, designed for use in cushions. Foam fill is widely available, and should add greater support while still providing a soft texture (Figure 11). A quantity of 2.5 pounds of foam fill is available on Amazon.com (offered by Bean Products) and costs $11.95. Two orders should be sufficient to make a comfortable seat cushion. Also, foam sheets are required to place over the chair’s springs, metal components, and wood frame.

The chair will also be covered in vinyl for long-life and easy maintenance. The chair will easily wipe down, and will be water and spill resistant. A quantity of vinyl can be easily purchased for less than $10 per square yard (Figure 12). Two square yards of fabric should be fine for the project. Sean’s favorite colors are red and blue, which will be considered when covering the seat. These items are included for comprehensiveness, as the upholsterer will be installing the foam and vinyl materials.

**Activity Tray Table:**

**Mechanical:**

**Frame:**

Sean’s activity tray table will consist of auditory toys and electrical components encased in a wooden frame. The basic shape is shown below, in Figure 13. To give Sean access to the full area of the desk, the frame will have an inclination feature on the bottom of the desk, which also acts as a track running along the bottom of the desk, allowing it to attach to the armrests of the wheelchair (similar to how the current tray table attaches). The mechanism can be seen below, in Figure 14. The frame itself must also be made of a hardwood to withstand daily abuse. An appropriate surface was found at the NEAT Marketplace. The surface
would also be coated with a scratch resistant paint for enhanced wear properties. The track on the bottom of the tabletop will be of the same material. All corners are rounded for safety. The tracks along the bottom of the desk will also have included clamps to secure the tabletop to the armrests.

**Figure 13:** Proposed activity desk basic design

**Electrical**

**Primary Auditory Stimuli:**

Sean specifically requires audio stimuli to best enjoy and learn from the activity tray table. To accomplish this, different electrical components and other games will be built into the table. One of Sean’s favorite toys produces sounds when buttons are pushed. In the proposed tabletop design, there will be a child’s keyboard toy that will emit music when the buttons are pushed (Figure 14). The keyboard toy will be a stand-alone unit, with its own battery power and speakers. It will sit directly on top of the desk, in front of the speaker enclosure. Also, it there will be a programmable music player, to prevent Sean losing interest in the toy. In response to this issue, it was decided that a programmable mp3 player and radio combination should be incorporated into the design. This required purchasing an mp3 player of suitable size, and mounting it onto the desktop. The existing circuitry should all be pre-existing, which means modification of the table to properly seat the unit will be necessary. Sean’s caretakers will have access to a play/stop, fast-forward/reverse, volume adjustment, and menu button. Although the music player will be accessible to Sean, it is not expected that he will be able to operate the player, as it requires a relatively high degree of fine motor skill. The removable part of the mp3 player will be recessed into the underside of the table so that Sean's parents can remove and program music to the player. The music players are relatively inexpensive, one such candidate is the COBY MP315 (Figure 14) available from newegg.com.
Speakers:
To emit the different musical outputs offered, there must be speakers built into the table. These will be recessed into the table, but oriented outwards towards the sides of the tray table in order to project the sound. By placing the speaker unit within the table, there is less chance of exposing the speakers to daily abuse, or spills. The fittings will also have significant insulation around the speakers themselves, to seal off the internal electrical components. For this design, the thinness of the speakers is a significant parameter, but suitable products are widely available. An image of the purchased speakers can be seen above, in Figure 15.

Switchbox:
The switchbox in the final design was not part of the original design, though the principle behind the subunit was. It was known that multiple audio inputs had to output directly to a single output (the speakers). After researching and much trial and error (see prototype testing), it was concluded that an audio/visual switchbox would be suitable for the project. The drawback of the switchbox is that only one audio input can be fed to the speakers at a time. However, because the keyboard has its own set of speakers, Sean will still be able to play with the toy while other components use the speakers. A picture of the switchbox is depicted below, in Figure 16.

Figure 14: Children’s keyboard (left) and mp3/FM radio player (right)

Figure 15: Slim, portable speaker system

Figure 16: Switchbox for input changing

Power:
For the three proposed electrical components of the table (music player, keyboard toy, and speakers) there must be some source of electricity to each. Many of the components are battery powered and run at low voltages, and their pre-

![Battery compartment for speaker system](image1.png)

**Figure 17:** Battery compartment for speaker system

existing battery needs will be used in the final design. This requires each component to be readily accessible to change the batteries. Because the keyboard toy and mp3 player (as well as any accessory audio component) are external to the electronics enclosure of the table, only the speaker’s batteries will be somewhat inaccessible. To change the batteries of the speakers (which power the external speakers amp) the lid of the enclosure will unscrew and partially lift off, giving access to the battery compartment. A picture of the battery compartment of the speaker system is above, in Figure 17.

![Potential additional toys for activity tray table](image2.png)

**Figure 18:** Potential additional toys for activity tray table

**Other**

**Other Tabletop Features:**

There are a few other features of the activity tray table. There will be a lip added to the top surface to prevent things falling from the tray table. Furthermore, there will be Velcro strips on blank areas of the tabletop, allowing for other toys to be attached when desired. Three such toys that should provide Sean with sensory stimuli and can be removed are the games pictured above in Figure 18. The pictured products are available from IKEA for $7.99, $5.99 and $5.99, from left to right.
2.3 Prototype Testing

Reclining Chair:

Prototype testing of the reclining chair was mainly accomplished during the reconstruction of the chair frame, and was also based off the consultation from the upholsterer. For example, the initial installation of the waist restraints was deemed to be too far back, especially once the foam and material would be added during re-upholstery. A picture of the original mounting can be seen below, in Figure 19.

![Figure 19: Original pad placement](image)

The pads in the picture were also reversed to add more support to Sean lower on his torso. Since they attach to the armrests of the chair, they were considered to be a little high, and to right this, the assemblies were deconstructed and the pads reversed, with minor modification.

Somewhat significantly, after using the chair in the lab, it was deemed that castors were not needed. Instead, the wheels would be left off, which would lower the center of gravity and make for a much more stable chair. This was considered to be more important on the power recliner than most other chairs, as the electric motor may shift the center of gravity to possibly dangerous locations (if castors were included in the design). Specifically, during elevation of the chair, the entire seat tilts forward to allow easier unloading of the user. If the chair was on the proposed wheels, then the center of gravity would be dangerously high and far forward in this position, and coupled with less frictional force imparted by the wheels on the floor, there could have been potential health risks.
The most significant change to the design, which stemmed from the prototype testing was the realization that it was not possible to provide a quality project without help from a professional upholsterer. After reconstruction of the frame, it was obvious that no one in the group had the expertise to cut and attach foam, and to wrap the chair in a way that would look presentable. After extending the budget, it was possible to enlist the help of a professional upholsterer. During the initial meeting, the upholsterer (John Taglieri, in Manchester, CT) expressed that cheap foam would not be suitable at all, especially for a chair that would be under significant stresses. This was just one example of the group not having the expertise to make the project to suitable quality without outside help.

Also, during testing, it was discovered that the footrest was not re-installed correctly, which was putting large amounts of stress on both the motor and the wooden frame. Also the footrest was not lowering to the necessary extent to be properly stowed. That was corrected, and the final frame of the chair can be seen below, in Figure 20.

![Figure 20: Final recliner frame with pads attached](image)

Attachment of the footrest pads was another area of concern that arose from prototype testing. Two sets of footrests had been purchased from NEAT Marketplace, with the intention of using one set, and with the other as back up. That proved to be necessary, as the first attempt at fixing the pads to the chair failed. Screw sinks were drilled into the back of the pads, which would then be attached to a metal bracket on the footrest of the chair. This was not possible, because the plastic on the back of the pad was thinner than first thought, and was incapable of keeping the screw sinks in place. To correct this, the original screw holes of the pads were used, that were known to be able to withstand large amounts of force.
Using parts taken from the waist restraints, a metal bracket was modified, and was used to fix the footrests to the chair. A picture of the footrest of the chair is included, as Figure 21.

![Figure 21: Front view of footrest with added padding](image)

**Activity Tray Table:**

The activity tray table underwent drastic changes in design compared to the relatively unchanged plan for recliner. The first plan was to have a single mainline power source from a wall outlet that would power each component. This would be accomplished using voltage regulators that would step down the voltage from the 120 V of the wall to the necessary input for the keyboard toy, mp3 player, and possible separate radio. This would have required modification of all pre-existing circuitry, and more significantly, printed circuit boards for safety to increase the endurance of the project. This was considered unfeasible with the money and time left, and it was decided that each component would be left to function off its factory recommended power supplies. A picture of the proposed voltage regulator needed can be seen in the following image, Figure 22.

![Figure 22: Voltage regulator in original activity table design](image)
After visiting the University of Connecticut Electrical Shop for consultation on how to proceed, a highly technical plan of action was adopted (though the complexity was not known at the time). The plan still used the voltage regulators that had previously been scrapped. It also made it necessary to design all audio equipment needed. For example, the preamp, amp, and speakers all needed to be built from basic electrical equipment, instead of utilizing the pre-made and readily available parts. After the complexity of the plan was fully realized, the idea was scrapped, as well, and a far simpler plan (similar to the first plan) was agreed upon. This plan required incorporation of the switchbox (which did not appear in the initial concept of the activity tray table). The switchbox provides four inputs into the back of the box, and a user can select the channel desired feeding to the speakers by pushing an appropriate button. An audio mixer was also considered, but the inputs/outputs of the box were not as readily compatible with the other audio equipment, and most required external power sources. Pictures of the switchbox can be found in the subunits section where the component is first introduced (Figure 16).

Problems were discovered during prototype testing regarding the keyboard toy as well, and minor changes in design were adopted. The first keyboard toy was purchased based on inexpensiveness and its simple shape, which was a simple rectangle. It was believed that it could be built into the desk with minor effort. However, the quality of the toy was too poor to use. Half of the keys did not work, the tones were shrill and would not bring any enjoyment. The originally purchased keyboard is below, in Figure 23, left. After the unsuccessfulness of the first toy, it was recognized that a slightly costlier, better quality toy would be far better for the design. Two options were considered, a flat “touch-screen” toy that had a small keyboard and drum pad, and a Cars themed toy, shown below (Figure 23, right). After considering the quality of both toys and speaker to the Munzers, the Cars toy was decided upon.

![Figure 23: Piano toys](image)

Changes to the speaker enclosure were also drastic. The first plan consisted of making a completely hollow desk that would house all electronic circuitry within. This was feasible for the previously designed symmetrical, rectangular desk. However, since the plan was changed to use the desktop from NEAT, the structure was not as easy to build. To ensure completion, the housing for the electronics was reduced to a rectangular structure that would hide all wires, the ports of the
switchbox, and the speaker assembly, which was the only disassembled electronic component. The holder for the mp3 player was changed to a channel on the surface of the enclosure. Another reason for the change was due to the complex curvatures of the switchbox. The buttons and circuitry were going to be removed from the plastic case, and recessed into the wood frame. However, the curvature did not allow for this. The new design is depicted below (Figure 18).

![Figure 18: General design of activity tray table before painting](image)

3 Realistic Constraints:

**Reclining Chair:**

*Health and Safety:*

Sean is extremely active, and kicks his legs to express joy. However, this often results in him repositioning himself, and sometimes in an unsafe way. To counter this, Sean requires the leg and side supports to keep him safely oriented in the chair, in both the reclined and upright position. A lap belt is also needed to hold him securely and well back in the seat. More details will be presented in the "safety issues" section that follows.

*Sustainability:*

The reclining seat is also built to last. As designed, the chair will account for Sean’s growth. For example, the leg and side restraints will be adjustable. The cushions will be stuffed with foam, and the vinyl outside will allow for easy cleaning and a resistant surface that will last. The frame of the chair itself will be solid wood and will easily accommodate Sean’s weight and all peripheral features (such as the restraints) will be on metal frames. If the chair is still in good shape after Sean’s use, it could potentially be donated to another individual with similar circumstances, extending the seat’s life.
**Environmental:**

There are no obvious negative environmental effects that the reclining chair will have, within reason. Disposal of the chair after it has served its purpose may require some disassembly to recycle the metal parts of the chair. The chair is also designed to be mainly for indoor use, although limited use outside in good conditions would be acceptable. Sean spends most of his time indoors, so the seat will be fine for his needs.

**Economic:**

Medical equipment of all kinds is sold at a premium cost. Recliners and alternative seats to wheelchairs are often prohibitively expensive, and are not made to the needs of the individual. Three previously existing designs were identified, made by O’Flynn Medical Limited, Winco, and Freedom Concepts Inc. each at a much higher cost than would be the cost to build the proposed recliner. In general, costs started at over $800 dollars, with options significantly increasing prices. Sean's seat should be an economically responsible design, especially by using already built components, such as the pre-made frame and reclining mechanism.

**Social:**

Sean is a happy, active, and healthy 11-year-old boy, but he spends most of his time in his wheelchair. For this reason, his family and caretakers like to give him an hour or two out of his chair each day. However, they don't have a very good alternative seat for him to be in, and he is usually given some time on the floor (although cushioned). This chair will give Sean a more comfortable and safe seating option, and will give those around him an easier way to interact with him outside of his chair. Also, special attention has been given to the fact that Sean enjoys kicking, and he will still have the freedom to do so.

**Manufacturability:**

Alternative seats to wheelchairs already exist, but there is a wide market for the designs, and a lot of room for improvement with pre-existing models. This recliner is being specially designed and built for Sean, but can be used for any similar patient, or modified in minor ways to make it applicable to other wheelchair bound people. Also, the chairs are typically not designed for children, which is a key aspect of this design. This project is considered to be superior to many of the comparable products that are sold at far greater cost, and would be in demand if manufactured for commercial purposes.

**Engineering Standards:**

The design and assembly of the reclining chair will be done in a precise, technical way to ensure the highest engineering standards. By thoroughly documenting the steps taken to complete the project, each component of the chair will be made to carry out its intended purpose, and each part can be remade or improved on based on the specifications outlined during the process. The chair will also operate in the same way as a traditional recliner, and any confusing or
potentially hazardous features will be documented and instructions will be provided. Available parts and standard sized components will also be used.

**Activity Tray Table:**

**Health and Safety:**

Special attention was given to the safety features of the activity tray table. The design incorporates electrical components, which may be used daily. The table must be completely safe for Sean and others to use, which means proper insulation and waterproofing. In addition, it needs to have rounded corners and be made of all non-toxic, non-allergenic materials. A lip around the edge will be included to keep items on the desk, and the table must be a reasonable weight for transportation. Specific details about the consideration of safety will be detailed in the following "safety issues" section.

**Sustainability:**

The tray table will be made to last. By selecting a durable, high strength wood such as plywood as the primary building material, marking, scratching and other abuse will be minimized. The scratch resistant surface will further increase the endurance of the tabletop. Insulation and waterproofing of the electrical components will keep the items functioning, while helping with safety. The table will be designed to fit Sean’s current wheelchair. It is therefore somewhat limited to the lifetime of the chair itself, but it could be used on a different chair with simple modification.

**Environmental:**

The activity tray table has no glaring negative environmental effects in the design or manufacturing process. The plywood was obtained as scrap, and latex-based paint was used which is generally more environmentally friendly than some of the oil based alternatives. The best environment for the tray table will be indoors, and in a dry location. It should also remain out of direct sunlight, in order to last longer, and to avoid overheating of the electronics, but no other significant packaging or care is required.

**Economic:**

The auditory stimulating tray table will be far superior to more expensive alternatives. There are many children’s games that are commercially available for not much money, but prices increase dramatically for anything specifically designed for attachment to a wheelchair. One previously existing product that was researched was the Gel-Top Sensory Stimulation Wheelchair Tray by Skil-Care, which was simply a soft gel-filled tray tabletop for sensory stimulation. This simple product costs over $120.00 for far less than what Sean’s custom built tabletop will offer.
Social:
The tray table will have a positive influence on Sean. It is designed to stimulate Sean through the audio components, and should help with learning and some positive influence on motor control. The features of the table will promote interactions between Sean and his friends, family, and caretakers. The available ports for auxiliary audio accessories will allow for Sean and his family to use the ipad that they currently use together, which is a significant priority of the design.

Manufacturability:
As with the reclining chair, this product is being made specifically for Sean, and as a result, this design will have limited use except for its intended use. However, it was seen during research that there is practically no competition for this product that is widely available. Although there are many children's activity tables with attached games, there are not many that are designed to have a specialized stimulus and response. A tabletop using electrical components such as this was not found. Existing products that provide the right kind of stimuli are almost certainly not available as an attachment to a wheelchair as a desktop. The existing products were far less sophisticated and costs were relatively high given the simplicity of the designs. A product such as Sean's activity tray table would be in high demand if commercially available.

Engineering Standards:
In the same way as with the reclining chair, every step of the procedure from design to construction of the tabletop will be documented. Standards for safety will be strictly adhered to, and dimensioning will be done to accepted engineering standards. This will allow for replication of the project given the specifications and detailed documentation kept during the process of building. The table will be simple to use, both for Sean and anyone else interacting with him and the game table. Any complicated features or special care requirements will be fully detailed as well.

4 Safety Issues

Reclining Chair:

One of the most important aspects of the design of the reclining chair is the attention to potential safety issues. First of all, Sean will be kept in a proper and safe position by including a lap belt in the design. This will keep him far back in the seat, and because Sean has the tendency to tip over, this is a major component of the project. This also is the motive for including the side supports on either side of the chair. The supports will keep Sean upright, but will be soft and cause no discomfort to anyone using the chair. Another aspect of the chair is the lateral supports for Sean's legs. He enjoys kicking, and as a result, can sometimes get his legs positioned outside of the safe areas of his wheelchair. To prevent this, supports that are similar
to his side supports will be added. These pads will be longer to keep his entire legs positioned safely in the chair, even when reclined. As previously noted, both the side supports and leg restraints will be adjustable, so that they can provide enhanced safety even as Sean grows. The chair will also have supportive but soft foam filling. This will completely prevent any uncomfortable areas where the frame could possibly be felt. The frame itself will be a solid wood base, with a low center of gravity, for stability. The chair will be tested before delivery to ensure safety.

**Activity Tray Table:**

There are a number of features of the activity tray table that have specially considered safety concerns and solutions. First and foremost, the tabletop involves electrical components, many of which Sean will directly interact with. The buttons that Sean will be playing with will be safe to handle, with no rough or sharp edges. They will also be set far from the connected circuitry below them, which will be enclosed in the center of the table. There will also be insulation surrounding the circuitry and directly below the buttons for waterproofing and for safety. The temperature of the electrical components will be tested to ensure fine operating performance. Likewise, Sean will not have access to any of the battery panels on the electronic components. One positive is that each of the electrical components operates at relatively low voltages, and do not pose much danger in usual circumstances. The tray table and any associated toys or features will not interfere with the care for Sean in any way, such as in feeding him via the G tube. The frame will have all edges smoothed and rounded, and the lip around the table will hold items on the surface. Additional toys for tabletop will be evaluated for safety. The table will also clamp onto Sean’s armrests to remain secured. As with the chair, all aspects of the table will be completely tested before delivery to Sean.

**5 Impacts of Engineering Solutions:**

During research and planning, one thing that was extremely evident was the high cost of medical equipment and the lack of personalization of the products that are available. It is therefore a significant project to develop medical goods for relatively low costs, and to make them patient specific. For the recliner, it was immediately seen that existing designs were generally made for fully-grown adults, and despite the simplicity of many designs, they were extremely expensive. It was proposed that using the proportions of the patient would make for a superior, patient specific design. In this case, Sean is an 11-year-old boy and it would not be appropriate for him to use a full-sized, ill-fitting recliner. By adding the features Sean needs, such as the restraints and supports, a superior product will be built. This method decreases costs compared to designing and building a chair to a patients’ specifications completely from scratch, but gives them a better product that is more in tune with their needs. In a medical supply market that has some
outrageously high costs, there is great importance in coming up with designs that are cost efficient to make, and inexpensive to sell. This is not only good for business, but gives people a better quality of life at a decreased cost.

Similar impacts of the design could be identified for the activity tray table project. Despite the countless children’s play-tables that are available, there are not many designed to attach to a wheelchair. Furthermore, there are practically no activity tabletops that attach to a wheelchair and promote a specific response to different stimuli. This project clearly identifies the lack of suitable products for disabled people despite the current progress in understanding and helping patients. The needs of two target audiences, in this case children needing educational and stimulating activities and wheelchair bound, disabled individuals, were considered to produce an item that is not easily available for purchase. In a society that is putting increased emphasis on healthcare, this is the type of product that is needed, and at far lower costs than at what is offered now. Also, the tray table project further illustrates how to start with a basic product and expand and improve on it. In this case, aspects of many different products were considered. Traditional wheelchair desks, existing music players, speakers, and toys were combined to produce a single, improved product.

6 Life-Long Learning

During the process of designing and beginning construction on the two projects for Sean Munzer, many engineering principles and lessons have been learned. First of all, the procedure for coming up with an idea for a product or solution to a problem was learned, while simulating a business like environment. It was seen how a project statement with initial parameters, constraints, and vague details could be refined into three or more design ideas, each with their own pros and cons. Factors such as budget, deadlines, ease of engineering and implementation, as well as trying to be ambitious and deliver the best possible product was considered at all stages of design, sometimes with compromises made in each area. Ultimately, the optimal design was chosen and further refined, to completely outline the proposed project.

Communicating with clients, bosses, and peers was also a major learning experience in the design of this project. Confidentiality agreements and rights to different research and design is important to consider, as is dealing with different personalities, which can sometimes be overlooked in basic classes. Also, planning a project with a group is a new request of the class, which requires cooperation, and use of programs such as Microsoft Project. Presenting yourself through a good résumé, and paying attention to good presenting traits is also important and is stressed in this course.

Another important aspect of the development process was learning the different software that will be needed in future engineering applications.
Solidworks and NX 8.0 are used as computer-aided design programs, which allow for designs and analysis of engineered parts and components. Also, Dreamweaver is used for the website design, which is an important aspect of presenting work. Often, the programs have little explanation other than the available tutorials, so developing independent learning is an important skill that is refined during this process. Coupled with the advising of the Covidien engineers, better engineering practices such as the inclusion of technical engineering sketches are promoted.

Although just beginning on the physical building of the projects, there have been countless lessons learned, and undoubtedly more will be learned as the building of prototypes start. It has been important to sometimes fail, and to have disagreements, but to learn from the mistakes. For example, sometimes there are disconnects between a part that is wanted and what is actually offered commercially. Altering the design and working around this problem, or finding an alternative solution is one of the many lessons. Learning how to actually create the components needed in the machine shop will be a necessary part of training to be an engineer. After simulating, building, testing, and presenting, the fundamentals of working as an engineer will be better known.

7 Budget

Reclining Chair:

Although the team has been given an approximate budget of $1000.00, this is to be divided between five projects for three families and was not enough for all the projects. The proposed list of necessary parts and prices for the reclining chair can be seen below, in Table 1.

<table>
<thead>
<tr>
<th>Part #</th>
<th>Part Description</th>
<th>Quantity Needed</th>
<th>Quantity Sold</th>
<th>Price/Rate</th>
<th>Subtotal</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Chair Structure As Purchased from NEAT</td>
<td>1</td>
<td>1</td>
<td>$100.00</td>
<td>$100.00</td>
</tr>
<tr>
<td>2</td>
<td>Waist Support Pads from NEAT</td>
<td>1 pair</td>
<td>1 pair</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>3</td>
<td>Machine Screw Sinks and Misc minor parts</td>
<td>-</td>
<td>-</td>
<td>$10.00</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Foot pads from NEAT</td>
<td>1 pair</td>
<td>2 pair</td>
<td>$20.00</td>
<td>$20.00</td>
</tr>
<tr>
<td>4</td>
<td>Parts and Labor from J.G. Taglieri Upholstery</td>
<td>-</td>
<td>-</td>
<td>$600-$800</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$730-$930</td>
</tr>
</tbody>
</table>

Table 1: Estimated budget for Sean’s reclining chair
Activity Tray Table:

There is a separate proposed budget for the activity tabletop. The costs are outlined below, in Table 2.

<table>
<thead>
<tr>
<th>Activity Tray Table</th>
<th>Quantity Needed</th>
<th>Quantity Sold</th>
<th>Price/Rate</th>
<th>Subtotal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speakers</td>
<td>1</td>
<td>1</td>
<td>$19.99</td>
<td>$19.99</td>
</tr>
<tr>
<td>Music Player</td>
<td>1</td>
<td>1</td>
<td>$16.99</td>
<td>$16.99</td>
</tr>
<tr>
<td>Keyboard Toy</td>
<td>1</td>
<td>1</td>
<td>$44.95</td>
<td>$44.95</td>
</tr>
<tr>
<td>Wood</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Dual Mini Jack Coupler</td>
<td>4</td>
<td>4</td>
<td>$5.49/1</td>
<td>$21.96</td>
</tr>
<tr>
<td>3 FT 1/8” ST Plug to RCA plug</td>
<td>4</td>
<td>4</td>
<td>$8.49/1</td>
<td>$33.96</td>
</tr>
<tr>
<td>Scratch Resistant Paint and Primer</td>
<td>2</td>
<td>13 OZ.</td>
<td>$20.00</td>
<td>$20.00</td>
</tr>
<tr>
<td>Switchbox</td>
<td>1</td>
<td>1</td>
<td>$19.99</td>
<td>$19.99</td>
</tr>
<tr>
<td>Misc (glue, screws, hinges, batteries, etc.)</td>
<td>As Needed</td>
<td>As Needed</td>
<td>-</td>
<td>$30.00</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>$207.84</strong></td>
</tr>
</tbody>
</table>

Table 2: Estimated budget for Sean’s activity tray table

8 Team Member Contributions:

There has been significant input from most group members in many different aspects of the projects for the Munzers. However some of the greater contributions are listed in the following sections. Also, there were times when the entire group worked together. Some of these group accomplishments include initial meetings with the clients and updates to weekly projects.

8.1 Ana Groff:

Ana has helped considerably in the design and construction of the reclining chair and the activity tray table. She has helped research parts for both projects, and has recorded the budgets and amounts spent by each team member. Ana helped strip down the recliner that was obtained from NEAT. This involved removing the upholstery, cushions, cardboard, and even pulling the staples from the frame. She also traveled to the NEAT marketplace and influenced the activity tray reclining
mechanism. Ana also provided weekly updates to the team's website. She also helped with a lot of the construction of the activity table, and has kept up to date with progress from the upholsterer.

8.2 Brandon Calavan:

Brandon has been instrumental throughout the entire design process. He has helped research parts, and even used friends and personal connections to get the very best deals possible. Some work for the recliner and activity table has been done at his house, using his workshop and tools. Also, some of the small pieces of wood for the tray table will come from some of the wood he already has. Brandon has also traveled to NEAT for ideas and purchasing. As a carpenter, he has had some of the greatest impact on what is feasible, and how best to handle the design. He also contributed to the alternative designs for the projects, both the recliner and tray table. He has helped in the building of the table and chair.

8.3 Dylan Rinker:

Dylan provided a great amount of help in the initial design and subsequent alternative designs for the activity tray table. He was largely responsible for some of the decisions as to what sensory stimulating toys will be incorporated into the design, and where. He also helped in the deconstruction of the NEAT recliner, as it was stripped down to the frame. Dylan also traveled to NEAT and came up with a number of ideas for the project based on the findings at the marketplace.

8.4 Sebastian Pineo:

Sebastian has helped with the purchasing of the power recliner from NEAT marketplace, and with the transport of the chair. He has given some input into the design of each project, and offered solutions to some of the circuitry questions that have arisen during the design of the activity tray table. He also helped in the disassembly of the power recliner. Sebastian helped research the activity table’s second design, when the plan from the electric shop proved to be too complex.

8.5 Steve Benn:

Steve has had input in every stage of the design and construction of the reclining chair and activity tray table. He has proposed most of the initial designs and alternative designs. Part research and purchasing has been done, and the recliner was picked up from NEAT. Other, extensive research has been done at the NEAT market. Steve has worked on developing the circuitry of the activity table, and helped dismantle the recliner. Steve has also helped Ana with support of the team’s website. He worked on every single project.
9 Conclusion:

There are two projects for Sean Munzer and his family and loved ones. The first request is for a comfortable alternative seat to Sean’s wheelchair. Sean has cerebral palsy and currently spends most of his time in his wheelchair, except for an hour or two a day when he is given “floortime.” While it is beneficial for Sean to be out of his chair, time on the floor does not offer the safety and comfort that should be possible. This will be achieved by altering an existing power recliner to better suit Sean’s specific needs. The chair will be fully automatic, and can be simply controlled by any caretaker. Also, it will have the waist supports that Sean needs, to prevent him from falling over. He will be kept in place by a lap belt, and his legs will be free to kick, which is important for Sean. However, there will be cushions to restrict Sean’s legs from becoming positioned in an unsafe way during kicking. The chair will also be mounted on lockable castors, for optional mobility. The chair should provide greater comfort for Sean, and further ease of care for his parents.

The other project was to construct an activity table for Sean. Because of his cerebral palsy, and related learning deficiencies, Sean requires toys that will provide sensory stimulation. Additionally, he enjoys auditory themed games, which will be incorporated into the tabletop. There will be a programmable music player, as well as a piano toy. The musical components will be hooked up to a pair of speakers and all the electrical features will be run off of battery power for portability. There will also be other toys that can be affixed to the surface of the desk. Also to add functionality, the desk is designed to have a workspace, and a mechanism to incline the desk. The tabletop should help develop Sean’s motor skills while providing auditory stimulation.

10 References:


11 Acknowledgements:

The team would like to thank the people that contributed to the overall success of the projects. Some of the individuals who have significantly helped include:

Sean and the Munzer Family: Design input and support
Katie Cooney: Design input
John Enderle: Advisement and technical knowledge
Sarah Brittain: Advisement and input
NEAT Marketplace: Design ideas, part ordering, and advice
Jennifer Delroises: Parts ordering
Orlando Echevarria: Website support
J.G. Taglieri: Professional upholstery help

12 Appendix:

12.1 Updated Specifications:

Reclining Chair:

Materials:

- Wood frame
- Metal frame components
- Foam sheets and filler
- Nylon thread
- Vinyl covering

Mechanical Details:
Size:
- Outer width: ~34"
- Inner width: ~20"
- Seat length: ~18"
- Seat back height: ~28"

Weight Allowance: 200 pounds.

Maintenance: Wipe down

Storage Temperature: 10 – 100 °F

Activity Tray Table:

Materials:
- Wood
- Speakers
- Music player
- Keyboard toy
- Switchbox
- Electrical accessories (buttons, wires, etc)
- Electrical insulation tape/foam
- Scratch resistant paint

Mechanical Details:

Size:
- Width: 22"
- Length: 28"
- Inner width (handle to handle): 19"

Weight: <10 pounds

Electrical:
- Voltage: 1.5 V
- Battery powered
- Rechargeable

Safety:
- Waterproof
- Soft edges
- Electronic components enclosed and insulated
Maintenance:

- Wipe down
- Replacement of all batteries (4 AAA, 3AA)

Storage Temperature: 10 – 100 °