Project Statement & Specifications
Comfort Head and Neck Support Device and Multi-Use Table

Team #1
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Project for Client: Annalee Hughes
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Statement of Need

The purpose of this project is to design a more comfortable head and neck support system for proper upper body and head positioning along with a multifunction, adjustable table for reading material and a laptop for Annalee Hughes, a 10 year old female suffering from Cerebral Palsy. Cerebral Palsy is a broad classification of abnormal conditions of muscle tone, reflexes, motor skills development, and fine coordination. Annalee is a bright, courageous, enthusiastic girl who is unable to stand or sit without external assistance and lacks the necessary core body strength due to a baclofen pump, which prevents muscle spasticity in the abdominal area. Due to the medical treatment and her chronic conditions, Annalee requires a suitable device to support her trunk section along with the head and neck. Since Annalee is confined to a power chair for a portion of the day, the device must be seamlessly integrated into her current power chair. In addition to a supportive device, Annalee requires another separate device for daily school learning activities and enjoyment at home. This device should correctly position her laptop, reading material, and homework that would lead her to elaborate on her creative side and exceed her academic goals. As with the first device, the second must also be seamlessly integrated into the current and possibly future design of her current power chair.

Introduction and Overview

For this project, the design team will construct two distinct devices, a head and neck supportive device and a mountable multipurpose table, each with their own specific function.

First, the purpose of constructing the head and neck support device is to provide the necessary comfortable support to the abdomen, trunk, and neck regions. The head and neck support device provides padded shoulder braces that correctly and anatomically position the core area. In addition, the device contains another padded support, positioned under the mandible to position and support the head. However, the device must not be cumbersome and overly restrictive to Annalee inhibiting the completion of everyday tasks. In addition to the primary objective of providing support, the head and neck support device must also be attractive to a 10 year old girl, interesting in design, and durable to withstand extended use and the outdoor environment. Furthermore, the head and neck support device must be completely compatible with her current power chair, with possible upgrades and future designs, along with changing physical development during puberty and later years.

Second, the purpose of the mountable multipurpose table is to provide an adjustable, hardtop desk for the completion of schoolwork, reading, and computer activities. Presently during school, Annalee is required use a special desk that accommodates for the size and configuration of her power chair. However, an incorrectly positioned table causes unnecessary gravitational strain on Annalee’s upper body. By designing a mountable, adjustable multifunction table, Annalee can comfortably and ergonomically complete any task a person can perform at a desk or table. Furthermore, the multifunction table will be collapsible and storable along side the power chair for convenience in transfers to and from the power chair. What makes the table multifunctional is the ability to hold reading material upright, i.e. as with a music stand, and then fold forward to lay parallel to the ground and function as a table. In addition to these major features, the multifunction table will contain a battery-powered light for adequate
lighting during reading, writing, and computer activities. Also, side mounted magnetically latching drawers for storing small electronic devices and school supplies.

**Realistic Constraints**

There are some outside factors that will constrain this project. Economic constraints are a big factor in influencing the outcome of the project because it effects how much can be developed. For this design project a budget of approximately $750 will need to cover all materials and services required to produce a positioning system and adjustable table. A higher budget allows for greater quality of the product due to materials that are better suited for the purpose but may cost more money. With a higher budget newer memory foams or high comfort gels may be used instead of less expensive foam. In this case, the client may not be able to pay much money because they have been burdened with a high cost of living that comes with dealing with a special needs child. This makes it crucial to design a product that is both cost effective and high quality so that it lasts a long time.

The project is also constrained by the environment in the way that it must conform to Annalee so that it is effective and does not harm her. The design must fit onto the existing power chair and not disrupt the layout that she is accustomed to. The positioning of Annalee may be optimized so that she is most comfortable which is related to gravity and Annalee’s size. Material selection can also be based on what is best for the environment and include green materials if they are available. The production process should also be adjusted so that there is minimal waste that could affect the environment.

The product needs to be sustainable so that it survives for many years and does not need to be frequently replaced. Therefore, the head and neck support device and multifunction table needs to be sturdy and any moving parts need to be designed to reduce fatigue and prevent failure points. Since the design contains motorized components, it would be important to have them easily serviceable and to provide a schematic to facilitate maintenance if device breaks down. Since there may be a variety of loads placed on the table, it is important to make it structurally sound and give it full support in all positions.

Manufacturability is essential for any design because if a product cannot be reproduced easily, it will increase the price and reduce the number of sales. For this project, current technology and ready made parts will be used to ensure that the finished project can be easily replicated. There may be some parts that have to be custom designed or adjusted, but a qualified person should be able to perform those tasks. All specifications and processes should be recorded so that it would be easy for another person to replicate the finished product if needed.

Some ethical constraints may include making sure that the product is beneficial to everyone involved and does not hurt any of the parties. Adjusting the head and neck support system should improve routine tasks performed by health care providers while not restricting Annalee’s comfort and dexterity. It is also important to ensure that Annalee has full mobility and that the design does not restrain or inhibit growth and activity. This also relates to some health constraints, which includes providing the most safety for Annalee. Any part that actually touches her needs to be padded to ensure her comfort. Hard, sharp edges need to be avoided so
that a quick movement does not cause her harm, especially since much of the project will be in close proximity to her. The materials used that are in contact with her skin need to be chosen to avoid rubbing, chafing, or allergic responses. The materials should be easily cleanable and sanitized in case food or other bodily fluid contact the materials. As designers, it is our ethical duty to design a product that is reasonably safe in all foreseeable uses.

This project does not have any political constraints but there may be some social constraints to consider. When Annalee is in public, she may want to remove some of the hardware so that she does not draw as much attention to her disability. The project should also be designed so that it is possible for her to socialize and interact with other people without feeling restrained or too far removed. All of these constraints will play a role in shaping and developing the best product possible for Annalee.

**Other Data**

At the age of 10, Annalee Hughes is approximately 56 inches tall and weighs about 62 pounds. She cannot walk or stand unassisted and requires some support while sitting. If she is holding something stationary, she is able to stand by herself and she is able to move her hips to aid in transfers and positioning. She has weak trunk muscles which cause her to lean forward and this will probably not improve with time. Her head tends to drop forward therefore some type of chin rest would be beneficial to her positioning.

The current head and neck support system mounts to the headrest. Changes to the armrests are currently being considered by her family which would impact the attachment site of the new multifunction table. Annalee is able to manipulate buttons and levers but does not have full extension of her arms, which may make it difficult to move sliding parts.

Figures 1 and 2 below illustrate Annalee’s current chair and how it is set up.
Figure 1. Annalee sitting in her current power chair, a lateral view
Questions

Are there any personal belongings that Annalee would like on her desk every day, or a special color she would prefer?
What mechanical or electrical interface will Annalee best be able to use for the adjustment of the desk (lever, joystick, or button)?
Where and how will the desk attach to the client’s current wheelchair?
What measurements of Annalee’s body will be required to create the best custom ergonomic design for the support system?
How will electrical motors be incorporated into the design?
What are the exact dimensions of Annalee’s current power chair?
Will the current i2i device be used with improvements made upon it, or will a new system be designed?
What is the optimal head and neck supporting position?
How would the PT adjust the head and neck positioning and support system?
What foam or gel system will be used as the material to provide comfort and padding throughout the support system?

**Operational Specifications**

An adjustable lap desk must be designed to attach to the armrest of the client’s current wheelchair. The desk should function as a secure and easily accessible space for all school related materials including: books, writing utensils, laptop computer, cell phone, remote, and Annalee’s lunch. The desk must allow Annalee to adjust the positioning and angle through the use of levers, buttons, or a joystick. The range of motion of the desk should allow Annalee to tilt it forward or backward, up or down, and move the desk out of the way for entering and exiting the chair. Access to lever, joystick, or buttons must be properly positioned according to the extension angle of Annalee’s right arm, which is not at 100%.

A head and neck positioning and support system must be designed to be 1) attached to the head rest of client’s current wheelchair for during school hours 2) adjustable in height and position to accommodate different chair angles and seating positions 3) provide extra support without being too restrictive specifically for Annalee’s head, which tends to drop forward while sitting 4) be ergonomically fitting to the client’s body and comfortable. Annalee’s parents or her physical therapist will adjust the head and neck positioning system.

**Technical Specifications**

Head and Neck Supportive Device

*Physical:* Lightweight metal frame surrounded by foam or gel padding

*Mechanical:
  * Size: Based on neck circumference, shoulder width, arm length, neck width, neck length
  * Weight: Not to exceed 10 pounds

*Environmental:
  * Storage Temperature: -20°F - 120°F
  * Operating Temperature: -20°F - 120°F
  * Operating Environment: Indoors, Outdoors

*Safety:
  * Easy to remove in case of an emergency (choking)
  * Maintain desired position throughout any rapid or cyclic movements

*Maintenance:*
Machine washable as needed
Adjustments to positioning as needed

Multifunction Table

**Physical:** Lightweight metallic connection with a durable plastic tabletop

**Mechanical:**
- **Size:** 24” x 18” x 4”
- **Weight:** Not to exceed 10 pounds

**Electrical:**
- **Collapsible Desk Lamp:**
  - Maximum Output Voltage: 3 Volts DC (VDC)
  - Maximum Output Current: 250 milliamp (mA)
- **Table Movement Motors:**
  - Maximum Input Voltage: 8 Volts DC (VDC)
  - Maximum Input Current: 2 Amps (A)
- **Battery:**
  - Maximum Input Voltage: 8 Volts DC (VDC)
  - Maximum Input Current: 2 Amps (A)
  - Maximum Output Voltage: 8 Volts (V)
  - Maximum Output Current: 2 Amp (A)

**Environmental:**
- **Storage Temperature:** -20°F - 120°F
- **Operating Temperature:** -20°F - 120°F
- **Operating Environment:** Indoors, Outdoors

**Software:**
- **User Interfaces:** Assistive technology switch (Buttons)

**Safety:**
- Possible danger from moving parts
- Possible electric shock
- Easy to remove in case of an emergency
- Manual override
- Rounded corners and padded edges

**Maintenance:**
- Charge and replace batteries as needed (3 years)