PROJECT PROPOSAL

HEAD-MOUNTED

&

ARM-MOUNTED

ART DESIGN SYSTEM

NSF SPONSORED PROJECT

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EXECUTIVE SUMMARY:

The following proposal explains in depth the intended specialized head and arm-mounted art design systems project that will aid people with cerebral palsy and hydrocephaly to create works of art. The client’s background, the details of her condition, and her overall wishes are outlined. Using different principles of engineering, a well designed and cost efficient project will be produced to best suit the client. A detailed description of the objectives of the project is proposed, which includes the system requirements and how the device will be implemented. Preliminary designs of the intended project will be shown as well. The analysis of possible design components will be written out, along with explaining the functionality of the overall device as a result of these main components.

Other existing art assistive devices made for people with limited motor skills in the market will be examined and compared to the overall conceived product. The possible use of components previously utilized by others will be discussed. In addition, existing patents of aforementioned devices will be overviewed in this proposal. The budget and anticipated cost of the completed project will be analyzed and compared to the existing products, as well as the performance of the art design system to the other established products. Overall, the proposal will provide the reader with a full and detailed description of the methods and goals of the project, while proffering insight into the art system’s effectiveness of reaching the goals of the client.

INTRODUCTION:

1.1 BACKGROUND:

“To create and live out a best practice model for collaborative art making between artists with and without developmental disabilities. This new mindset demonstrates that creativity is innately a part of all people and recognized that art enhances the quality of life and strengthens communities.”-Passion Works Studio

The Passion Works® Studio, with the aid of the National Science Foundation, is requesting more available resources to help individuals with limited motor abilities to express themselves through the visual arts. This Studio, located near Ohio University, is a well-established program that assists adults with cognitive and physical disabilities in the arts to better their quality of life. Passion Works® is recognized nationally for the artwork made by its talented artists. The proposed art design system will help its respective user to depict various squiggle designs. The completed head and arm mounted systems will not only decrease the work and stress on the client but it will also allow the user to better fit in this art enriched environment.

Stacey, who has both cerebral palsy and hydrocephaly, is the primary motivation for this project. Cerebral palsy is a condition that results from brain damage. Hydrocephaly is a buildup of cerebrospinal fluid in the ventricles of the brain, which can compress and damage the brain. The weight of Stacey’s head and her restricted range of motor functions prevents her from drawing in the way that she desires. Previous attempts to address her needs failed miserably. She longs for
devices that can attach to her head and her arm that will overcome her motor limitations, and will let her create works of art. The new design will be comfortable, functional, durable and user friendly in hopes that she can fulfill the Passion Works Studio vision. This unique system will make drawing easier for other artists at the studio who experience similar disabilities as Stacey as well.

1.2 PROJECT PURPOSE:

The project envisioned is to create devices that will assist Stacey and other artists like her at the Passion Works® Studio in reaching their maximum artistic potential. Dr. Brooke Hallowell will be the National Science Foundation representative consulting on the project progress of the head and arm mounted art design systems.

Since this device may be used on multiple people, the head mounted system will be comfortable and adjustable that can cater to head sizes of all circumferences. In addition, the hand or wrist component will be lightweight and able to fit multiple people as well. The head and arm pieces are meant to be compatible for paintbrushes and thick markers since Stacey will be using multiple types of art tools. The units will keep aesthetics in mind, but also be durable and easy to clean. The design system will be easy to set-up and store. These arm and head devices will allow the artist with limited motor control to create fun, artistic patterns with simple brush to canvas contact.

PRIOR WORK DONE BY OTHERS:

1.3.1 PRODUCTS:

In the market today there are very limited options for Stacey that might allow her to paint or draw with limited control of her motor skills. There are products that address some of her needs, but do not encompass all of them into a single product. For example, there are motorized pens available in many toys sections of retail stores. However, these do not aid Stacey with her limited motor skills.

The National Science Foundation has sponsored somewhat similar art-related projects in the past. An adjustable pencil gripper made by students Binghamton University, SUNY in 1998 was a hand-held gripper that allowed the user to use writing instruments when they were unable to grip the pencil well. The handle of the pencil gripper was perpendicular to the writing instrument, which allowed the user to lay his or her hand on the table while writing. However, Stacey requested a device that will attach to her wrist and will not rely solely on her holding the art instruments.

The “Painter’s Aid” produced by a Mississippi State University engineering students made a device for a woman left with no movement in her fingers and had very limited wrist control. In the end, she was able to dispense paint from a tube onto a palette for her use with the simple touch of a button. A lever required only gross motion with limited force and operates the device.
The device sealed the tube after dispensing the paint. Also, NSF has requested many different types of easels for people with limited motor control, but that does not help Stacey’s situation.

1.3.2 Patent Search Results:

Doing a thorough search for United States patents similar to an intended project before the design stage is mandatory. A patent legally restricts the use of any component described in that patent in order to not allow other companies to steal their ideas. The appeal of the patent is that it covers a 14 year period after the grant date of the patent to ensure no other companies copy its ideas. All the patents below were found using the search patents option located at www.uspto.gov.

Patent 6,966,075 relates to an adjustable helmet made of a first and second shell connected together. Each shell features a smooth interference-free sliding surface where the two shells fit together in an overlapping fashion. The two shells are locked together by a manual locking device. The smooth interference-free sliding surface allows for easy helmet size alterations.

Patent 6,665,884 describes a helmet invention with self-adjusting padding designed to adjust to various head sizes of individual wearers of the helmet. The protective helmet has a helmet shell having an interior surface, a first helmet pad, a second helmet pad, and at least one expandable band. At least one expandable band is attached to each of the second pad sections.

Also found on the patent search was D331,778 for a motorized pen with an ornamental design. In addition patent number 6,434,774 is a motorized brush apparatus that includes a supply of a fluid, such as water, that is actuated upon a targeted surface. A switch allows the user to interrupt the rotational movement applied to a rotating brush assembly at one end of a shaft. A motor assembly is mounted at the other end of the shaft. The bristles are perpendicularly mounted to a rotating base plate provided with arched openings that allow the fluid to pass through.

Patent 5,732,920 describes a Lamp neck assembly for an architect lamp, which its ideas will be utilized in the final crane arm design. The mounting assembly secures a lamp head to a lamp support arm with at least one accurate wall upstanding from the base, and an open top secured to the lamp head. A pivot bearing is mounted in the base for rotation on a first axis perpendicular to the base. An additional manually adjustable clamping device is provided to apply additional force to the pivot means to resist pivotal movement, which holds the lamp head in a fixed position.

Project Description
2.1 OBJECTIVE

The head and arm mounted art design system, as previously stated, is for artists at the Passion Works Studio with cerebral palsy and hydrocephaly. These disorders lead to some brain damage and involve limited motor movements. Therefore, the artist is not able to draw any desired shapes that he or she may want to incorporate into their artwork. The head component in this art design system makes it a very unique device, since it has not been made previously by any NSF funded project at the University of Connecticut. This project will completely transform the art capabilities of the client. As the name suggests, this device will have two parts to it: the head mounted part and the arm mounted part. These two parts will not be attached to each other and therefore can be used by two different people at the same time.

The primary function of a National Science Foundation funded senior design project is to aid persons with disabilities. The head and arm mounted art design system does just that. The specific objectives of this project are to design a low-cost, versatile and easy-to-store art design system that will completely transform the life of the client. Stacey will be able to use multiple types of art tools such as markers, brushes, and pencils as the devices will be adaptable to fit any of those circumferences.

The head component of this system will be composed of a headpiece that would contain an extension to load a variety of art tools. This extension would also be able to retract so that the system can be stored away in a safe manner. The origin of the extension system would be from the back of the headpiece, but would be able to have 3-D motion therefore allowing the client to draw, paint or color on a desk or on a canvas. The arm component of the system will contain a wrist support which will be used to mount the extension that reaches the art tool to the medium. The extension in the arm will have a movement of 180 degrees so that the client could display their artistic abilities both on paper and on the canvas, which is in a vertical position. The distal ends of the extension system will also contain electrical motors that would be used to draw different types of squiggles and will be operated by an on/off switch. The whole system will be operated by a rechargeable battery, so that unnecessary wires in the art room will be avoided.

The weight of both the parts of the system will be within a comfortable range for the client, not exceeding the threshold of the weight a human’s head may maintain. The aim is to have the head mounted device be approximately 15 pounds and the arm mounted device being about 5 pounds. Most importantly, the device and its operations must be safe and sound. The safety of the user is of utmost importance and will be the vanguard of concerns. The motors will be altered so that Stacey and others will be able to choose between 2 to 3 designs to paint or draw with. The texture, corners and edges of the head and arm mounts will be specifically designed to avoid harm to people around the user in the art studio. To reiterate, the head and arm mounted painting system not cause harm to the user while in operation. Ideally, this innovative design will enhance the artistic side of the client at the Passion Works Studio.

2.2 METHODS

In order to build the best art design systems, many factors and different components of the device must be taken into careful consideration. Some of the technical specifications include
center of mass, range of motion, and spring kinetics. In addition, mechanical, electrical, and environmental features must be factored in. These include corrosion resistance, good weatherability, high strength to weight ratio, easy storage, adjustability, durability and light in weight. The project is broken down into the components of the head and arm mounted pieces.

In the head mounted portion, the components will be the adjustable headpiece and the extension arms. For the arm mounted art design device, there will be the comfortable wrist cuff and the extending antenna port. Some pieces that will be utilized and interchangeable for both of these systems are the motor, rechargeable battery, and the adaptable utensil holder. See figures one through three for visual representation of system.

The head mounted art system as depicted in figure 1 and 1.1 is composed of a basic head piece and an extension crane. Since one of the client specifications was that any number of patients with varying head circumferences will need to utilize the system, the head piece will be made of a very sturdy yet flexible material. The adjustable crane will be docked in a location which will minimize stress on the patients head and neck. The crane will be composed of very light, durable and corrosive resistant material. The idea of center of mass plays a crucial role in the design and construction of the head mounted art device. Since the crane has a large freedom of range the material used to build the crane must be extremely lightweight in order to prevent any unwanted strain on the patient. But because the cranes positioning will be altered often and since it also must provide a harbor for the adaptable utensil holder, it will be both durable and possesses strong mechanical properties. Materials which have these valuable qualities; aluminum and ultra high molecular weight polyethylene (UHMWPE), are being considered as potential candidates to make up the crane. Other hazards such as sharp corners will be vanquished with the addition of polymer or other soft ductile and durable components.

About four springs will be used in the crane in order to maximize both stability and maneuverability of the docked art utensil. Typical hardened steel springs will be prone to corrosion due to water from painting and electricity due to the mounted motor. This is why a phosphor bronze alloy (for reduced corrosion resistance) and a beryllium copper coating (for increasing electric resistance) will be used. Since the springs are relatively light, there presence will further enhance the overall component.

The hand device (Figure 2) will be fabricated out of neoprene and other durable and comfortable fastening components. The neoprene fabric will provide the right amount of ductility and firmness, plus its water resistant and easy maintainability factors make it very user friendly. Velcro was initially to be used in the fastening components but due to its short life span, the idea was discarded. Instead a latch and loop metal and polyurethane system will be used to fasten the glove and keep it in place. On top of the hand device will be the extending antenna port (Figure 2.1) which will also serve as a dock to the adaptable utensil holder (Figure 3).

The purpose of the extending antenna is to increase accessibility of artists drawing surface to the respective art utensil. The extending antenna behaves very similarly to an electronic car antenna in that it is able to increase its length when turned on. But instead of having a fixed extension length it will be able to change length depending on the users preference.
The adaptable art utensil is a simple and user friendly device that can be mounted to both head and hand mounted art devices. For the head mounted device it sits atop the end of the crane in the designated port. On the hand mounted art system the device will be attached to the end of the extendable antenna. The art utensil holder functions much like a drill. Instead of a rotating drill bit there will a moving art utensil. The fastener surrounding the clamp permits for interchanging art tools with a simple turning motion for tightening and loosening. Currently a small pressure activated motor will allow the artist to automatically pick up and interchange art tools, but they might require some extra assistance.

Both hand and head mounted art systems will be able to endure exposure to sun and rain, but extreme heat will be potentially detrimental to both components. Moisture and humidity will have no hazards effect on the designs except with respect to client comfort. If the artist is working in extraordinarily hot and humid conditions, they might feel discomfort when using the neoprene hand mounted art device for, the neoprene material is not breathable. It is not recommended that the user not work in these conditions with the device, but if they intend on it then a potential breathable nylon mesh membrane, perforated neoprene or Stomatex® neoprene fabric could be used. Stomatex a new form of neoprene which copies the transpiration processes of plants yielding a nonporous breathable and waterproof material. The devices should be stored at room temperature and in a dry environment at all times when not in use. If all above listed precautions are followed the life span of the system will be increased.

The electrical aspect of this system is an important one because one of the primary needs for this device is safety. This aspect should be taken very seriously as it has been the cause of a relatively large number of accidental deaths per year. In our device, the only part that will require electrical activity will be the motors. The motors that will be used in this art design system will be approximately 2 cm in diameter and length. The rotational speed of the DC motor is proportional to the voltage applied to it. Due to the fact that the motor making the squiggle designs does not require high speed revolutions, the maximum amount of voltage will be 9 Volts. These 9 volts will be provided for with a rechargeable battery, which may be plugged into a standard outlet for charging. The battery will power the antenna aspect of the arm mounted contraption.

A motor that has the following specifications is ideal for this project:

- Operating range: 6 - 15V
- Nominal voltage: 12V
- Speed: 100 rpm
- No load speed: ≤500 rpm
- No load current: ≤9.5mA
- Out diameter: 27.7mm
- Shaft diameter: 2.3mm
- Body length: 32.6mm
Figure 1
Head Mounted Art System
Side View

Figure 1.1
Head Mounted Art System
Frontal View

Adjustable Head Piece
Chin Strap
Figure 2
Arm Mounted Art System
Top View

Figure 2.1
Hand Mounted Extension Antenna *Extended*
Frontal View

Figure 3
Adaptable Utensil Holder
Frontal View
As can be seen in the above figures, the center of mass is an important aspect to think about for the head mounted art design system. The center of mass of a system of is a specific point at which, the system's mass behaves as if it were concentrated. The center of mass will be located right around the top of Stacey’s head. If it were not, it would cause her head unnecessary strain and to tilt over. She already has difficulty keeping her head in an upright position due to her hydrocephaly, so the aim is to not have this difficulty further exacerbated. The range of motion will also be carefully considered when the prototype is made. The crane arms must be able to move to either side of the client’s body, while also being able to reach a canvas or to reach the desk in order to paint or draw. In addition, the crane arms must give some leeway for the markers or brushes to go towards the left and right sides of the paper. Similar reasoning is applied to the arm mounted component as well. The antenna coming off the wrist will be able to move approximately 180 degrees so that if Stacey holds her wrist in the middle of a paper, the designs may be drawn on either sides of her hand onto the paper. For the spring component in the crane arms on the head, physics of springs will have to be examined closely. The spring must have an appropriate modulus of elasticity to allow the crane arms to stretch easily, but not too high of a modulus or else the arms will not stay in place after being positioned. Also, the spring must not deform past its elastic limit or else it runs the risk of snapping and possibly injuring the user or others around.

**B U D G E T:**

The total project budget is $750 USD with the aid of the National Science Foundation. Currently out in the market there are no similar biomedical products that aid people with limited motor skills to paint or draw. Since the intended product is very unique and specific, the aim is to not make an overly expensive product since the goal is to make the client feel happy and satisfied. This includes having a product which has a low cost for production, yet a high quality finished art system. See table 1 for estimated component prices below.

<table>
<thead>
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<th>Table 1 Forecasted Component Pricing Ranges (USD)</th>
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<tr>
<td><strong>Headpiece</strong></td>
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<tr>
<td><strong>Lamp Arms</strong></td>
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<tr>
<td><strong>Wrist Guard</strong></td>
</tr>
<tr>
<td><strong>Motor</strong></td>
</tr>
<tr>
<td><strong>Rechargeable Battery and Wall Mount</strong></td>
</tr>
<tr>
<td><strong>Antenna</strong></td>
</tr>
<tr>
<td><strong>Springs</strong></td>
</tr>
<tr>
<td><strong>Aluminum Stock</strong></td>
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<tr>
<td><strong>Net estimated costs:</strong></td>
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Taking into consideration the challenges that engineers come across during the designing portion of a project, it can be expected that the total production cost of will be much greater than the cost of the actual product to ensure that the best prototype may be made. With costs of materials and costs of the various components on the available market, it may be estimated that the overall cost of the finished product will be approximately $300.00. However, the maximum budget is $750.
which will leave room for some minor errors along the way. The target cost of the completed product is the estimated $300.00 cost, which takes notice of the 35% of the maximum cost of prototype production.

**CONCLUSION:**

The head and arm mounted art design system is a result of a very unique need of a client who, as mentioned above, has cerebral palsy and hydrocephaly. This product is specially customized because the client wants to fully display and incorporate her imaginative ideas using these pieces. The final model is thoughtfully catered for the needs posed forward by the client as indicated by Dr. Brooke Hallowell. This device will be user friendly to its utmost potential and will help the artists at Passion Work Studio to enjoy art activities and use this device as a therapy. Overall, this device will reduce the amount supervision done on the artists who have limited motor control and have required considerable amounts of attention in the past.

In addition, the device would be resilient and robust to withstand everyday wear and tear plus any relative misuse. It is important to note that this device will not only be used by Stacey but also, many others at the studio and therefore making it a very popular tool. As mentioned earlier, there is no product in the market that caters specifically to Stacey’s exact needs. There will be no market issues since there has been no market made yet for this innovative type of product as of late, yet there is a demand for these two devices. The budget is projected to be within the allotted $750, so there should be no concerns in this area either. In conclusion, the arm and head-mounted art design systems will utilize biomedical engineering technologies to help better the lives of these individuals with cerebral palsy and bring them to a whole new level of expressing themselves.