Accessible Adjustable Easel (AAE): An Assistive Tool for Community Skill Building

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Problem Statement/Research Question and Background

Community Living and Support Services (CLASS) is an independent organization located in Pittsburgh, PA that provides community services to people with disabilities. As part of their curriculum they offer a number of community skills classes that assist adults with disabilities in gaining valuable life skills. One of these classes is an art class similar to what a person may have participated in during their years in school. This class allows for people with disabilities to interact with one another while participating in a classroom like environment. Many of the students who are in the class have some type of disability that affects their ability to ambulate. Because of this a number of the students use either a manual or power wheelchair to navigate the facility and the art room.

The main problem that our group has observed with students in the art room is how the students interact with the equipment and art supplies. One reason for this problem is the organization of the room and how much of the space is taken up by furniture. To alleviate this issue some students who use a wheelchair will instead use a free-standing easel to paint or complete other art projects. However, this easel is not designed with the wheelchair population in mind as there are a number of issues that affect how they interact with it. These issues included having a base that didn't allow for the wheelchair user to get as close to the easel as was necessary. The mechanisms for adjusting the height and angle of the device were also not very precise and had to be operated by an instructor rather than the student. Essentially the device served a purpose but was not meeting the needs that were required by the people who were using it.

Methods/Approach/Solutions Considered

The first step in designing a product to solve the problem that was observed in the art class was to establish a list of client needs. This list included:

1. The inclination angle is adjustable by a user or instructor
2. The height of the device can be adjusted by a user or instructor
3. The device can be locked in a position that is suitable for the user
4. The user can store the current tool on the device for later use
5. The device can be moved by the instructor in order to accommodate space
6. The device is able to withstand a significant load without deforming
7. The user is able to adjust the surface of the device to complete a desired task
8. The device remains functional after multiple uses at various angles
9. The device is accessible to a wheelchair user

From these needs we established specific metrics that would allow us to measure the user's performance in regards to each of the needs. Following that a thorough search of comparable products was performed to assess how these products would meet the customer needs. Early sketches were done by all members of the group to decide what mechanisms could be made to solve the client needs. Discussion between the group members led to a consensus on what we wanted the final prototype to look like and what features we would want to incorporate into it. Baseline measurements were taken from the target population to determine ranges of adjustability needed for the height and angle. Testing protocol was also developed to measure the usability and durability of all subsequent prototypes.

Prior to construction of the prototype a number of Solidworks 3D models were created to understand how the device would be built. The initial design that was considered is included in Figure 1 and is highlighted by a single pillar frame with two guide rails. The angle adjustment in this prototype also uses a set of bearings with a lock-pin. The next design that was considered is included in Figure 2 and includes two pillars with a more fixed angle adjustment system. Issues with the single pillar design included stability and access for the wheelchair. Issues with the two-pillar design included being able to adjust both sides at the same time. Although both of these designs met our client needs, they also created new problems that would negatively affect the students. These initial concepts helped guide our team to the final design that solved most of the needs while helping us to avoid the same pitfalls that we experienced with these two designs.

Figure 1: Initial Single Pillar Design

Figure 2: Initial Two Pillar Design

Description of Final Approach and Design

After gaining feedback from earlier prototypes and interviews with clients, we decided on a design that incorporated ideas from all the previous prototypes. The final design is shown in Figures 3 and 4 which includes a 3D model rendering and physical prototype. The final design maintains the one-pillar frame but adds in a more user-friendly system for adjustment. The top post telescopes into the bottom post and is aligned with a 3D printed piece. A number of pre drilled holes at one-inch increments allow for height adjustability with a lock-pin to secure it at the desired height. The angle adjustment is done by using an adjustable tension screw that allows the user to move the easel to the desired angle and then have an instructor tighten it to lock it.

Figure 3: 3D Model of Final Design

Figure 4: Physical Prototype

In addition to the modifications to the adjustment system there were also changes made to the base design of the easel. This was done to accommodate for the length of the footplate and casters of the wheelchair during operation of the device. The support bars that were on the front of the base were removed in order to allow the wheelchair user more room to maneuver in front of the device. The overall footprint was minimized to allow for the device to not take up too much room in the already crowded art room. Casters were added to the base to assist an instructor with transporting the device between the art room and the storage area.

Outcome

A survey was developed in order to assess the usability of the device for anyone who may use it regardless of their disability or their type of mobility aid. The survey had questions based on how the device met each of the client specific metrics generated from our list of needs. An example of the survey is included in Figure 5. The target users were surveyed with the current free-standing easel that currently is used in the classroom. Data was obtained from 4 users that resulted in a mean score of 16/28. This group was made up of both manual and power wheelchair users that had different disabilities. This value was used as a baseline and was compared to the final survey data that was obtained with the final prototype.

Question	4 points	3 points	2 points	1 point	Total Score
What percentage of the desk are you able to access?	75-100%	50-75%	25-50%	0-25%	
Are you able to adjust the device to the desired height?	Yes, with no assistance.	Yes, with assistance.	Able to adjust slightly but not to the desired height.	Not able to adjust at all.	
Are you able to adjust the device to the desired angle?	Yes, with no assistance.	Yes, with assistance.	Able to adjust slightly but not to the desired height.	Not able to adjust at all.	
Are you able to access the easel with your wheelchair?	Yes, can enter from all angles.	Yes, can enter if moved straight in.	Part of the wheelchair can access the easel.	No, unable to access the easel.	
Can you store items on the ledge?	Yes, can store any type of item on the ledge.	Yes, can store multiple smaller items on the ledge.	Yes, can store one small item on the ledge.	No, can't store any items on the ledge.	
Do you feel safe using the device?	Yes.	Yes with an attendant present.	Yes, during some activities but not all.	Not at all.	
How long does it take to transport the device? (INSTRUCTOR)	<3 minutes	3-5 minutes	5-10 minutes	>10 minutes	

Figure 5: Usability Survey

The baseline data showed that the device was meeting some of the user's needs but had room for improvement to be usable for additional users. After creating the prototype, it was tested by a user to assess whether it would improve on the baseline scores taken with the current easel that was being used in the class. This user scored a 24/28 on the usability survey which was a large increase compared to the initial data. The primary areas where the user improved according to the survey was in perceived safety and accessibility for the wheelchair. Although this user showed improvement in most of the categories, additional users must be retested to gauge which areas are still proving to be a problem.

In addition to the feedback gained from the users, feedback was also obtained from the instructor who will be assisting with setting up the device and accommodating any issues that the students have with it. The instructor's reactions were very positive and primarily focused on the increased durability and portability offered with the prototype compared to the current device. Other feedback that the instructor provided included information about making sure the desk is usable for different activities.

Cost

All cost associated with the creating the prototype are included in Table 1. In addition to the cost of the components to build the prototype, an estimate to machine and assemble the components was also included. The unit price of one easel was calculated to be $177.00 which included $127.00 for components and $50.00 for assembly and machining. The choice of materials was based on availability and ease of manufacturing. Building multiple easels would help to reduce some component and machining costs and thus reduce the total unit price of each

easel. Additional prototyping would allow for alternative materials to be tested and possibly replace the higher priced components if their strengths were comparable.

Table 1: Prototype Cost

Components	Price
Hardware	$13.40
Aluminum Tube	$21.00
Steel Tube	$17.95
Lock Pin	$33.90
Casters	$7.28
Wood Desk	$7.00
Hinge and Bracket	$17.20
Rubber Bumper	$9.27
Total Component Cost	$127.00
Machining/Assembly Cost	$50.00
Total Cost	$177.00

Significance

The easel system that was created has a larger significance than just in the wheelchair user population. People with all types of disabilities can access and use the easel to perform tasks related to art or other skill building activities. The large degree of adjustability and durability make this product an ideal alternative to other commercially available products on the market that claim to be designed for accessibility. There is also the option for children with disabilities to use this easel as an alternative desk setup for performing schoolwork and other classroom activities.

The ability to participate as part of a community is a basic human right that all people are entitled to. This device enables people with a disability to participate in activities that previously were only possible with the help of another individual in a unique setup. The independence offered with this device could go a long way into improving the quality of life for a person with a disability.

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References

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