

Assistive Device for the art Studio

Preliminary Report

Team 27

Abdulrahman Almarri

Aly Alharbi

Jarraah Albathali

Yongzhen Li

Rakan Alhajraf



Department of Mechanical Engineering

Northern Arizona University

Flagstaff, AZ 86011

10/28/2016

Project Sponsor: Hozhoni Company

Faculty Advisor: Sarah Oman

Sponsor Mentor: Terri Engel

Instructor: David Trevas

TABLE OF CONTENTS

[Use your word processor to delete the following Table of Contents and insert a new TOC. Include front matter (except for the cover page), body of the report, and all appendices. The Table should include four levels of headings, e.g., down to 2.2.1.3, as illustrated below.]

DISCLAIMER	Error! Bookmark not defined.
EXECUTIVE SUMMARY	Error! Bookmark not defined.
ACKNOWLEDGEMENTS	Error! Bookmark not defined.
TABLE OF CONTENTS	1
1 BACKGROUND	1
1.1 Introduction	1
1.2 Project Description	1
1.3 Original System	1
1.3.1 Original System Structure	Error! Bookmark not defined.
1.3.2 Original System Operation.....	Error! Bookmark not defined.
1.3.3 Original System Performance	Error! Bookmark not defined.
1.3.4 Original System Deficiencies.....	Error! Bookmark not defined.
2 REQUIREMENTS	2
2.1 Customer Requirements (CRs).....	2
2.2 Engineering Requirements (ERs).....	2
2.4 Design Links (DLs)	3
2.5 House of Quality (HoQ)	5
3 EXISTING DESIGNS	6
3.1 Design Research	7
3.2 System Level	7
3.2.1 Existing Design #1: Descriptive Title	11
3.2.2 Existing Design #2: Descriptive Title	11
3.2.3 Existing Design #3: Descriptive Title	12
3.3 Subsystem Level.....	12
3.3.1 Subsystem #1: Descriptive Title	Error! Bookmark not defined.
3.3.1.1 Existing Design #1: Descriptive Title	Error! Bookmark not defined.
3.3.1.2 Existing Design #2: Descriptive Title	Error! Bookmark not defined.
3.3.1.3 Existing Design #3: Descriptive Title	Error! Bookmark not defined.
3.3.2 Subsystem #2: Descriptive Title	Error! Bookmark not defined.
3.3.2.1 Existing Design #1: Descriptive Title	Error! Bookmark not defined.
3.3.2.2 Existing Design #2: Descriptive Title	Error! Bookmark not defined.
3.3.2.3 Existing Design #3: Descriptive Title	Error! Bookmark not defined.
3.3.3 Subsystem #3: Descriptive Title	Error! Bookmark not defined.
3.3.3.1 Existing Design #1: Descriptive Title	Error! Bookmark not defined.
3.3.3.2 Existing Design #2: Descriptive Title	Error! Bookmark not defined.
3.3.3.3 Existing Design #3: Descriptive Title	Error! Bookmark not defined.
4 DESIGNS CONSIDERED	12
4.1 Design #1: Descriptive Title	Error! Bookmark not defined.
4.2 Design #2: Descriptive Title	Error! Bookmark not defined.
4.3 Design #3: Descriptive Title	Error! Bookmark not defined.
5 DESIGN SELECTED.....	14
5.1 Rationale for Design Selection	14
5.2 Design Description	14
6 PROPOSED DESIGN	Error! Bookmark not defined.

1 BACKGROUND

1.1 Introduction

There are many examples of assistive devices for people with manipulative and locomotive disabilities. These devices enable disabled people perform many activities of daily living thus improving their quality of life. Disabled people are increasingly able to lead an independent life and play a more productive role in society. In the case of disabled children, such assistive devices have been shown to be critical to their cognitive, physical and social development.

This is a high level engineering project. Our goal is to design a device, which can assist the disable people. The objective of this project is to survey the cutting edge in the innovation for assistive gadgets for individuals with handicaps, with a specific concentrate on the innovation that is approximately alluded to as apply robotics. Many assistive devices for manipulation and locomotion have been made. We have focus on making an assistive device, which can help the disable people to perform their tasks easily.

1.2 Project Description

We are making a device, which can help disable to perform any task lie drawing, sketching etc as the chair is capable of holding the paper. This device or machine will be able to assist disable to get their work done. For this we have brainstormed many ideas and designs. These device will help those disable people to enjoy or get entertained without any motion and pain.

We have utilized the concept of hydraulic system too in our machine to make it more efficient. Despite rapid scientific and technological progress in allied disciplines, there has been very little innovation in wheelchair design. We will focus on this aspect as well. Hence the following report will describe all the designs and their comparative analysis.

2 REQUIREMENTS

As the device is to be used by disable people so the main requirement is that it must be safe to use so that they can handle it with safety. Moreover the settling time of the device must be as small as possible so that the disable people can set it at minimum time required. It must be flexible and should not be dangerous at any cost. Moreover another requirements Is the cost effectiveness. A complete analysis of requirements was done to meet the most important of them .For that we set priority list for these requirements and worked on it to achieve the goals.

Moreover we also interviewed the customers and the clients who are the real stakeholders in this case. We listen down their requirements and decided on the basis of that.

2.1 Customer Requirements (CRs)

2.1) CUSTOMER REQUIREMENTS:

To find out what requirements are necessary and important for the customers we did a complete analysis and research on this process. WE interviewed few disable people who were interested in this project. We asked them what their most important requirements or needs are. Following table describes the compact interview we took from 3 of our customers.

customer requirement	Weight
Adjustable	4
Easy to use	4
Light weight	4
Safety	5
Easy to store	5
Size	3
Easy to clean	4
comfortable	4
saving time	3
Cheap	2

Fig.1: Customer Needs

In this part of our project we integrated customers' requirements in our projects. Our objective is to make it according to the needs of the customers. While interviewing the customer everything became clear to us that the designing process must focus on the needs of the customers. If we design it according to the needs of the customers, it will give them a lot of opportunities to explore their life and show their hidden skills and make themselves feel better than laying idol.

2.2 Engineering Requirements (ERs)

Here is the list of requirements we will be keeping in mind while selecting our design.

Sharp parts, Movable, Light Material, Flexible, Simple Design, little force, Cleanable, Easy to handle, Time, and Low cost. This list was approved by engineering's who thought about their requirement in the device that they are building as a Capstone project.

Engineering Requirement

No sharp parts*

Movable*

Light material < (20lb)

Flexible*

simple desing *

muscle less = 5 lb

Cleanable*

Easy to handle *

time = 2 Hr

Low cost < 500 \$

[add or remove ER columns, as necessary]

Fig.2: Engineering Requirement

2.3 Testing Procedures (TPs)

For testing we did many procedures, which can be listed below:

- 1) House of quality matrix.
- 2) Decision Matrix.
- 3) Customers analysis.

DECISION MATRIX:

After analyzing all the designs we worked on choosing one of the designs. Here is the list of designs we did decision matrix for:

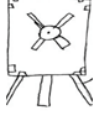
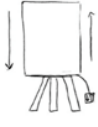

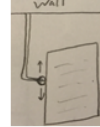
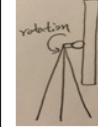

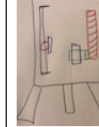
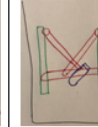
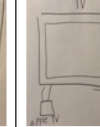
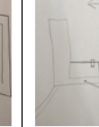
Concept										
Criteria	1	2	3	4	5	6-D	7	8	9	10
Design Name	Rotation Easel	Hydraulic	Adjustable Easel	Wall Stand	180 Stand	Wheelchair Stand	Easel Gear	Regulator	Ipad	Chair Stand
No sharp parts	+	+	-	-	-	+	-	-	+	-
Movable	S	+	+	-	+	S	+	+	-	S
Light Material	+	-	+	-	+	-	-	-	-	-
Flexible	+	+	+	-	+	-	-	+	-	-
SimpleDesign	S	+	-	-	-	S	-	+	+	S
Muscle less	+	+	-	-	-	+	+	+	+	+
Cleanable	+	-	+	+	+	+	-	-	+	+
Easy to handle	+	+	+	-	+	+	+	+	-	+
Time	S	-	-	-	-	S	-	-	+	+
Low cost	+	-	+	-	+	+	-	-	-	+
$\sum -$	0	4	4	9	4	2	7	5	5	3
$\sum +$	7	6	6	1	6	5	3	5	5	6
$\sum S$	3	0	0	0	0	3	0	0	0	2

Fig.3: Decision Matrix

After complete analysis we came off the result that rotation easel is the design we will continue working with.

	Criteria	No sharp parts	Movable	Light Material	Flexible	SimpleDesign	Muscle less	Cleanable	Easy to handle	Low cost	Total
	Baseline	0	0	0	0	0	0	0	0		
A	Rotation Easel	5	3	5	5	4	4	3	5	3	37
B	Hydraulic	5	4	3	3	2	3	4	2	2	28
C	Adjustable Easel	2	3	5	3	5	2	3	4	3	30
D	Wall Stand	4	5	2	2	2	2	3	3	3	26
E	180 Stand	3	2	2	5	3	3	2	3	3	26
F	Wheelchair Stand	3	4	3	3	4	2	3	4	4	30
G	Easel Gear	2	3	2	5	2	1	3	2	3	23
H	Regulator	3	5	3	1	4	3	2	3	1	25
I	Ipad	2	1	3	2	5	3	2	4	2	24
J	Chair Stand	3	2	2	1	4	5	3	2	4	26

Fig.4: Pugh Chart

Pugh chart also shows that the design which is most preferable is design 1.

2.4 Design Links (DLs)

We did benchmarking to determine what and where improvements are called for, to analyze how other organizations achieve their high performance levels, and to use this information to improve performance. It was important to create the HOQ and benchmark these requirements so that the team had an accurate understanding of the expected technical requirements of the project. To find out the needs of these types of designs we researched many articles and visited websites. The website disabled world also gave a complete overview on how the designs must be made to feel the disable more comfortable. Furthermore the website arch2o was also a good source which helped us a lot to understand the requirements.

2.5 House of Quality (HoQ)

2.5) HOUSE OF QUALITY MATRIX:

HOQ helps us compare devices based on different parameters. It helps to analyze the design to be selected. This assists us in making the decision of selecting the design. This is done by keeping in mind all the requirements, which we have analyzed above. The requirements list enclose that the design must be moveable, Light in weight, Flexible, Easy to handle, Low cost/cheap, Less settling time, Safety, ease of assembling etc. This list helped us a lot while designing the device. This process helped us in making functional improvements.

Customer Requirement	Weight	Engineering Requirement	No sharp parts*	Movable*	Light material < (20lb)	Flexible*	simple desing*	muscle less = 5 lb	Cleanable*	Easy to handle*	time = 2 Hr	Low cost < 500 \$	[add or remove ER columns, as necessary]
1. Safety	5		0	0			0			0			
2. Easy to store	5			0	1	0	0			0	0		
3. Light weight	4			0	0	0	0			0		0	
4. Adjustable	4			0	0	0	0			0	1		
5. Easy to use	4			0	0	0	0	0		0	0	1	
6. Comfortable	4		0	0	0	0	0	0	0	0	0	0	0
7. Easy to clean	4		1			0	0		0	0	0		
8. size	3			0			0			0		0	
9. saving time	3			0		0	0		0		0		
10. Low cost	2			0	0		0					0	
[add or remove CR rows, as necessary]													
Absolute Technical Importance (ATI)			73	183	77	111	222	60	90	123	94	85	
Relative Technical Importance (RTI)			9	2	8	4	1	10	6	3	5	7	
Target(s), with Tolerance(s)											<2 hr	<500\$	
[add or remove T/T rows, as necessary]													
Testing Procedure (TP#)													
Design Link (DL#)													
Approval (print name, sign, and date):													
Team member 1: Jarrah Albathali													
Team member 2: Abdulrahman Almarri													
Team member 3: Aly Alharbi													
Team member 4: Rakan Alhajraf													
Team member 5: Yongzhen Li													

Fig.5: House of Quality Matrix

3 EXISTING DESIGNS

3.1 Design Research

There are many devices in the industry and market, which are designed for disable people. These devices either help them move from one place to another or they help them to pick things by moving. We have researched many devices on interest especially which have been designed for disable people. These all devices were really inspiring and creative but we were focused on naming a device, which can help the disable people to do their art without any difficulty. People with limited mobility are often unable to socialize; leading to developmental challenges later in life.

To find out the needs of these types of designs we researched many articles and visited websites. The website disabled world also gave a complete overview on how the designs must be made to feel the disable more comfortable. Furthermore the website arch2o was also a good source which helped us a lot to understand the requirements.

1) Rotation Easel

This is a comfortable support system and is highly safe. It has wheels, which can even be locked if the person is not moving. It is highly suitable for those who are unable to stand on their own. It is adjustable. The art book or paper fits nicely on my table top rotating easel. It will no longer require the person to be bending over a flat surface to do his artwork. It elevates to 3 heights and rotates so that the people don't have to keep picking up his art to turn it while working on it.

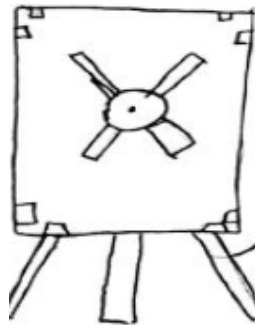


Fig.6: Rotation Easel

2) Hydraulic

This hydraulic design system incorporates a hydraulic power unit, advanced circuitry and pressure transducers which will evaluate and react to the pressures on and movements of the vehicle during access. This system is effective and, above all, safe to use.

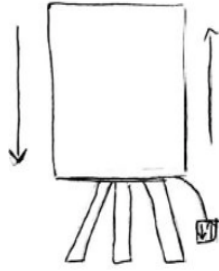


Fig.7: Hydraulic Easel

3) Adjustable Easel:

This easel design is adjustable and moveable. It's easy to use, transportable, easy to store and allows the person to get close to the work when working on the paper or artwork.

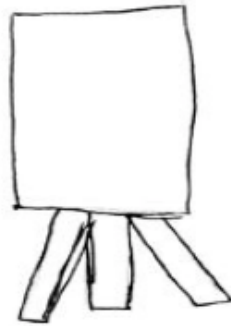


Fig.8: Design

4) Wall Stand

It's wonderful for those with disabilities and limited mobility. This is comfortable for them to use.

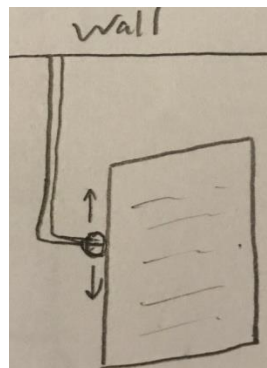


Fig.9: Wall Stand

5) 180 Stand:

This design is feasible to use and is movable. This helps the person to move the paper or rotate it as required.

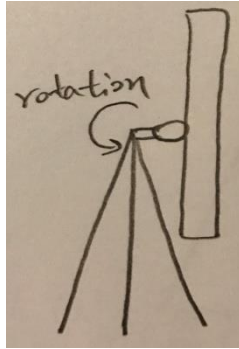


Fig.10: 180 Stand

6) Wheelchair Stand:

This stand is also a comfortable and easy to use design. It helps them do their work in complete ease.



Fig.11: Wheelchair Stand

7) Easel Gear:

This design is adjustable and can be handled up to different levels. It is stoppable and has a gear too. It's moveable and depends on the activity the person is performing.

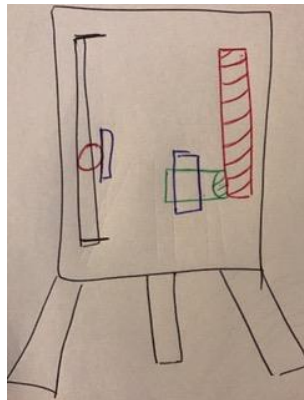


Fig.12: Easel gear

8) Regulator:

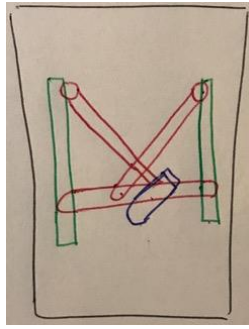


Fig.13: Regulator

9) iPad:

IPad is an easy to use way for the disabled people to do their artwork. This can help them do their work in a comfortable way.

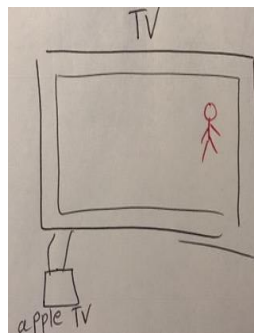


Fig.14: iPad

10) Chair Stand:

This design is basically a chair with a stand of wood placed in front of it. This stand is basically attached with the chair. It is not too easy to move though.

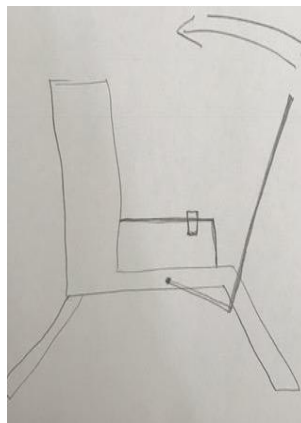


Fig.15: Chair Stand

3.2 System Level

There are three system levels in this device. Following are the designs that we have analyzed in system level:

- 1) Rotation Easel
- 2) Hydraulic
- 3) 180 Stand

In these designs we have first of all analyzed the levels to which the device can move and its accessibility. The hydraulic design is complex design. 180 design is easy to use but it can just move to a certain angle. Rotation easel is most suitable for this design.

3.2.1 Existing Design #1: Descriptive Title

1) Rotation Easel

This is a comfortable support system and is highly safe. It has wheels which can even be locked if the person is not moving. It is highly suitable for those who are unable to stand on their own. It is adjustable. The art book or paper fits nicely on my table top rotating easel. It will no longer require the person to be bending over a flat surface to do his artwork. It elevates to 3 heights and rotates so that the people don't have to keep picking up his art to turn it while working on it.

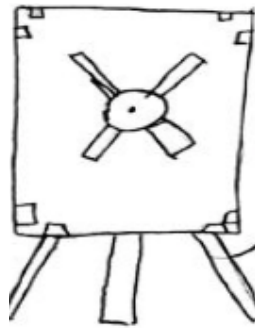


Fig.16: Rotation Easel

3.2.2 Existing Design #2: Descriptive Title

Hydraulic

This hydraulic design system incorporate a hydraulic power unit, advanced circuitry and pressure transducers which will evaluate and react to the pressures on and movements of the vehicle during access. This system is effective and, above all, safe to use.

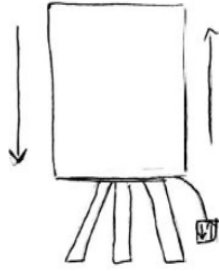


Fig.17: Hydraulic

3.2.3 Existing Design #3:Descriptive Title

180 Stand:

This design is feasible to use and is movable. This helps the person to move the paper or rotate it as required.

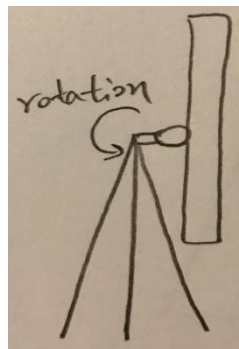


Fig.18: 180 Stand

3.3 Subsystem Level

Rotation easel has a bearing and a stand, which can rotate on this bearing. It rotates your work 360° so it turns the piece because it's top rotates on ball bearings. It can be taken to 3 levels depending on the ease of the customer to use.

4 DESIGNS CONSIDERED

We have considered 10 designs for short listing and converging towards one efficient design:
The list of designs is as follow:

- 1) Rotation Easel
- 2) Hydraulic
- 3) Adjustable Easel
- 4) Wall Stand
- 5) 180 Stand
- 6) Wheelchair Stand
- 7) Easel Gear
- 8) Regulator
- 9) iPad
- 10) Chair Stand

5 DESIGN SELECTED

5.1 Rationale for Design Selection

After doing complete research and analysis, we have selected Rotation Easel as our selected design.

5.1 Rationale for Design Selection

The reason why we selected this design is that

- It is lightweight
- It has a built-in carry handle that makes it easy to take to anywhere.
- It rotates your work 360° so it turns the piece because it's top rotates on ball bearings.
- This saves the time from having to constantly pick up the piece to turn it to the area the person wants to work on.
- Easy to operate and maneuver.
- It adjustable and enables to elevate the artwork work to 3 different heights.
- it can move the piece in a complete circle for the person
- it's wonderful for those that have disabilities and limited mobility. The different elevation brings the work closer to the person, instead of having him to lean forward. Plus, it can help the person's hand, wrist, and neck and back avoid stress and strain.

5.2 Design Description

This is a comfortable support system and is highly safe. It has wheels, which can even be locked if the person is not moving. It is highly suitable for those who are unable to stand on their own. It is adjustable. The art book or paper fits nicely on my table top rotating easel. It will no longer require the person to be bending over a flat surface to do his artwork. It elevates to 3 heights and rotates so that the people don't have to keep picking up his art to turn it while working on it.