

**Hozhoni Art Program
Development of an Assistive Workstation
Preliminary Report**

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1 Background

1.1 Introduction

The primary goal of the Art Team's senior design project is the successful design, build, and implementation of an assistive working station for the comfortable holding of Hozhoni clients' work and supplies during creation. The Hozhoni Foundation is a local Flagstaff organization dedicated to the support of individuals with developmental disabilities [1]. While the foundation provides a number of services to its clients, one of the largest programs is the Hozhoni Artists Program—a nonprofit studio for Hozhoni clients where they can spend time on self-expression and creativity [2].

The day program is renowned for aiding in the self-expression of the artists; applauded for its ability to foster growth, communication, and awareness in a guided atmosphere [1]. The clients are encouraged to experiment with a number of different mediums with help from fellow artists and staff. One of the largest challenges for the program however is in creating a comfortable working environment for those clients with special mental and physical needs [1]. Due to the unique disabilities faced by program individuals finding a comfortable and ergonomic method of painting or drawing has proven difficult to accomplish. It is therefore the goal of this project to create a tool for the program's use that provides physical support during work for the Hozhoni clients.

Upon building of a successful workstation the clients will have a place where they can work comfortably for an extended period of time with convenient supplies and aid. Ideally this will aid in increasing productivity and reduce long-term physical harm.

1.2 Original System

The following subsections detail the original system structure, functions, and deficiencies. Many of the characteristics described are instrumental in the formation of the customer and engineering requirements discussed in subsequent sections.

1.2.1 Original System Structure

The Hozhoni Foundation Art Program provides aid and support to individuals with disabilities—allowing for their creative expression in a guided environment. The art program frequently supports 15-30 individuals in a multi-room studio environment. There are three main rooms where artists are supplied with the tools they require for painting, drawing, pottery, printmaking, metal work, sculpture, textiles, and carving [1]. Tools and equipment are stored in small, locked storage rooms when not in use.

Currently almost all artwork is done on tables. The two easels the foundation possesses are a simple three-point easel and a wooden support, which can be placed on tables or used to display art upon completion. These two easels are insufficient for use in the program and are discussed further in the Original System Deficiency subsection below. Art supplies are abundant and the knowledgeable staff offers as much support as necessary while allowing the client's own creativity.

1.2.2 Original System Operation

The creation of this assistive workstation must not dramatically change the current operation of the Art Program as specified in the Customer Requirements section. The current staff is primarily women who aid the day program during the eight-hour working shifts. The staff must be capable of moving the workstation as well as storing the platform in the limited storage locations. These operational requirements are likewise further discussed in the Customer Requirements section.

1.2.3 Original System Performance

The current art program is renowned for its support of the Hozhoni clients. The disabilities the clients face range in both type and severity from developmental to physical to mental and emotional. The services

provided by the Hozhoni Foundation have allowed many of these individuals to experience life and opportunities like anyone else [1]. The art program provides a way for these clients to express their creativity, uniqueness, and emotion. Unfortunately, many of the clients have suffered from poor posture and joint pain. This could be in part due to the lack of ergonomic and supportive workstation as well as long time spans sitting in the same location. There is also very little support for wheelchair bound clients.

1.2.4 Original System Deficiencies

The primary deficiency in the way the Hozhoni Foundation currently conducts their art program is in the existence of workstations. There are two primary easels:

1. Three point easel: The three-point easel is a small, non-adjustable wooden support with three legs. Currently only one client uses the easel due to the lack of adjustability and inability to accommodate clients bound to wheelchairs. The easel is also flimsy, cannot hold large canvas or paper, and must be supported by other means while drawing.
2. Wooden support: The wooden support is a heavy, non-collapsible wooden structure that allows for the propping of canvas. It is currently only used to display finished work or paintings in progress.

Neither the three-point easel nor the wooden support allow for the holding of art supplies. Current clients are therefore more likely to use tables to draw and many suffer from back pain due to lack of support and poor posture. It is therefore vital for our workstation to provide the necessary support for both sitting and standing clients.

2 Requirements

The team's main goal is to create a system that helps Hozhoni clients in the art program work more comfortably. With that in mind, the team and the Hozhoni Foundation worked together to develop a series of design requirements that the team should consider in the generation on their ideas. The team must design a system that will assist current and future Hozhoni clients with their art and other creative projects. The system must help the clients work more comfortably throughout the day, and provide multiple configuration options to accommodate the client's needs. With these broad design constraints in mind, the team generated a series of customer requirements, which were further clarified with engineering requirements.

2.1 Customer Requirements

Based on the conversations with the Hozhoni Foundation, the team came up with ten customer requirements that could be used to assess the feasibility of the designs. Each of these requirements was weighted with a point value out of 250 total points. The weight represents the importance of each requirement relative to each other, with a higher number of points correlating to a higher importance to the overall project goal. The customer requirements are listed in Table 1 below.

The most important requirement, with a weight of 45 points is that the system has an adjustable configuration. The Hozhoni Foundation has observed a clear increase in focus and productivity in some of their clients when they transition between sitting and standing to do their art. They also have several clients in wheelchairs that find themselves very limited on where in the studio they can work due to the table height and space restrictions. Any system designed should be able to accommodate artists sitting and standing, and also in wheelchairs. Next, and also very important to the client, the system must be durable. The art program is open for client use eight hours a day almost every day of the year. In order to be feasible the system must be able to last at least several years. Because the art program is so large and active, they are looking for a system that can be easily stored out of the way when not in use in order to leave more floor space for client use, and decrease safety hazards.

Furthermore, clients tend to work on their art for hours at a time, so the system that the team creates must be comfortable for daily use for prolonged periods of time. It must also be safe to use, and clients should not require supervision while using it. Most of the Hozhoni workers in the art program are female, and clients often largely outnumber them. In order for a system to be feasible it must be able to be set up easily by one person, more specifically, a female worker.

The artists at the Hozhoni Foundation use a variety of sizes and types of templates for their art, from canvas, to cardboard, to paper. The customer would like a system that can accommodate the variety of resources at the foundation’s disposal, so it must be able to accommodate different size templates, and also different types of templates. As was mentioned earlier, space in the art studios is fairly limited, so an ideal system should be able to contain the artists art supplies so no other surface or space is needed. Finally, because of the number of clients working in the studios at any one time, in order for the team’s system to truly have an effect they would ideally be able to make more than one system for the artists to use.

Table 1: Customer Requirements and Weights

Customer Requirement	Weight
Adjustable configuration	45
Durable	40
Easily stored	30
Comfortable for daily use	25
Easy to assemble and disassemble	25
Safe to use	25
Capable of holding art supplies	20
Accommodate different size templates	15
Able to be duplicated	15
Accommodate different types of templates	10

2.2 Engineering Requirements

Based on the above customer requirements, the team came up with sixteen engineering requirements that further define the team’s future system. The engineering requirements were defined by a target value and an acceptable tolerance range when applicable.

First, in order to support the customer’s desire to have an adjustable configuration, the system must have a work surface capable of pivoting between 0 and 90 degrees from vertical. It must also be adjustable for heights between .8 and 1.5 m, and have a base less than 1 m wide. The team is aiming for a base width of .8 m. Second, in order to be considered durable, the system must have a material lifespan of more than 1000 uses, have at least four points of contact with the ground, and must not break if pushed over in its usable configuration.

In order to be easily stored in the limited space of the studio, the system must be contained within a volume of at most 1 m³, and the team is aiming for a volume of .75 m³. It must also be collapsible for

simple storage, out of the way of the clients. In order for the system to be simple for one person to assemble and disassemble, it must not require more than five steps for use and must weigh between 10 and 40 lbs, with a goal weight of 30 lbs. In order to be safe for the clients to use, the system must not have any exposed pinch points, as many points of contact with the ground as possible, and all edges should be rounded with a radius of at least .2 mm.

If the system is capable of holding art supplies, all components that come in contact with the supplies must be able to be washed by hand, for the convenience of the workers. Also, in order to make more than one system for the foundation, the total cost of one unit cannot exceed half of the team’s budget, or \$750. Finally, because the Hozhoni Foundation uses a wide variety of templates, the system must accommodate templates from .25 to 1 m wide, and up to 15 lbs. These more detailed requirements helped the team analyze the feasibility of their designs during the brainstorming sessions.

2.3 House of Quality

The House of Quality is a tool that can be used to visualize the correlation between requirements from the stakeholders and engineering requirements. For this report, the House of Quality includes the customer requirements, engineering requirements, and appropriate tolerances, as decided by the team members. This can be seen in Figure 1 below. The customer requirements were sent to both the Hozhoni Foundation for approval of this early draft. The signed approval from the stakeholder can be found in Appendix A.

Customer Requirement	Weight	Engineering Requirement	Work surface adjustable angle	Rounded Corners	Collapsible	Must be contained within set volume	Movable by one person	Can be cleaned by hand	Requires less than 5 steps for use	No exposed pinch points	Can accommodate different template widths	Can accommodate different template weights	Will not break if pushed over	Many points of contact with ground	Long material lifespan	Have a minimum leg width	Adjustable template height	Low cost to build	
Adjustable configuration	45		9																
Durable	40				3					1			9	9	9		1	1	
Easily stored	30		1		9	9	3			1							1	1	
Comfortable for daily use	25		9	3			1	1	3	3	1	1					3	3	
Easy to assemble and disassemble	25				3	1	9		9	3									
Safe to use	25			9						9	1	1		9					
Capable of holding art supplies	20							9											
Accommodate different size templates	15			3							9	9							
Able to be duplicated	15																		9
Accommodate different types of templates	10			3							9	9							
Target(s), with Tolerance(s)			0-90 deg	> .2 mm	0-1 m ³ -- .75m ³ 3	10-40 lbs -- 30 lb					.25 m to 1 m	up to 15 lbs		4 pts	> 1000 uses < 1 m -- .8 m	.8 - 1.5 m	<\$750		
[add or remove T/T rows, as necessary]																			
Testing Procedure (TP#)																			
Design Link (DL#)																			

Figure 1: House of Quality

3 Existing Designs

In order to design a solution, which satisfies the needs of Hozhoni art program participants, it is necessary to perform benchmarking and state-of-the-art design research. The existing system at the Hozhoni art program was closely examined, and existing technology relevant to the customer needs was researched.

3.1 Design Research

The benchmarking process included visits to the Hozhoni art studio. The team has visited the Hozhoni studio several times in order to better understand the existing system. During visits to Hozhoni, employees showed the team the facilities including the art rooms, storage closet, and gallery while explaining the organization and current devices in use. Issues confronting Hozhoni artists and design limitations were discussed with employees. Hozhoni artists showed off their creations and added some input as well. From site visits to Hozhoni, the team will be able to better understand some of the needs and limitations of the art program participants.

Furthermore, background research was conducted on existing designs relevant to the customer requirements. Research was conducted through online searches and product browsing. Publications explaining some of the benefits of art therapy were helpful to understand the potential this project has at improving quality of life. However, most background research involved current technology relevant to the Hozhoni artist's needs, specifically assistive devices. Background research was focused on two areas, general assistive technology and art related assistive technology. The results of the background research into existing designs is explained in the following section.

3.2 System Level

Background research was divided into two areas of focus, general assistive technology and art assistive technology. Assistive technology can be defined as systems or devices providing assistive, adaptive, or rehabilitative support for individuals with special needs or disabilities. Assistive technology covers a extremely wide variety of needs and applications. Background research produced three general assistive technologies and three art related assistive technologies, which were most relevant to the needs of Hozhoni artists. These existing systems and devices provide insight as to how others have solved similar problems. The concepts portrayed by the designs explained in the following section are relevant to the needs and limitations of Hozhoni artists.

3.2.1 Populas Wheel Chair Accessible Desk

There are many different shapes and sizes of wheel chair accessible desks. This particular design, as seen in Figure 2, is a rectangular desk with a slight cut out in the edge to allow the user to comfortably work on the surface. A knob on the legs of the desk allows for the height to be adjusted as well, which is a largely weighted requirement in this project [3].

3.2.2 ErgoRest Arm Support

This device is easily clamped onto the side of a table or desk providing the user with arm, shoulder, and neck support. It is comfortable and does not restrict any motion of the user. This device could be important to this project in that it can show the team how to provide comfort and support to the client without restricting their motions so that they can still work [4].



Figure 2: Wheel Chair Accessible Desk

3.2.3 Ergo Q330 Notebook Stand

This notebook stand allows the user to adjust the angle at which their laptop is facing them. This product is important to this project because the easel needs to have an adjustable angle too. The team can learn from how this stand works and implement it into the design of the easel [4].

3.2.4 Da Vinci Multi Media Easel

This device provides a platform for painters and drawers alike. The easel was chosen since it incorporates several of the customer requirements presented in section 2.1. First off, the easel is adjustable. The frame, which holds the canvas, can be positioned vertically and horizontally, and anywhere in between. This easel's adjustability is reflective of the most heavily weighted customer requirement for this project, since the device must be wheelchair accessible. When not in use, the easel can be folded and stored flat, another important characteristic given the limited space in the Hozhoni art studio. The easel features a center mast stabilizer and rubberized grips on the top and bottom canvas holders to allow for different sizes and types of media. Finally the easel has a built-in utility shelf for storing supplies. This easel is much better suited for use at Hozhoni than the current system, and its characteristics will be considered during the design selection process.

3.2.5 Digital Wheel Art

Digital Wheel Art is a system, which allows wheelchair bound individuals to create visual art, in real time, using the movement of their chairs. The system can be implemented with either a powered or manual wheelchair. A sensor is placed on the user's chair, which transmits a signal to a Nintendo Wii remote. The remote then communicates with drawing software that projects the user's movements as colored lines onto a screen for real time viewing. This technology is relevant to the customer requirements in that it provides an alternative method for people with disabilities to express themselves.

3.2.6 Mabef Workstation Easel

This device provides a workstation for artists in wheelchairs as well as artists who prefer to paint sitting down. The workstation has ample space down below and a U-shaped design to comfortably accommodate a wheelchair. The easel can be positioned vertically or horizontally, and can even lean forward up to 10 degrees. Vertical and horizontal drawers are featured on the sides to store art supplies, and shelves, which swivel outwards further increase workspace area. In accordance with the customer requirements this device is adjustable for individual needs and features multiple storage compartments.

4 Designs Considered

For the designs considered, the team decided upon five art assistive devices best suitable for the clients. As stated earlier, it is important that the product be suitable for any canvas size, easy to assemble and disassemble, take up minimum storage space, and comfortable for the clients. All the following designs can be seen in Appendix B.

4.1 Folding Easel

The first design appears as a simple 4-legged, stand-alone easel. There is a wide board that holds the canvas in place on top of 4 sturdy legs of an undefined material, and a plank attached to the back legs to add support to the easel. The left and right edges of the board can be folded into the center of the board to save space and be adjustable for the size of the canvas. The front and back legs can be folded vertically as well to help with storage space. Lastly, the board is supported by a dowel attached to the back legs, and the dowel can be adjusted to any angle.

4.2 Round-About Easel

This design is a half moon shaped desk with a wooden frame standing up from the desk's surface. The shape of the desk is created that way so that it is wheelchair accessible. The purpose of the desk is to have some room for art mediums, or to create some room for clients who lay down their heads and arms while they create their art. The wooden frame is the structure where the canvas is placed. The roundabout easel has 3 foldable legs that help for storage space, and the wooden frame can be adjusted to support the size of the canvas.

4.3 Sawhorse Easel

The sawhorse easel is an easel created from two individual parts. For the legs are an adjustable sawhorse stand, with the legs placed on the side so that it is wheelchair accessible. Depending on the height of the client or the canvas, the sawhorse legs can move from a small angle to a larger angle to change the height. The easel frame was inspired from the Russian dolls concept, where the frame is consisted of different beam sizes so that it can expand or contract to the size of the canvas. This concept allows the frame to be stacked inside of each other to decrease space.

4.4 Full Moon Easel

This design is a full circle easel that lays parallel to the floor, much like a table. However this stand has an opening to allow clients of all sizes to fit, and empty space inside of the stand for clients to work in. Like the other designs, it is also wheelchair accessible. This stand can be folded in half for storage, and is lightweight for easy removal by the workers or clients. One section of the stand will have an area to hold a canvas at an angle. This stand can be used for holding paints and canvases, and multiple clients can use this stand since they can create art inside or outside of it. The four legs that hold the stand fold up to help with storage.

4.5 Skeleton Easel

The skeleton easel will not have many components to it. It consists of four legs with rollers to help mobility and a stand to connect the legs with the easel frame. The easel frame consists of two rectangular aluminum bars in the shape of a cross, and each bar has holes in it. These holes are points where small blacks can lock into place to hold the canvas up, and the different lengths of each hole allows larger canvases to be placed upon it. At the bottom of the vertical bar is an extended plank to hold up the easel. This plank is extended so that paints and paintbrushes can be within reach. This design is lightweight, easy to transport, and sturdy.

References

- [1] Hozhoni.com, "Hozhoni Foundation - Dignity Through Opportunity", 2015. [Online]. Available: <http://www.hozhoni.com/>. [Accessed: 16- Dec- 2015].
- [2] Hozhoniartists.org, "Hozhoni Artists & Art Studio | A non-profit visual arts program where artists with developmental disabilities create, exhibit, sell and collaborate with other artistsHozhoni Art Studio", 2015. [Online]. Available: <http://hozhoniartists.org/>. [Accessed: 16- Dec- 2015].
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Appendix A

Stakeholder approval of the customer requirements.


Customer Requirements:

- Comfortable for daily use
- Easily stored
- Easy to assemble and disassemble
- Accommodate different size templates
- Accommodate different types of templates
- Capable of holding art supplies
- Durable
- Adjustable configuration
- Able to be duplicated
- Safe to use

Engineering Requirements:

- Work Surface angle adjustable up to 90 degrees
- Rounded Corners
- Collapsible
- Must be contained within max volume of 1 m³
- Movable by one person
- Can be cleaned by hand
- Requires less than 5 steps for use
- No exposed pinch points
- Can accommodate different template widths
- Can accommodate different template weights
- Can be pushed over and survive
- As many points of contact with the ground as possible
- Long material lifespan
- Minimum leg width of standard power chair + 2 in per side
- Adjustable template height from 2.5 to 4.5 feet
- Cost to build less than half total budget

I agree with the above stated Customer and Engineering Requirements.

 12-9-15

Appendix B

All of the designs considered that were included in Section 4 of the report.

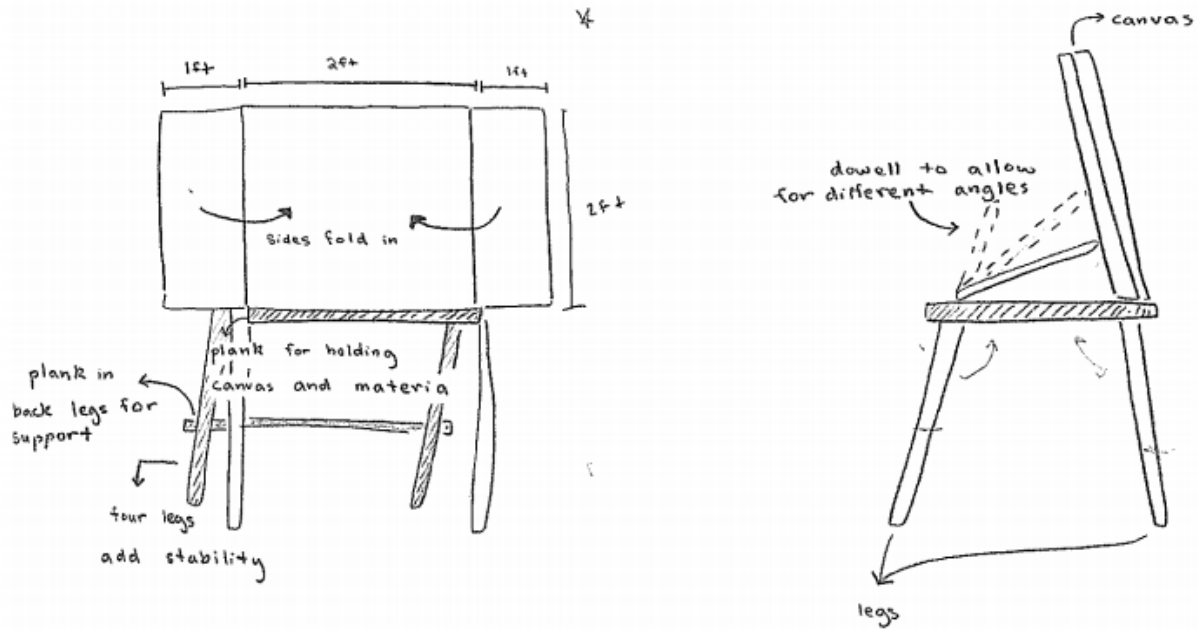


Figure B.1: Folding Easel

Round-about Easel

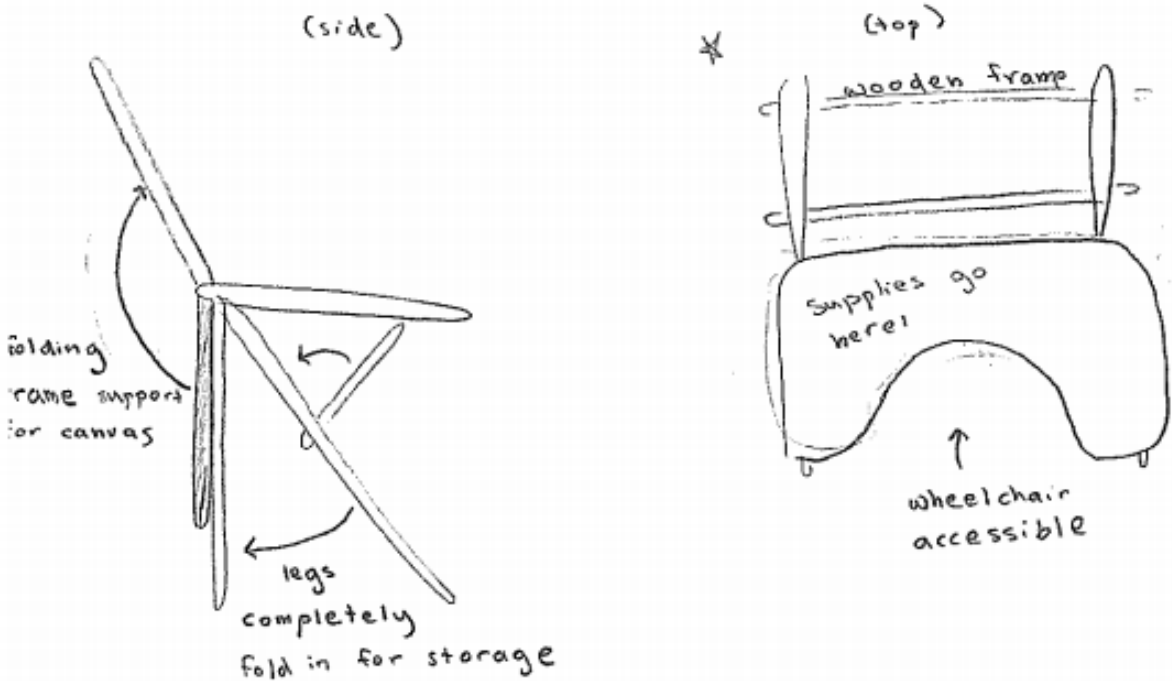
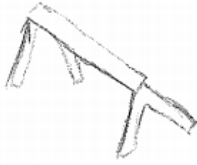
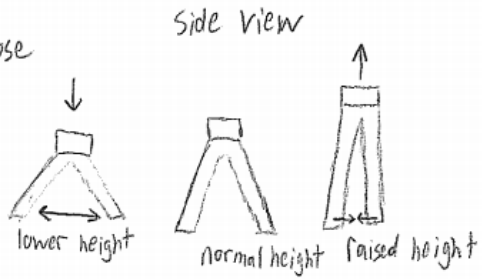


Figure B.2: Roundabout Easel

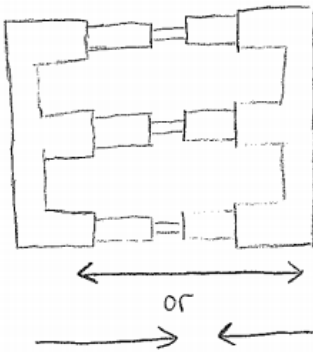
Sawhorse Concept for base



- legs can open or close to adjust height
- legs on sides so wheelchair can fit in between



* Easel Frame



- expand or contract to accommodate different size canvases
- concentric cylinders/beams of different areas
- can be stacked inside each other

Figure B.3: Sawhorse Easel

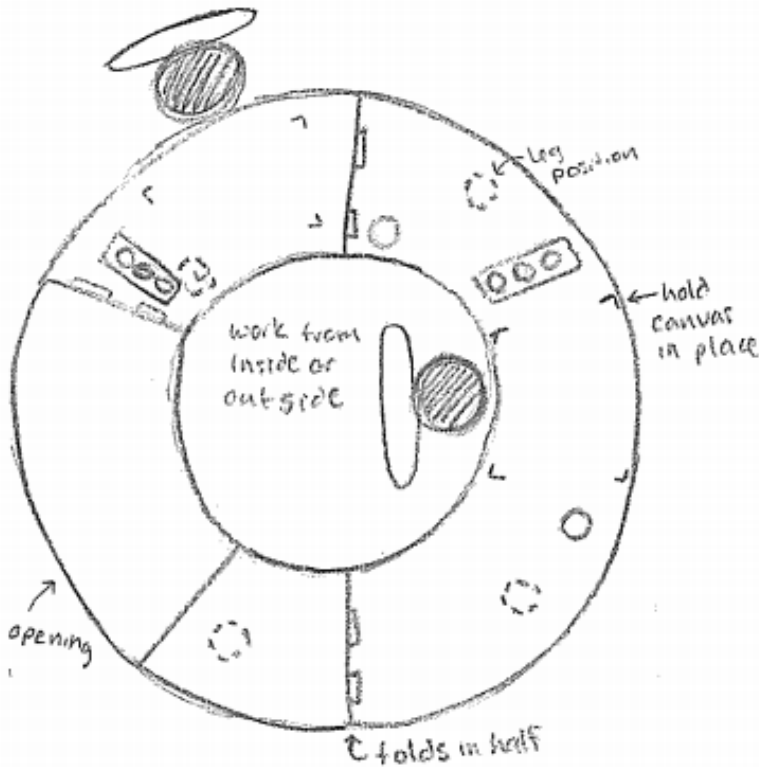


Figure B.4: Full Moon Easel

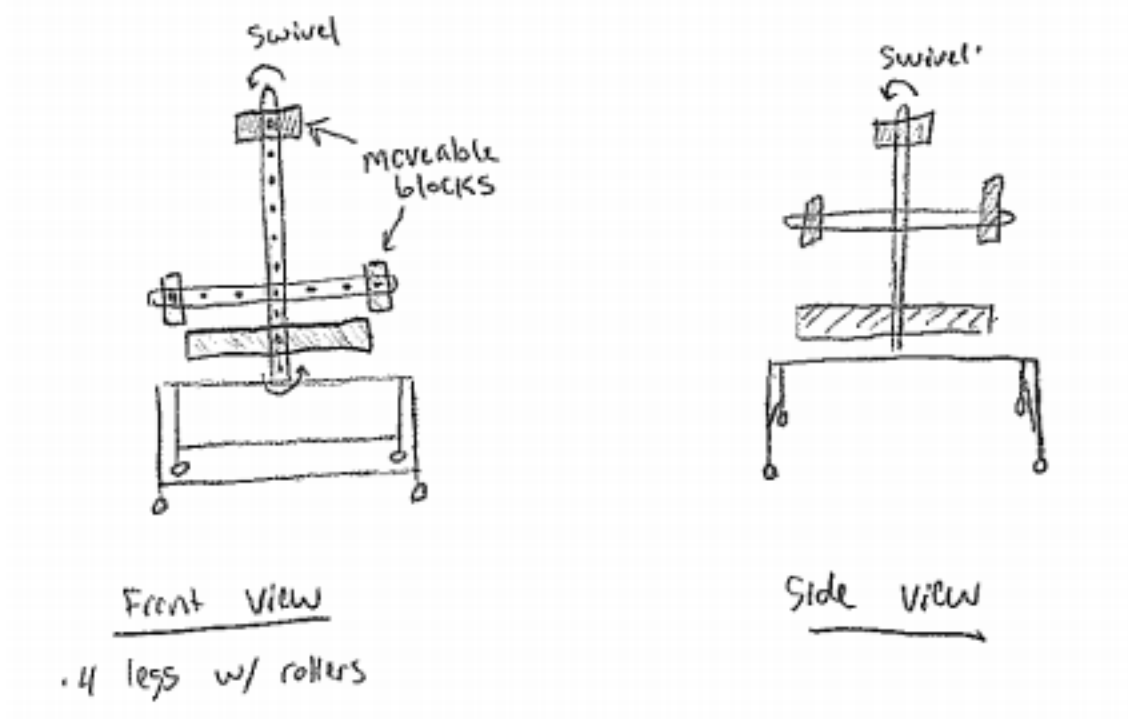


Figure B.5: Skeleton Easel