Wedge and a Ledge

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1. Problem Formulation

1.1. Introduction

In Phase 1 of the design process, the Imagineers created an objective statement along with a black box diagram shown in Figure 1-1.

1.2. Objective

The Imagineers' objective was to design and construct a wedging table for our client, Zane Middle School, in Eureka, California. The wedging table will be sturdy enough to withstand the forces of kneading clay, as sustainable as possible, and portable.

1.3. Black Box

Figure 1-1 Black box model (Made by: Shaela Hogue)

2. Problem Analysis and Literature Review

2.1. Introduction to Problem Analysis

The Problem analysis clarifies all of the client's criteria that they want to be met along with the client's constraints.

2.2. Input Variables & Input Constraints

2.2.1. Input Variables

Wide variety of materials to choose from, safety of children, amount of usage, and location for finished product.

2.2.2. Input Constraints

Materials all must be non-toxic, would be used about half the year, and waterproof.

2.3. Output Variables & Output Constraints

2.3.1. Output Variables

Affordable materials to not exceed the $300-dollar student input, approval from the client, efficient, and can be used whenever needed.

2.3.2. Output Constraints

Must be a 2’x2’x3’ table, 6” depth of plaster, storage for student tools, storage for specialty tools with fastened drawers, and locking wheels.

2.4. Usage

The usage of this wedging table will mainly be for the art teacher. Students may use the table from time to time. This wedging table can be used year round however the course will not be requiring the table daily.

2.5. Product Volume

Only one of these tables will be made for the client. The client will not need more than one wedging table. The table will be stored in the back room where there is also only enough storage space to house one.

2.6. Introduction to Literature Review

The purpose of this Literature Review is to provide appropriate background and relevant information for the Portable Wedging Table project. This literature review will cover the following topics: Client Criteria, Wedging Table Background, Drying Rack Storage, Casters and Caster Locking Mechanisms, Safe Paints, Wood Materials, Metal Materials, Screws, Plaster, and Canvas Top.

2.6.1. Client Criteria

Our client is Zane Middle School in Eureka, Ca. Our client has requested a wedging table for the teacher’s use in the ceramics classroom. Currently, the ceramics class has no wedging table.

2.6.2. Wedging Table Background

A wedging table is a plaster and/or canvas covered table used by potters to “wedge” clay. “Wedging” is the process of throwing and kneading clay to get air bubbles out of it and to dry it out if it’s too wet. The plaster and/or canvas top on the table is what takes the moisture out of the clay.

2.6.3. Drying Rack Storage

To provide space for drying and storing pottery, shelves can be added underneath the tabletop. One option for shelving is shelves that each have a 12” height and are smooth as to not dent the clay bottoms (Wickersham, 2016).

2.6.4. Casters and Caster Locking Mechanisms

In order for the wedging table to be portable and still stable while in use, locking casters can be implemented. There are several ways for casters to be locked. One option is to have individual locks on each caster, as in figure 2-1. These locks are activated by flipping a small lever with the foot, which presses a plate against the wheel, prohibiting the wheel from rolling.

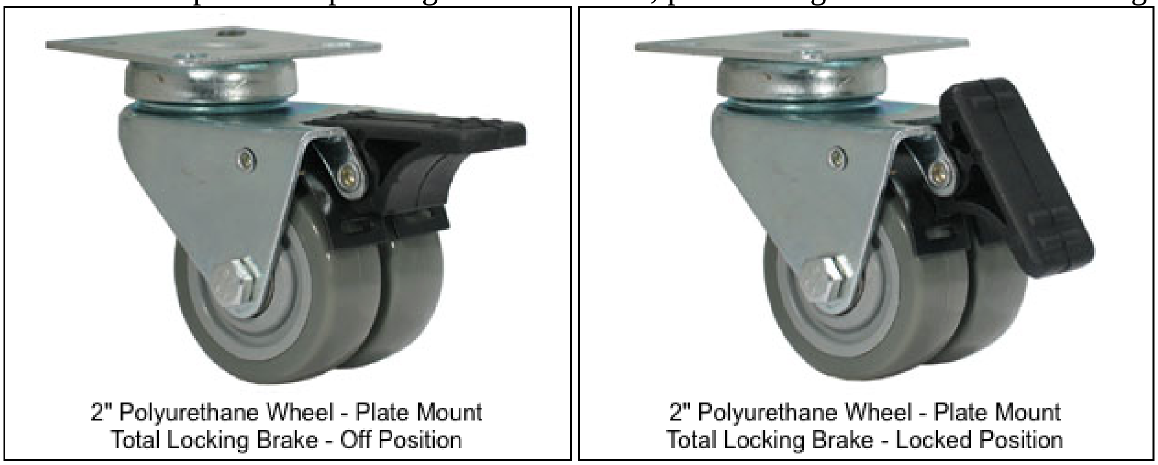


Figure 2-1 Individually Locking Casters (Caster City. 2016)

Another type of caster system, shown in figure 2-2, is one in which a lever arm completely lifts the casters off of the ground, allowing table legs to make contact with the ground.

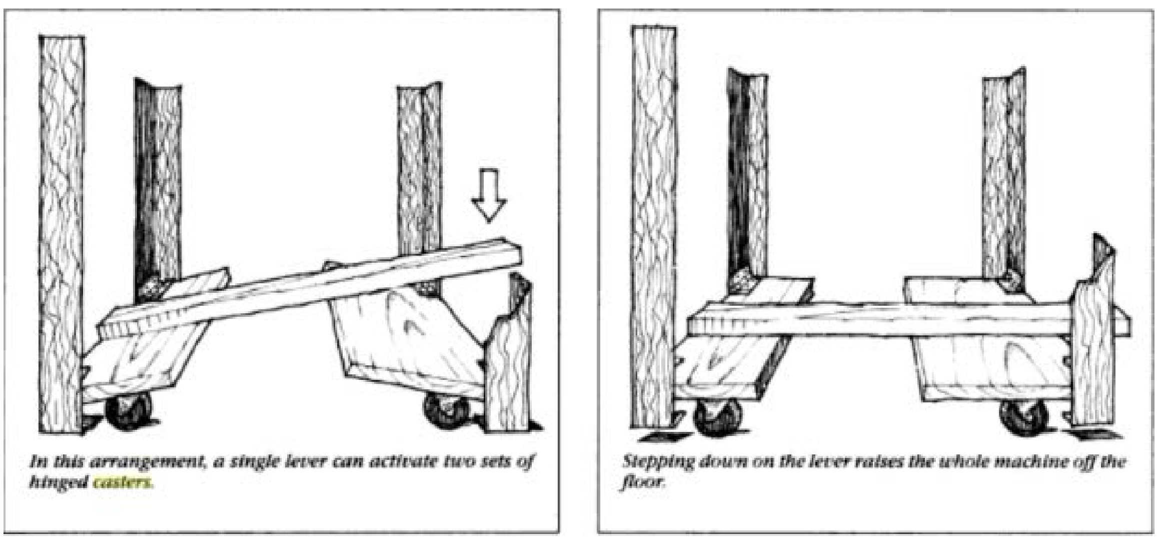


Figure 2-2 Lever Locking Caster System (Boesel, J., Richey, J. 1993)

2.6.5. Paints

The most common wood paints come as a Semi-Gloss paint that creates a clear or colored coat over the wood protecting the wood itself along with creating a more attractive look to unappealing woods (Mike, 2014).

2.6.6. Stains

Polyurethane clear coats are ideally, a paint that is thinner than most used with a bristled brush, rather than a foam brush, this provides a smooth finish. Multiple thin coats will come out more ideally than applying one large thick coat. Multiple thin coats result in a more durable outcome (Rockler, 2007).

2.6.7. Softwoods

- Cedar is a wood that works well for outdoor furniture, desks, and building exteriors. It is less likely to rot from outdoor weather conditions (Meier, 2008).
- Fir is a wood that works well for buildings and some furniture it's inexpensive, however it looks better when painted. It is considered one of the stronger woods in the soft wood category (Meier, 2008).
- Pine is a wood that works well for furniture because it is easy to carve, it also looks good with stain. Using a stain is recommended because the wood itself can ooze (Meier, 2008).
- Redwood is a wood that works well outdoors, it is fairly moisture resistant. It is soft and has a straight grain, along with being fairly easy to work with (Meier, 2008).

2.6.8. Hardwoods

- Ash is one of the hardwoods that is easy to work with. It takes a stain nicely, however the downside is that it is hard to find (Meier, 2008).
- Birch has two main types but comes in more forms as well, however, all forms are fairly hard. When it is available it is affordable along with being easy to work with. Birch should be painted because it is difficult to stain (Meier, 2008).
- Cherry is a wood that works well with furniture because it is easy to work with. It stains great due to its looks with an oil finish, however it is hard to find (Meier, 2008).
- Mahogany is a common wood for furniture; it stains well and looks good with an oil finish. Mahogany is very hard to find and it can be very expensive (Meier, 2008).
- Maple has two main types: a hard and a soft form. The hard form is difficult to work with while the soft form is easy to work with. It is considered a more stable wood however it is slightly harder to find (Meier, 2008).
- Oak is the wood that is most used furniture. It is easy to work with plus it is resistant to moisture, meaning it works well for outdoor use. However, it is slightly hard to find (Meier, 2008).
- Poplar is considered a soft wood in the hard wood category. It is easy to work with but it is not a pretty wood. It should be painted and it is easy to find (Meier, 2008).
- Walnut is a wood that is good for accent or inlays. It has a lot of conditions though, it is expensive, difficult to use, and it is hard to find (Meier, 2008).

2.6.9. Metal Materials

- Aluminum Alloy is lightweight and easy to bend (Hirata, 2002).

- Stainless Steel is an alloy of iron and carbon. Stainless steel is high in strength and has great heat resistance. It resists stains (ex. rust resistant) Ideal for use where it is exposed to water (Hirata, 2002).
- Brass has good soldering properties. Brass is very heavy due to its high density and will oxidize when exposed to weathering unless a clear coat of lacquer is used as protection. It is very expensive when compared to other materials (Hirata, 2002).
- Carbon Steel is an alloy consisting of carbon and iron. It is cheap and it excels in weld ability. Carbon steel has a black surface and it is very hard. Also very resistant to heat. (Hirata, 2002)

2.6.10. Builders Safety Horse Clamp

This clamp provides a quick and easy method of making sawhorses and can be readily disassembled for storage. This safety horse clamp provides two simple, carefully designed, and reinforced plates made from sheet metal. They are light weight and extremely strong (Walstrom, 1942).

2.6.11. Metal Design and Fabrication

2.6.11.1. Properties of Various Metals

- Iron and steel variations produced today are referred to as Standard Steels. Standard steels are categorized into carbon and alloy steels. Carbon steels are used for most structural and mechanical applications. Alloy steels are steels with more than one percent carbon content as well as steels that contain special additives. The most common alloy steels are called stainless steels. Stainless steel resists corrosion, and is often stronger and harder than carbon steel. Chromium, a very hard metal, is added to most stainless steel alloys for strength. Stainless steel is more expensive than identical parts made from carbon steel (Frisch, 1998).
- Aluminum is non-magnetic and non-sparking. It's soft and it can be welded. Aluminum is very reactive with oxygen. Aluminum parts form a microscopic layer of oxide on their surface when they are exposed to the atmosphere. This layer makes aluminum very resistant to weathering. It is extremely conductive. It is highly reflective and can reflect up to 90 percent of radiated heat (Frisch, 1998).
- Titanium is roughly equal in strength to steel, but only half as heavy. It is resistant to things that can destroy other metals, such as oxidizing acids, seawater, and chlorine gas. It is resistant to corrosion, non-magnetic, and is expensive (Frisch, 1998).

2.6.12. Mechanical Fastening

The definition of mechanical fastening is the act of joining parts with the aid of devices such as screws, rivets, and pins (Frisch, 1998).

- Screws and bolts are categorized by their specific use, the type of tool used to tighten them, their head shape, and their strength. Bolts are meant to be fastened by turning the nut and holding the bolt steady. Screws however turn the head while the nut is held steady. Bolts are only intended for use with nuts, while screws can be used independently. Self-tapping screws are sharply edged allowing them to cut their own thread into the material (Frisch, 1998).

- Set screws are usually headless, they are meant to fit into a tapped hole to hold materials together by friction. Set screws are frequently used in for shafts.
- Bolts are made from heat-treated carbon steel and stainless steel. They are intended for structural use because of their strength (Frisch, 1998).
- Machine and Cap Screws are fully threaded. They can be turned by a variety of screwdrivers, and are intended for relatively low-strength applications. They are frequently made from soft metals, such as brass and non-heat treated steels. Socket head cap screws have circular heads that are turned by inserting hexagonal drivers into a matching hole in the center of their head. They are considered the most well-machined of all fasteners, and typically the most expensive (Frisch, 1998).
- Nuts can be either open ended or close ended. Close ended nuts are called acorn nuts; they keep threads safe from damage. Wing nuts can be found in open or closed varieties and have a pair of ear-like protrusions cast into their sides. Thumb nuts are round and have a knurled edge so that they can be turned like a knob (Frisch, 1998).
- Washers spread the forces generated by a tightened screw over a larger area rather than putting all the force on the head of the nut. They can also provide aid in locking fasteners into position and resisting vibration (Frisch, 1998).

2.6.13. Table Top

Table tops for wedging need to be sturdy, unlikely to flake or splinter, and porous to help dry the clay.

2.6.14. Plaster

Plaster has four types: gypsum plaster, lime plaster, cement plaster, and heat-resistant plaster (Miodownik, 2013). Wedging is most commonly done with a type of gypsum plaster called Plaster of Paris, or sometimes pottery plaster. Plaster is porous, sturdy, and is the most popular material for wedging clay. This is because it is absorbent to take moisture from the clay, and is strong so it will not break when in use. However, the wrong types of plaster will flake and mix with the clay which can cause problems (Gumpert, 2014).

2.6.15. Canvas topped Wood or Plaster

Canvas is another common surface for wedging. Having wood or plaster underneath the canvas makes a hard and sturdy surface for removing bubbles from clay. Canvas is porous and will not flake into clay, and can be removed if needed. Canvas, however, will need to be replaced if used often (Walters, 1935).

2.6.16. Concrete

Concrete is occasionally used in wedging tables. It is sturdy and will not flake. Concrete is not as porous as plaster but can be poured in larger areas and is marginally easier to clean (Ceramic Arts Community, 2014).

3. Alternative Solutions

3.1. Introduction

Alternative solutions to our design were generated through brainstorming sessions held on the Humboldt State Uiversity campus in the Science D building. All of the following designs meet the objective and criteria that we have stated for the wedging table. Eight designs total were made within these two brainstorming sessions.

3.2. Brainstorming

Two brainstorming sessions were conducted with full team attendance. During the first session, notes of our ideas were taken down with pen and paper. At the second session, each member took some of the ideas from the first session and compiled them into simple drawings of their ideas that could be potential final designs.

3.3. Alternative solutions

Below is a compilation of the eight alternative solutions created from the brainstorming sessions. A visual aid is provided along with a detailed written description explaining each alternative. These solutions will later be weighed against each other in order to decide which is best for the final design.

3.3.1. Full Throttle Bottle Cart

As shown in Figure 3-1, the Full Throttle Bottle Cart has a wooden and plywood frame. Storage drawers on the cart are made of bottles that are fastened together and pull out as a row unit. Either 12 ounce or one liter size bottles could be used depending on client preference. The bottles are cut in half to make sections in the drawers. The top of the cart has plaster to serve the main purpose, which is a wedging table. The casters on this alternative would all lock and unlock individually.

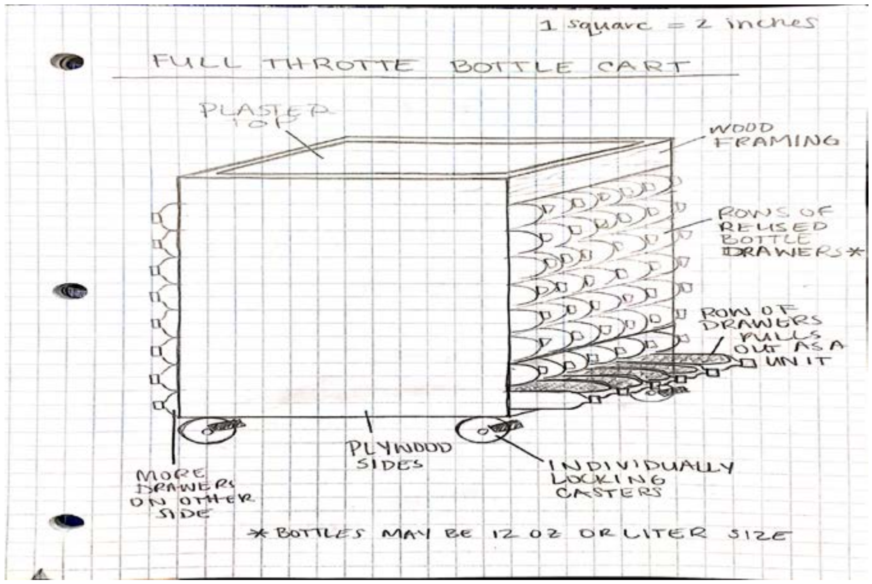


Figure 3-1: Full Throttle Bottle Cart (Drawn By: Shaela Hogue)

3.3.2. I Can’t Believe It’s Not Wedge

I Can’t Believe it’s not Wedge, pictured below in Figure 3-2, is a sturdy wedging table made to function as well as save materials and money with a potters’ plaster top over space-filling recycled bottles. The wood surround for this plaster top has windows to help the plaster dry out. Under this top there are drawers for storage and retractable legs for making height adjustments. The ends of these legs have locking casters for fast and easy movement.

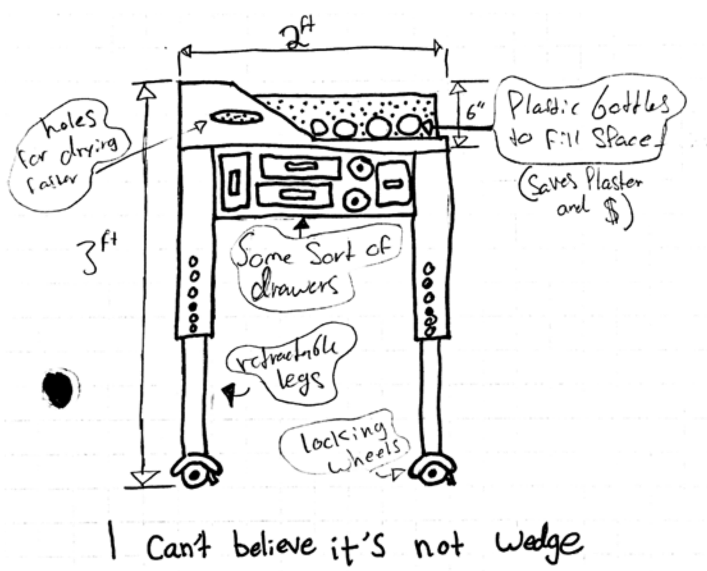


Figure 3-2: I Can't Believe It's Not Wedge (Drawn By: Erin Pyne)

3.3.3. It Can Fit

The It Can Fit design is one similar to an outdoor storage cabinet. As shown in Figure 3-3 it has been modified with a plaster table top the measures 2'x2'. Its height is 3' giving it plenty of room to include a spacious slide out drawer for object that might roll around, and a cabinet fitted with two shelves to store baskets, tools, rolling pins, etc. The unit also has an opened cabinet section where you can store bagged clay ready for the days to come. Lastly the table is easily portable using locking casters.

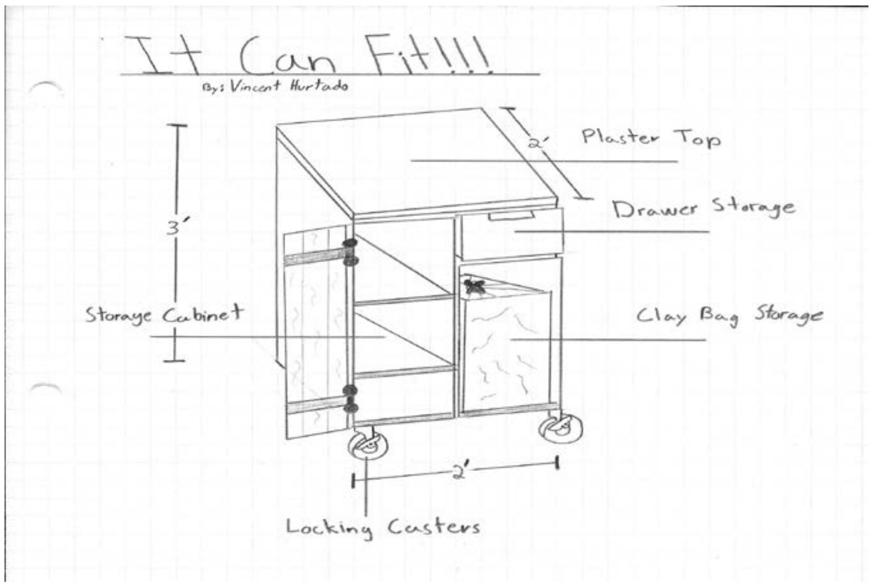


Figure 3-3: It Can Fit (Drawn By: Vincent Hurtado)

3.3.4. Slider 3000

The Slider 3000 is a workshop wedging table that is portable and has storage. Shown in Figure 3-4, the table comes fitted with a plaster table top with dimensions of 2'x2'. The table's height is 3' the legs are equipped with large felt balls as caps that will give friction free movement to the table when it needs to transported. The table also comes with two side shelves where string or large tools can be placed. Lastly the table have a total of four drawers that easily slide out when needed with plenty of room to store any loose tools or materials needed for the projects.

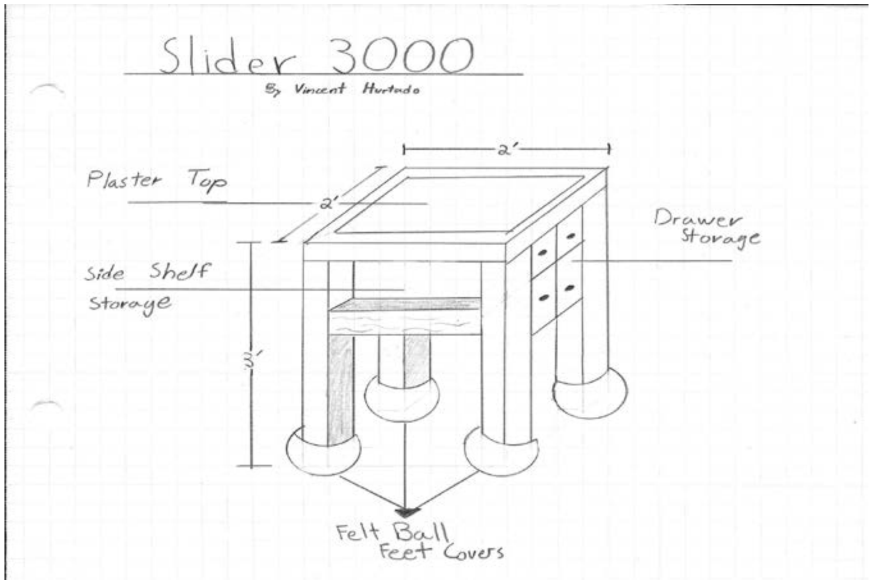


Figure 3-4: Slider 3000 (Drawn By: Vincent Hurtado)

3.3.5. The Spoink Wedge 4000

The Spoink-Wedge is wedging table design based around being height adjustable. Figure 3-5, below, shows a diagram of the design. The table has felt feet for easy sliding attached to the ends of scissor-lift like legs for easy height adjustment between the heights of students and teachers in the classroom. Supported by those adjustable legs is a plaster top with wooden surroundings and a pre-installed wire for easy clay portioning once the wedging is complete. Attached under this top is a set of drawers made from recycled bottles and cans that will hold tools easily and accessibly for the user.

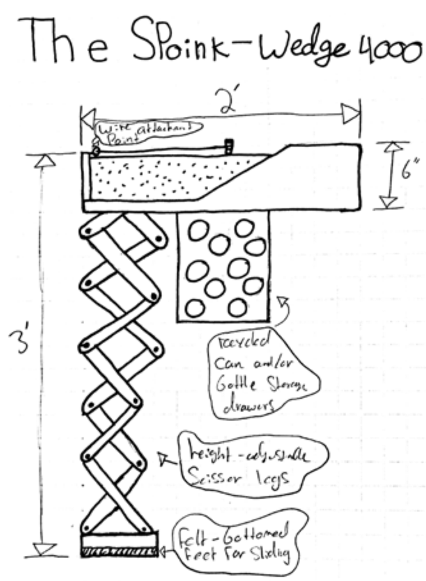


Figure 3-5: The Spoink Wedge 4000 (Drawn By: Erin Pyne)

3.3.6. Wedge and a Ledge

The "Wedge and a Ledge" alternative, shown in Figure 3-6, has a metal frame made from angle iron. This alternative has regular drawers as storage space. A slide out shelf/ledge provides more space to work with clay. This design has a one-step caster locking mechanism. Crossbars 1 and 2 are attached to the angle iron via hinges and each crossbar has two casters attached to it. When mobile, crossbar 3 holds crossbars 1 and 2 in place which pushes the wheels onto the ground for rolling. When the table must be stable, the latch on crossbar 3 is released. The weight of the table pushes down which pushes crossbars 1 and 2 up and the angle iron legs of the table make contact with the ground.

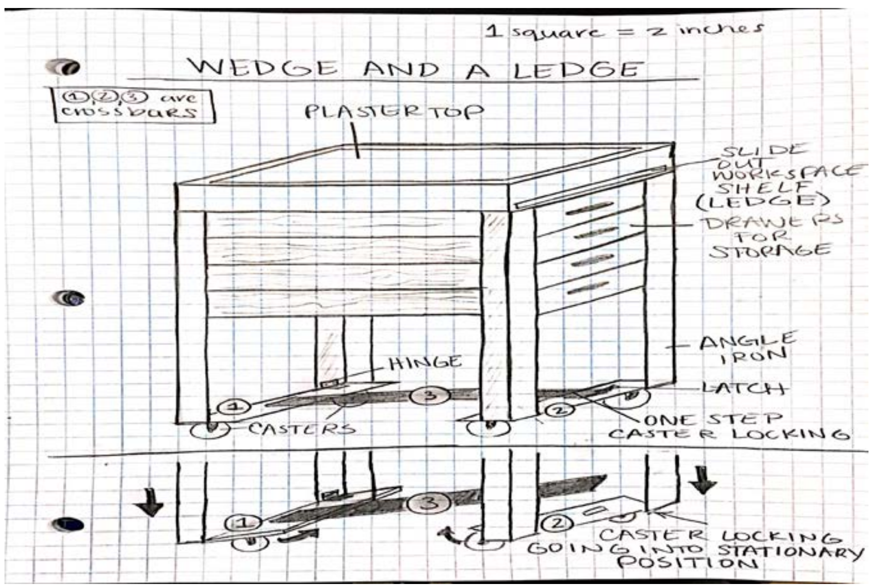


Figure 3-6: Wedge and a Ledge (Drawn By: Shaela Hogue)

3.3.7. Wedging Table with Drainage System

The Wedging Table with Drainage System's design models a table to wedge clay on. Shown in Figure 3-7, letter "A" would be where the clay is wedged. Letter "B" is where the clay is cut. Letter "C" is a drainage system. Letter "D" is the storage system. Part f is a way for the table to transport, while still having the ability to stay in place.

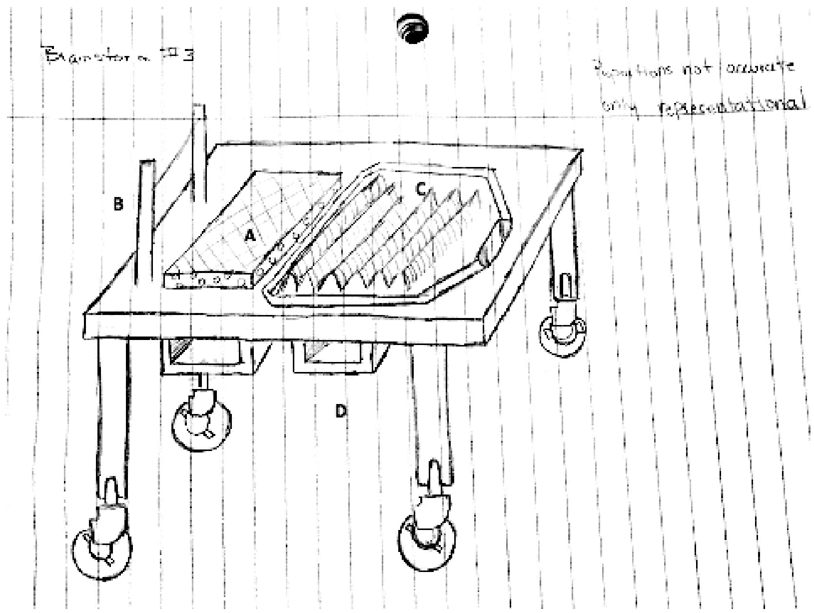


Figure 3-7: Wedging Table with Drainage System (Drawn By: Oscar Bermudez)

3.3.8. Height Adjustable Clay Wedge-R

Found in Figure 3-8 the Height Adjustable Clay Wedge-R shows a sketch of a wedging table with a storage design idea. Instead of constructing a table with storage drawers the idea is to simply build underneath the tabletop a space to easily put things on and take things out of as modeled by letter “C”. This saves the hassle of having to open and close the drawers. This figure also shows the design idea for height adjustability. In these drawings the holes on the legs of the table (letter “D”) are representational of how the design is meant to work. As the height is adjusted the legs lock into the holes. Preventing the legs from further moving up and down. When the height needs to be adjusted again, the simple turn of a knob releases the lock. Letter “A” shows the design idea for a clay cutting device which will make cutting the clay in the classroom much easier. Letter “B” shows a layer of plaster above the wood in order to make wedging clay easier.

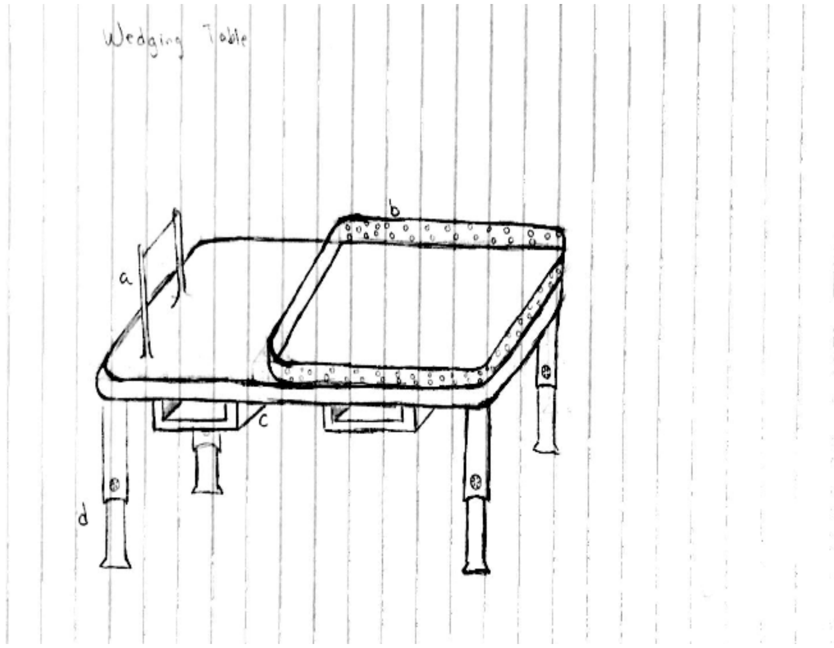


Figure3-8: Height Adjustable Clay Wedge-R (Drawn By: Oscar Bermudez)

4. Decision Making Process

4.1. Introduction

Section 4 describes the process the team used to decide which alternative solution to use for the final design. The decision process considered the criteria, and the relative importance of each criterion. Each alternative was given scores for each criterion.

4.2. Criteria Definition

Listed below are definitions of the criteria from Section 2 that have been used in the decision process.

- **Aesthetics-** The table needs to be appealing to the eye.

- **Cost-** The cost should not exceed a budget of $300.00

- **Durability/Longevity-** The table should need little maintenance, and should be able to withstand minor wear and tear.

- **Environmental Impact/Sustainability-** The use of reusable and non-harmful materials would be preferable.
- **Portability-** The table should move with ease and be able to lock in place.

- **Safety-** The table should not contain any toxic materials, sharp metal, or splintered wood.

- **Sturdiness-** The table should not teeter over, the wood and metal must be securely attached throughout the table, and the caster locking mechanism must be able to remain locked.

4.3. Solutions

Below is a list of the alternative solutions that were described in Section 3.

- Full Throttle Bottle Cart
- I Can't Believe It's Not Wedge
- It Can Fit
- Slider 3000
- The Spoink Wedge 4000
- Wedge and a Ledge
- Wedging Table with Drainage System
- Height Adjustable Clay Wedge-R

4.4. Decision Process

The decision process includes brainstorming, client requests, and the numerical weights of each of the alternative solutions. Each alternative was given a relative score in each of the weighted categories. These scores were determined by client requests, as well as input of the teammates. The information was then placed into a Delphi Matrix that broke down the scores, resulting in the decision. Table 4-1 shows the weight of importance per criteria for the completed design. Table 4-2 shows the weighted criteria multiplied by the score that represents how much that design fulfills each criteria.

Table 4-1 Criterion

Criterion	Weight (0-10)
Safety	10
Portability	9
Sturdiness	8
Cost	7
Durability/Longevity	7
Environmental Impact/	5
Aesthetics	3

Table 4-2 Delphi Matrix

Criterion	Weight (0-10)	Alternative Solutions (0-30 high)							
		Full Throttle Bottle Cart	I Can't Believe	It Can Fit	Slider 3000	The Spoink Wedge 3000	Wedge and a Ledge	Wedging Table With	Height Adjustable
Safety	10	30 / 300	28 / 280	28 / 280	27 / 270	15 / 150	28 / 280	27 / 270	28 / 280
Portability	9	30 / 270	30 / 270	29 / 261	21 / 189	17 / 153	28 / 252	29 / 261	21 / 189
Sturdiness	8	25 / 200	25 / 200	25 / 200	25 / 200	15 / 120	27 / 216	24 / 192	26 / 208
Cost	7	26 / 182	18 / 126	20 / 140	20 / 140	20 / 140	21 / 147	21 / 147	21 / 147
Durability	7	19 / 133	23 / 161	23 / 161	22 / 154	17 / 119	23 / 161	23 / 161	24 / 168
Sustainability	5	30 / 150	25 / 125	23 / 115	21 / 105	23 / 115	22 / 110	23 / 115	23 / 115
Aesthetics	3	20 / 60	20 / 60	21 / 63	22 / 66	16 / 48	22 / 66	21 / 63	21 / 63
Total		1295	1222	1220	1124	845	1232	1209	1170

4.5. Final Decision

Through the use of the Delphi Method, the solution with the greatest ranking is “Wedge and a Ledge”. This design meets most of the criteria adequately. It is aesthetically pleasing, affordable, made of durable materials, uses materials with low impact to the environment, is highly portable, is one of the safer alternatives, and is reinforced with three crossbars providing support.

5. Final Design

5.1. Introduction

The purpose of Section 5 of this design document is to go into more detail about the design chosen in the previous section. An in-depth description will be provided as well as an overview of the costs associated with our design. Hours spent, materials purchased, and predicted operation and maintenance costs will be covered. This section will also include instructions of how to use our wedging table design.

5.2. Description of Solution

The "Wedge and a Ledge" alternative, shown in figure 5-1, has metal legs made from aluminum square tubing. This alternative has shelves as storage space. This design has a one-step caster locking mechanism as described in section 3.3.6. Crossbars 1, 2, and 3 are not pictured here, but are pictured and described in section 3.3.6. as well.

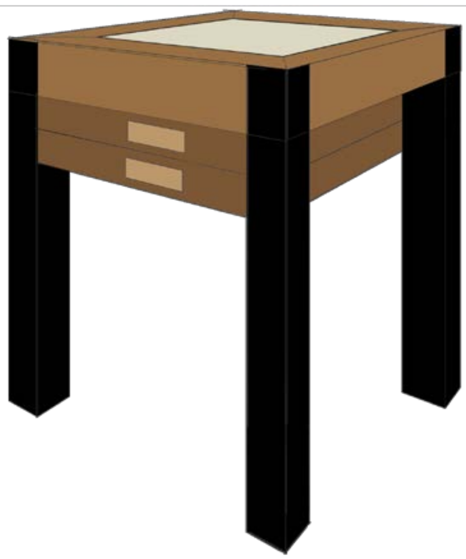


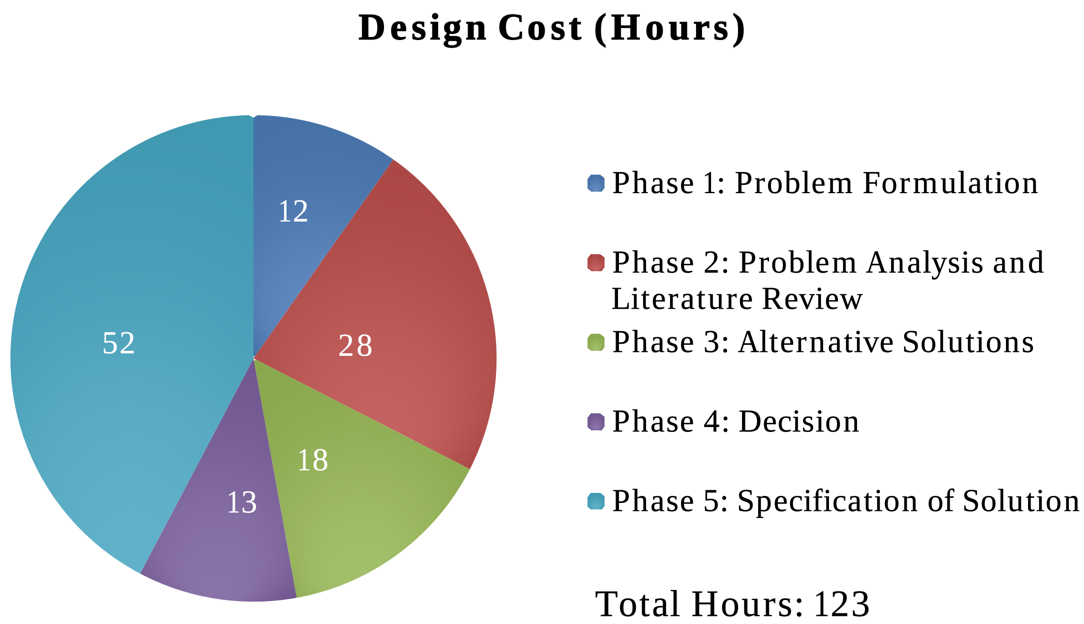
Figure 5-1 Wedge and a Ledge (Drawn By: Erin Pyne)

5.3. Costs

5.3.1. Hours Spent

Table 5-1, below, shows the total hours spent in each phase of the project.

Table 5-1 Hours Spent on Project



5.3.2. Cost to Build/Implement

Table 5-2 shows the respective cost and quantities needed to build our project. The total project cost was $168; this does not include the value of the materials that were donated.

Table 5-2 Cost of Materials

Item	Cost ($)	Quantity	Total ($)
Casters	7.99	4	31.96
Hinges	5.39	4	21.56
Screws for casters	0.22	16	3.52
Aluminum legs	7.50	2	15.00
Screws for hinges and plaster box	Donated	1/2 pound	0
Wood	Donated	2 boards 2 sheets of plywood	0
Wood glue	Donated	1 bottle	0
Plaster of Paris	21.00	3 bags	63.00
Miscellaneous Hardware & etc.	32.76	NA	32.76
Total			**$168**

5.3.3. Cost to Maintain

The cost to maintain the "Wedge and a Ledge" design is, for all practical purposes, nothing. Unless the plaster top gets broken or cracked, the table will be functional indefinitely.

5.4. Build/Implementation Instructions

The "Wedge and a Ledge" design will be placed in the art room storage area while it is not in use. The table will remain stationary while the caster locking mechanism is disengaged. When the table needs to be used, the mechanism must be engaged for the table to be rolled to the designated wedging area. Once in that area, the mechanism can be disengaged so that the table remains stationary during use.

5.5. Results

As of Monday, May 2nd 2016, the "Wedge and a Ledge" design was completed and is ready for use by the Ken Weiderman and his students. We successfully demonstrated our constructed design to judges, our peers, and our instructor during a presentation to Zane Middle School.

6. Appendices

6.1. Appendix A: References

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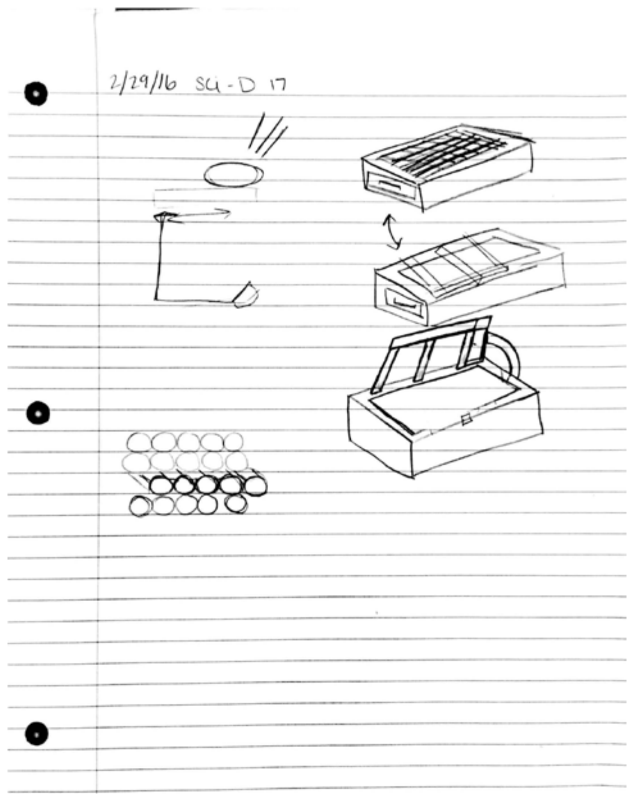
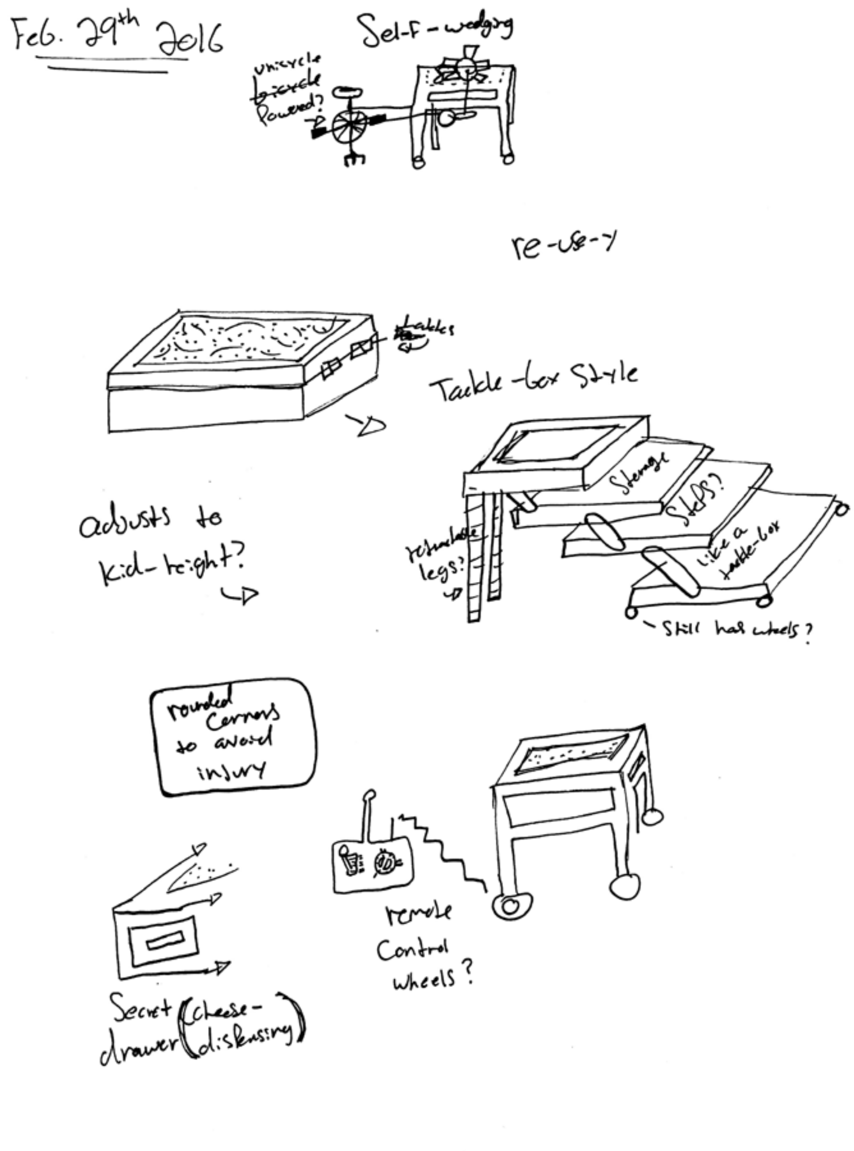
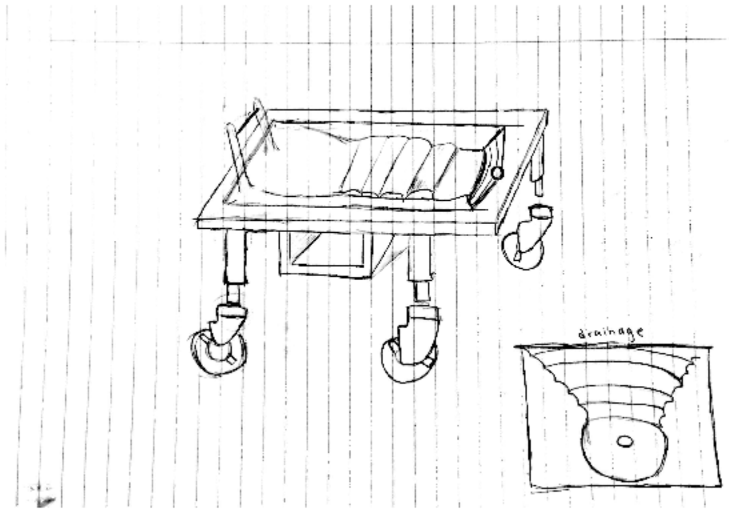
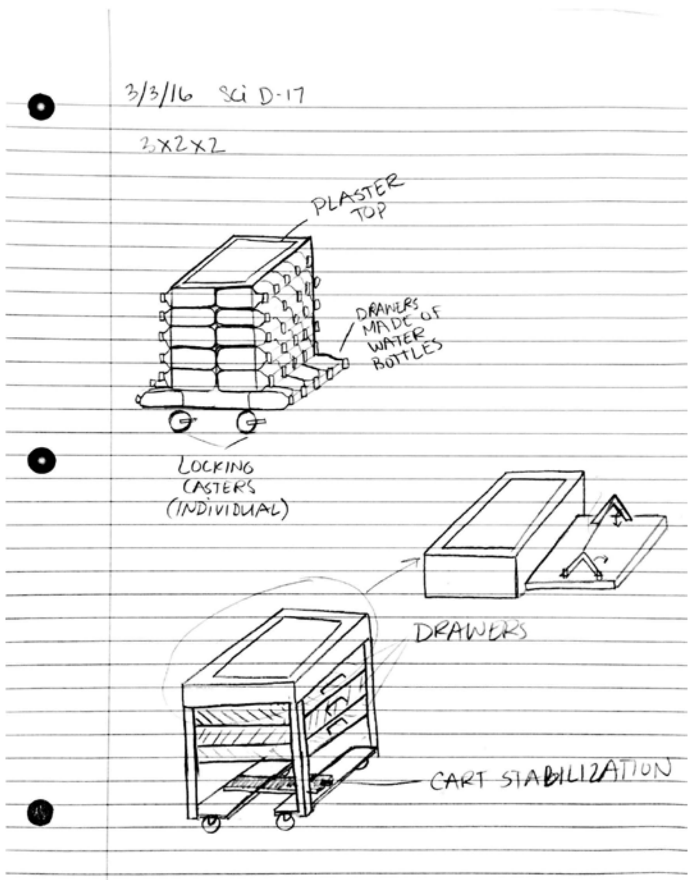
6.2. Appendix B: First Brainstorming Session Notes

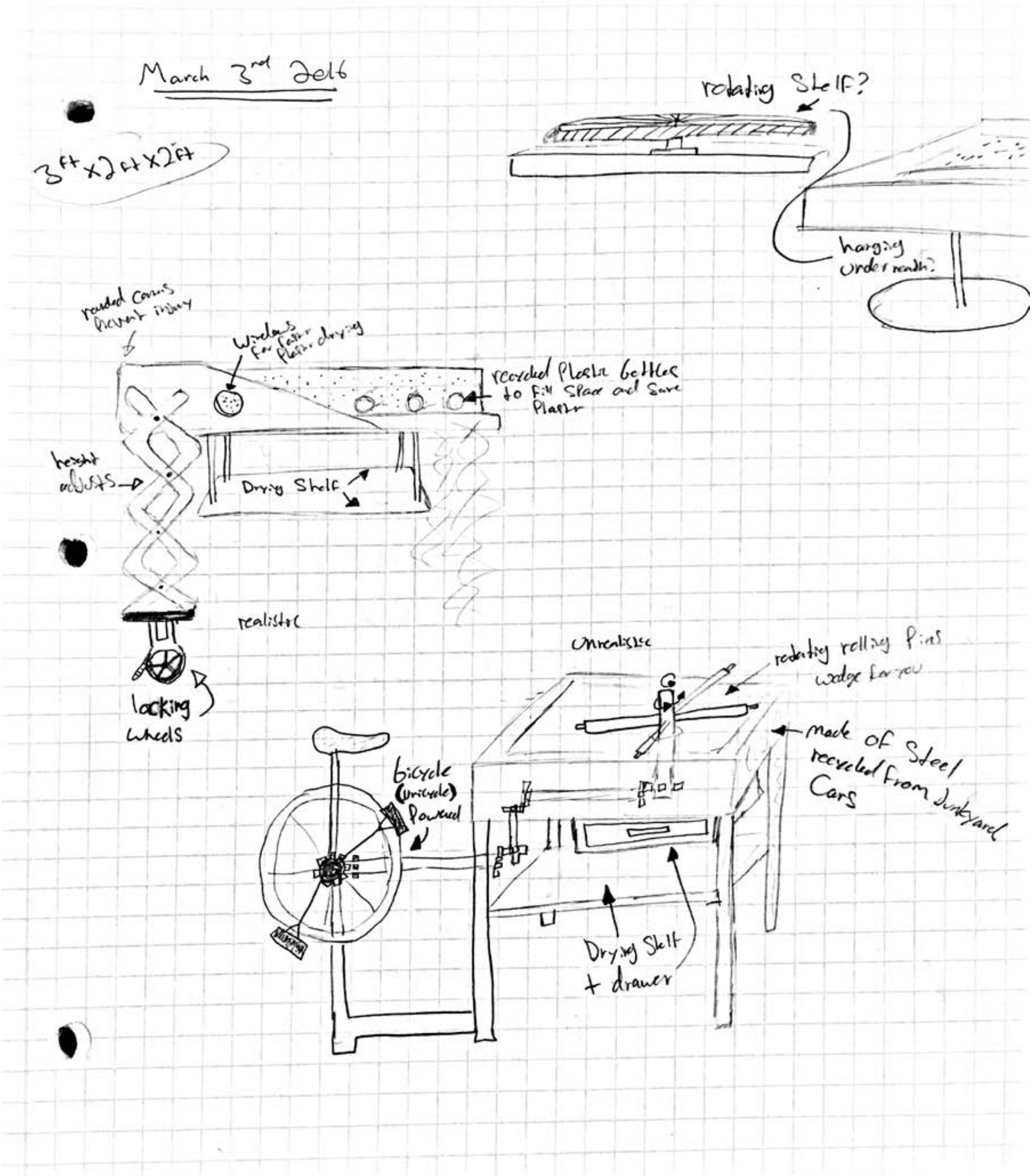



Feb. 29th 2016
Self-wedging
unicycle
bicycle
Powered?
re-use-y
Tackle-box Style
Storage
Steps?
removable legs?
like a tackle-box
adjusts to kid-height?
Still has wheels?
rounded Corners to avoid injury
remote Control wheels?
Secret drawer (cheese-dispensing)

6.3. Appendix C: Second Brainstorming Session Notes






March 3rd 2016
3ft x 2ft x 2ft
rotating Shelf?
hanging underneath?
rounded corners prevent injury
windows for faster plaster drying
recycled Plastic bottles to fill space and save Plaster
height adjusts
Drying Shelf
realistic
locking wheels
unrealistic
rotating rolling Pins wedge for you
made of Steel recycled from Junkyard Cars
bicycle (unicycle) Powered
Drying Shelf + drawer