PRODUCTIVE COMMUTING

PORTFOLIO SUMMARY

Productive Commuting

Kelvin Lao, Alex Sung, and Michael Youngblood

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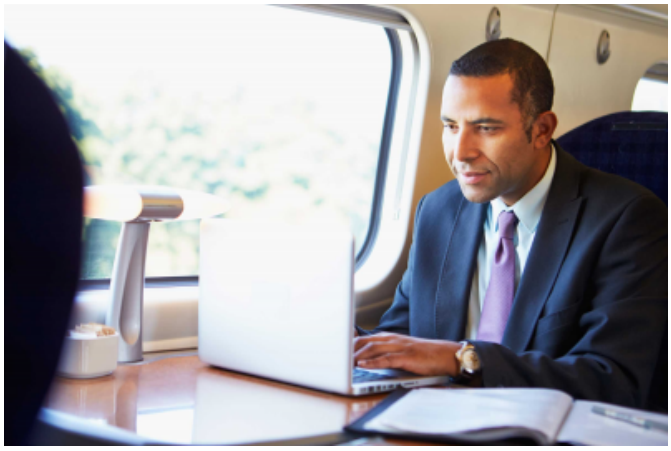
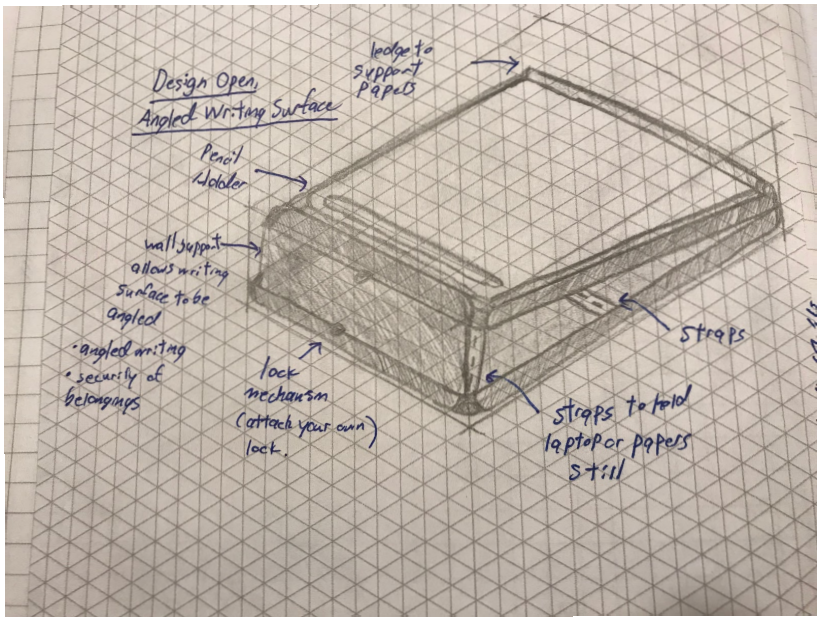




Portability

Safety

Ease of Setup

Ease of Use

Comfort

Durability

Price

Counter-Wobble Capabilities

Size

Weight

Plan for Disposal

PORTFOLIO ELEMENT A

PRESENTATION AND JUSTIFICATION OF THE PROBLEM

Business Plan

Kelvin Lao, Alex Sung, and Michael Youngblood

Executive Summary:

Problem Statement:

Travel time takes too long. People who take public transportation lose productive time on a packed train or bus. Although it is possible to work on public transport, it is often too unstable and difficult.

Existing Markets:

The current market that best fits our Problem Statement is the portable productivity market. Products in this market include lap desks, portable tablets, mobile computer desks, and phone productivity apps. All of these products work to increase the consumer's productivity in their "wasted time," daily actions, and busy schedules. This market fits with our Problem Statement, as we are hoping to increase productivity on Public Transportation.

Our Market:

There is reasonable evidence for the need for our product. We surveyed over 120 Jones High School students, and found that almost 80% of students wished to be more productive on the train. Only approximately 30% of students are productive on the train currently, and this means our market could serve upwards of 50% of the population we surveyed. Our data also shows that 65% people would be willing to pay $10 for this product. Our research shows that there is a reasonable need for our product. These people are willing to pay for this product, and we could make a profit off of our design.

The Industry:

At the current time, there is no industry that specifically appeals to commuters on public transit. The closest industry would be the lapdesk industry that appeals to laptop owners at home. While the lapdesk can be used on public transit, it tends to be too bulky and not designed to be used in this situation. At its current state, the lapdesk industry seems to be heading towards optimizing lap desks for larger laptops and increasing convenience at home (bigger and sturdier, space for a phone and coffee cup).
While we will be competing with other lap desks, our lap desks will be optimized for use on Public Transit. Our product will also be more useful to use as a surface to write on when compared to other lap desks. In conclusion, our product be a specific niche in the lapdesk industry, with our target market being commuters on public transport.

Market Analysis:

Target Market

Our competitors are LapGear, Honey Can Do, Sofia + Sam, and Huanuo. All of these companies make portable lap desks that allow users the freedom to work anywhere. These products are applicable to working on public transport, but are not specifically designed for public transport. This means that most are bulky and take up lots of room. These lap-desks would be hard to take out of a bag on the train, and would not fit easily on your lap in a full train car. These products would be hard for commuters to use on their public transportation rides due to their size.

Future Potential Competitors

Future potential competitors are phone makers, who expand the capabilities of their phones. If people can do all their work on a phone, they will not need to take out our product to work on physical paper or a laptop computer. Another future competitors are train makers themselves, who could design trains that increased commuter productivity.

The barriers for entry for new competitors are the creation and development of the products, and mass manufacturing the items.

Total Available Market

The total available market is all commuters who want to get more done on their commute. This applies to most commuters including over 1.5 million daily on Chicago's CTA. People want more free time off the train or bus, and complain about their commute being unproductive time. Some larger firms or companies might buy our productive transport solutions to increase worker output. If workers

were able to work on the train they could gain almost an hour of productive time for the company, creating better work.

Market Research

Online Market Research:

To learn more about public transportation and our possible market, we completed some online research. This research shows us that there are lots of people on the train, and we used this data to figure out our target market. We researched specifically the CTA and commuters in Chicago. Our product is applicable to all urban environments, but we will begin sales in Chicago.

Monthly System Totals for Chicago Transit Authority (CTA)

Monthly System Totals	Monthly Total (actual) Last Yr	Cur Yr
Bus	21,076,518	19,949,111
Rail	20,489,102	19,457,196
System Total	**41,565,620**	**39,406,307**

Public Transportation Passenger Age Breakdown Compared to US Population Age Breakdown

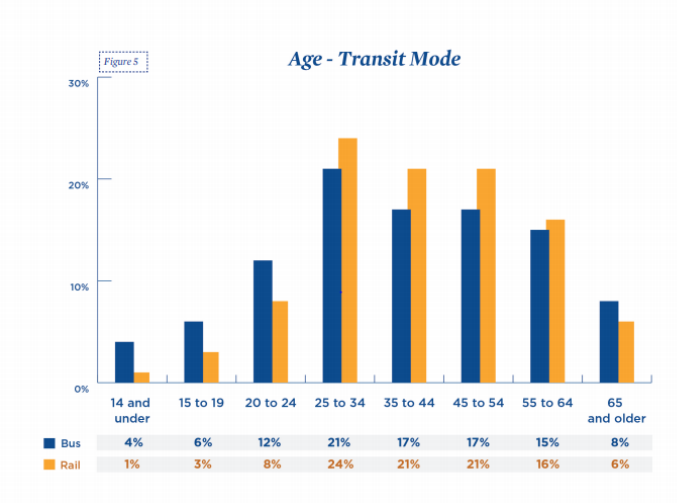
Table 3 - Population & Riders 15 And Older

Age	U.S. Population	Transit Users
15 to 19	9%	4%
20 to 24	9%	10%
25 to 34	17%	23%
35 to 44	16%	20%
45 to 54	17%	20%
55 to 64	15%	16%
65 and older	17%	7%

# of reports: ***195***
Average # of riders surveyed per study: ***3,352***
 # respondents: ***653,642***
Annual ridership of systems responding: ***8,144,397,645***

Source: American Community Survey, Five year estimates, 2014

Age Breakdown for Mode of Transit



CTA Ridership Per Average Weekday
Bus and Rail Breakdown

Ridership

Average Weekday (2016)	
Bus	826,322
Rail	759,866
Total system	**1.59 million**

Number of Students in CPS,
Part of Target Audience: Student Commuters

Level and control of institution, enrollment level, and attendance status and sex of student	Actual			
	1990	2000	2010	2015
1	2	3	4	5
All levels	**60,683**	**68,685**	**75,886**	**76,177** [1]
Elementary and secondary schools[2]	**46,864**	**53,373**	**54,867**	**56,189** [1]
Public	41,217	47,204	49,484	50,438 [1]
Private	5,648 [3]	6,169 [3]	5,382 [3]	5,751 [3]
Prekindergarten to grade 8	34,388	38,592	38,708	39,692 [1]
Public[4]	29,876	33,686	34,625	35,388 [1]
Private	4,512 [3]	4,906 [3]	4,084 [3]	4,304 [3]
Grades 9 to 12	12,476	14,781	16,159	16,496
Public[4,5]	11,341	13,517	14,860	15,050
Private	1,136 [3]	1,264 [3]	1,299 [3]	1,446 [3]

Sources:

Governing.com

All Chicago-Naperville-Elgin, IL-IN-WI, area public transportation commuters spend an average of 49.5 minutes traveling to work. By comparison, it takes those who drive alone 29.0 minutes. The 524,323 estimated public transportation commuters account for 12% of all commuters.

Figures represent estimates for all workers age 16 and older. They do not account for varying travel distances.

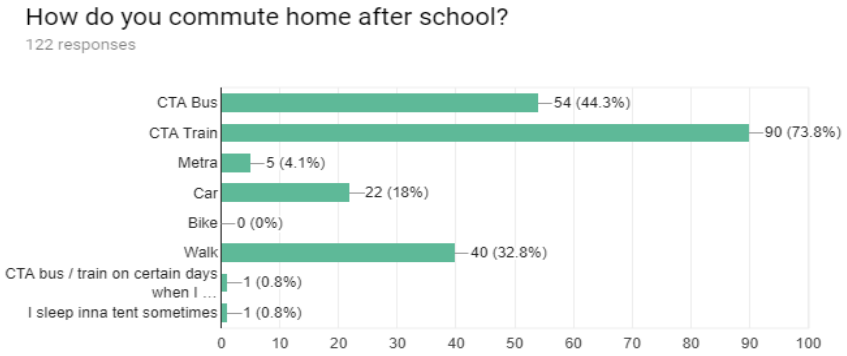
SOURCE: *Governing* calculations of 2011-2015 American Community Survey data

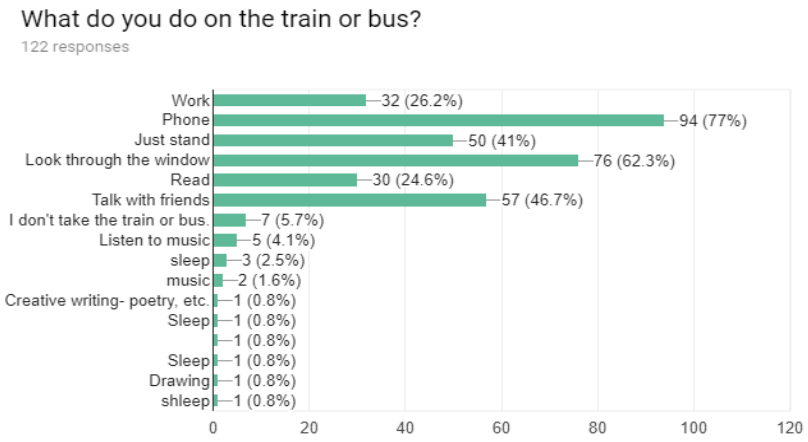
Our Market Research:

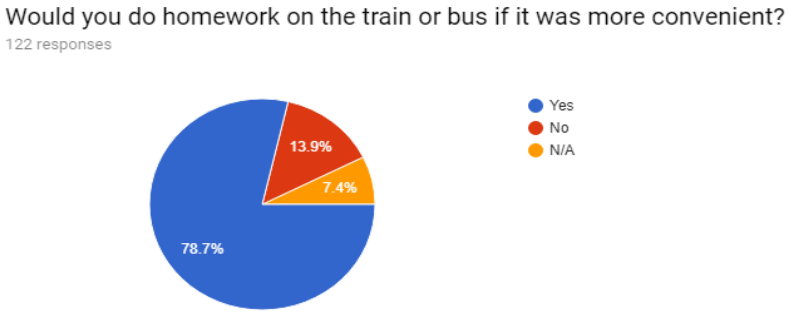
Data Introduction

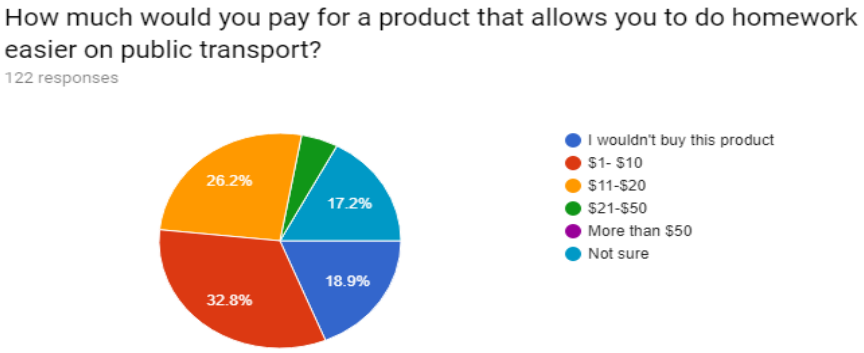
To learn about the Market, we performed a Survey of the Jones Senior Class about who takes Public Transportation, what they do on their commute, and how much they would be willing to pay for our solution. We received over 120 responses, or about one quarter of the Jones Senior Class.

Research Survey Questions and Responses









Research Analysis:

Out of 115 students surveyed, over 90 take some form of Public Transportation to Jones in the morning. 31 people take the CTA bus and 66 people take the CTA Train. These students lose productive time on the train, as only 30 percent of students said they work on the train. In contrast, over 75 percent of students said they went on their phones on the train. These percentages do not add up because students do a variety of tasks on the train. However almost 80 percent of respondents said they would work on the train if it was more convenient. This means that there is an untapped resource of almost half the Jones population that would work on the train. This data shows there is a large market for a product to help students increase productivity on public transport.
Our survey found that Jones students spend an average of around 30 minutes on each public transportation trip. Jones Students average two trips per day, or a total of one hour on public transportation. This tells us that people do not have an endless amount of time on the a vehicle to work. This means our product have to be convenient, easily accessible. If it takes a long time to set-up and start working, people will not have lots of time to be productive.

Our survey also asked about the expected price of this product. Over half of students surveyed said they would buy the product, for an average of around $10.

Our personal market research has shown a wide open market for students who want to be productive on public transport. This is a real need, as it would improve student life overall.

If students were able to complete more homework on the train, they could have more free-time at home or afterschool to do what they wanted.

PORTFOLIO ELEMENT B

DOCUMENTATION AND ANALYSIS OF PRIOR SOLUTION ATTEMPTS

Prior Solution Attempts

Kelvin Lao, Alex Sung, and Michael Youngblood

Introduction:

In this step of the design process, our team found prior solutions to our problem statement. We researched on Amazon.com and other websites to find existing products and patents related to our Problem Statement. We found a total of six products, and created a list of Design Specifications to evaluate the products we researched. We looked into the strengths and weaknesses of each design, and how they can guide our brainstorming process. Finally, we made a Similar Solution Matrix to discover which previous solutions best solve our problem statement.

Competitive Product Analysis:

1. LapGear: Essential Lap Desk, Rose Quartz

3701 New York Ave. Suite 100
Arlington, TX 76014
https://www.lapdesk.com
1 (800)LAPDESK (527.3375)
info@lapdesk.com - Customer Service

Materials:

- Plastic
- Foam
- Fabric

Pros:

- Comfortable
- Varying sizes
- Claims to help laptop life.
- Convenient to use at home.
- Relatively cheap

Cons:

- Not portable enough
- Too Wide, hard to pack.
- 13.75" x 10".
- Made for laptops, not as comfortable for writing.

Quality:

- (4/5 stars) with 223 customer reviews on Amazon.com

Sold mostly online through Amazon and lapdesk.com, have products in typical office stores such as Office Depot, Staples, and Best Buy. Communication mostly through their website.
Prices: Comes in different colors. $12.

Overall, this product is useful and convenient but only at home. It is too bulky to take out to use on public transport and does not provide enough stability in order to do homework on it. It is useful but would not solve our problem. It is also not useful for standing Public Transport users, and passengers would want to use it regardless if they have a seat or not.

2. Huanuo Adjustable Lap Desk

Shenzhen Huanuo AV technology Co. Ltd
Room 1006, 1st Floor, Block 7, Vision Business Park, No.9
Gaoxin South Road, Nanshan District, Shenzhen, China
+1 (323) 522-5603(US Number)
customerservice@huanuoav.com

Amazon.com

Materials:

- Foam
- Plastic

Pros:

- Can be used while reclined
- The angles can be adjusted
- Can hold heavy objects
- Can hold any technology
- Comfortable on lap
- Price

Cons:

- To big
- No wrist support
- Uncomfortable for writing
- 14 x 1/2 x 10

Our product competes with this design as the Huanuo Lap Desk is too large. This would not be useful on a full train car, as it would go into other passengers personal space. This design also does not work for standing Public Transportation riders. This is around half of the people on every train or bus, and would limit the usefulness of the product.

3. Connect A Desk

Phone: (940) 247-7391
Website: connectadesk.com
Email: info@connectadesk.com
706 W. Ben White Blvd.
Suite 191B
Austin, TX, 78704

Overall Quality:

- 4.0 Stars on Amazon.com

Price:

- $49 on Amazon.com and connectadesk.com,
- $39.95 on Ebay (might not be real Connect A Desk on Ebay, might be knock-off).

Materials and Specs:

- Materials: Nylon, Foam, and Plastic.
- Platform size: 12”width x 10” depth
- Fits into most laptop bags
- Has optional 4-year and 3-year protection for around $5.00.
- There is no data on the market share or advertisement data for this product.

Pros:

- Allows use of a computer or writing easily while standing.
- Holds most sizes of laptop
- Better than holding it in your hand

Cons:

- The desk sits too high to work if you are seated.
- Not stable in a vehicle.
- Overpriced
- Laptops overhead on the surface, it insulates the battery too much.
- Not comfortable
- Hard to use for more in-depth work.
- Hard to get on and off, awkward
- Does not hold a large laptop

The general consensus on Amazon reviews was that it is a good idea, just poorly implemented.

Our design competes with this product because it only fulfills one purpose of a standing desk. While this is usable on public transportation, the design is bulky and requires your elbows to protrude to the side. This design would not work in a cramped train or bus. On top of that, users complained it was not stable in a vehicle. This means it would be especially unstable in a train, bus, or other public transport vehicle. The device is also difficult to get on, as you need to put it around your arms and over your head. This would require taking off a backpack, and would not be possible in a tight space on Public Transport.

Patent Search Activity

Patent 1:

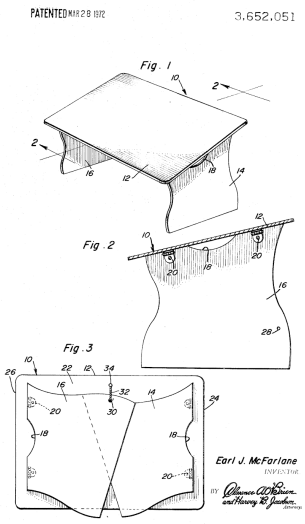
US3652051A
McFarlane, E. J. (1972). *U.S. Patent No. US3652051A*. Washington, DC: U.S. Patent and Trademark Office.
Google Patents

Patent Summary:

This product is a simple foldable desk meant to be portable. It is supported by 2 wooden frames that are attached to hinges that allow it to be foldable. The wooden desk is to be placed on the outside of the legs which makes it very hard for the user to get comfortable. Although the material is cheap it is terrible for comfort. The two sides also has a set length and angle which makes the product not adjustable.

Patent Critique:

This device tackles our main problem which allows it to become quite portable and easily accessible. Not only but it is also cheap and data from our survey says that the price should stay under $20. But this product sacrifices the feeling of comfort. The desk being fully made out of wood and not adjustable does not achieve the goals for our product. Overall this patent is quite simple and our goal is to fix our problem while keeping simplicity.



Patent 2:

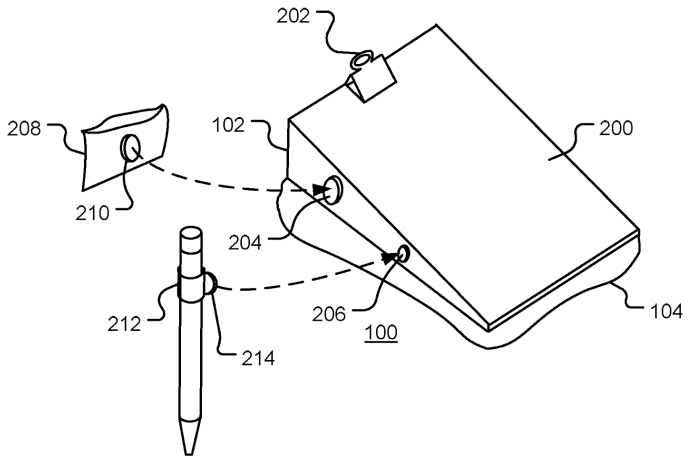
US20110056413A1
Andochick, S. E. (2011). *U.S. Patent No. US2011005641 3A1*. Washington, DC: U.S. Patent and Trademark Office.
Google Patents

Patent Summary:

This device makes clipboards and other writing surfaces safer in a vehicle, or vehicular crash. Normally, writing surfaces are very hard and can cause damage if the user is writing in a vehicle that undergoes a crash. This design lowers that risk through using softer materials, and uses magnets to attach two pieces of foam. The foams are firm enough for writing, but soft enough to avoid harm in a collision or crash. The bottom piece of foam allows the user to create a flat surface, as the bottom foam will mold to their knee and leg shape and sit flat.

Patent Critique:

This design fits with our Problem Statement as it addresses the needs of seated passengers, and ensures their safety through a smarter use of materials. However, this device does not help standing passengers. The foam construction of this device also causes the device to be larger, and it might not be easy to set up quickly in a moving vehicle. The size of the object also means that while it will hold a variety of materials for the user to view, it will possibly be larger than the space available. The slant of the surface makes it better for writing, but makes computers harder to use.



Patent 3:

US6173656B1
Google Patents
Blanchard, D. K. (2001). *U.S. Patent No. US6173656B1*. Washington, DC: U.S. Patent and Trademark Office.

Patent Summary:

A portable lap table for children, meant to be used on transport in a car. No edges for safety, surface has various holes for holding crayons, drinks, and the like, a gutter for containing liquid spills, an outer lip to prevent objects from rolling off the surface, and handles for portability.

Patent Critique:

This lap desk attempts to solve the problem of children having nothing to do in car rides, and providing a steady table for sources of entertainment like coloring books. Although the patent could solve the problem they set out to, it isn't suitable to solve our problem. It is portable and safe for students to use on public transport, but all the holes and extra functions designed for children would just get in the way. This patent introduces the safety aspect of the product on public transport to us.

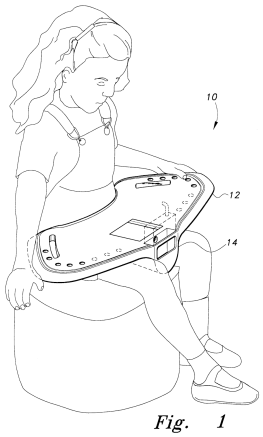


Fig. 1

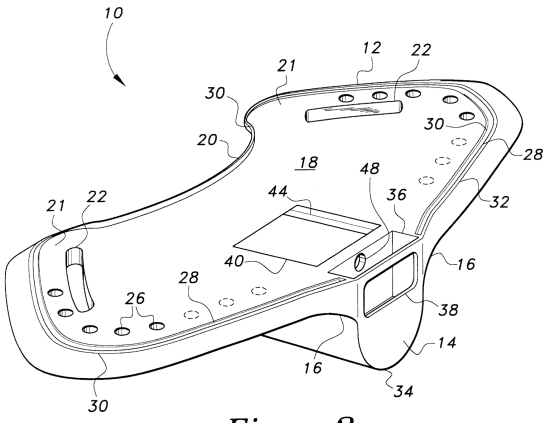


Fig. 2

Specification Categories:

- **Price**
- **Portability**
- **Durability / Quality**
- **Comfort**
- **Size**

- **Weight**
- **Safety**
- **Ease of Use: Seated**
- **Ease of Use: Standing**
- **Ease of Setup**
- **Counter-Wobble Capabilities**
- **Plan for Disposal**

Comparison Tables and Matricies

Table 1.1: Meaning of Ratings 1-5

Specification	5	4	3	2	1
Price	Less than $5	$5-10	$10-20	$20-50	More than $50
Portability	Extremely Portable	Very Portable	Somewhat Portable	Not Very Portable	Not Portable at all
Durability/ Quality	Lasts more than 2 years	Lasts 2 years	Lasts 1 year	Lasts 6 months	Lasts 3 months
Comfort	Feels Amazing	No Pain	Insignificant pain	Moderate pain to use	Lots of Pain to Use
Size	L: 13-14 in W: 10-11 in	L: 12, 15 in W: 9, 12 in	L: 11, 16 in W: 8, 13 in	L: 10, 17 in W: 7, 14 in	L: 9, 18 W: 6, 15
Weight	Less than 1 lb.	Less than 2 lb.	Less than 3 lbs.	Less than 4 lbs.	More than 4 lbs.
Safety	No safety risks	Insignificant safety risks	Small safety risks	Considerable safety risks	Dangerous!
Ease of Use: Seated	Usable when sitting	Usable with little difficulty when sitting	Usable with moderate difficulty when sitting	Usable with great difficulty when sitting	Unusable when sitting
Ease of Use: Standing	Usable when standing	Usable with little difficulty when standing	Usable with moderate difficulty when standing	Usable with great difficulty when standing	Unusable when standing
Ease of Setup	Less than 20 seconds to setup	20-60 seconds to setup	61-90 seconds to setup	90 seconds to setup	More than 90 seconds to setup
Counter-Wobble Capabilities	Always Stable	Stable unless under a large force	Stable under normal circumstances	Stable but can become unstable easily	A breath can shake it
Plan for Disposal	Easy to Recycle	Plan for Disposal, Recyclable	N/A	N/A	No Plan for Disposal, Not Recyclable

Table 1.2:LapGear Essential Lap Desk, Ratings

Specification	Rating
Price	4
Portability	3
Durability/ Quality	5

Comfort	4
Size	5
Weight	5
Safety	5
Ease of Use: Seated	5
Ease of Use: Standing	5
Ease of Setup	5
Counter-Wobble Capabilities	5
Plan for Disposal	1
Total	48

Table 1.3: Huanuo Adjustable Lap Desk, Ratings

Specification	Rating
Price	3
Portability	3
Durability/ Quality	5
Comfort	4
Size	5
Weight	3
Safety	5
Ease of Use: Seated	5
Ease of Use: Standing	2
Ease of Setup	5
Counter-Wobble Capabilities	4
Plan for Disposal	1
Total	45

Table 1.4: Connect-a-Desk, Ratings

Specification	Rating
Price	2
Portability	2
Durability/ Quality	4

Comfort	3
Size	4
Weight	4
Safety	2
Ease of Use: Seated	2
Ease of Use: Standing	5
Ease of Setup	2
Counter-Wobble Capabilities	3
Plan for Disposal	1
Total	34

Table 1.4: Patent US6044758A: Foam Lap Desk, Ratings

Specification	Rating
Price	3
Portability	3
Durability/ Quality	4
Comfort	5
Size	3
Weight	4
Safety	5
Ease of Use: Seated	5
Ease of Use: Standing	2
Ease of Setup	5
Counter-Wobble Capabilities	4
Plan for Disposal	1
Total	44

Table 1.5: Patent US3652051A: Foldable Lap Desk, Ratings

Specification	Rating
Price	3
Portability	4
Durability/ Quality	4
Comfort	4

Size	3
Weight	4
Safety	4
Ease of Use: Seated	2
Ease of Use: Standing	4
Ease of Setup	3
Counter-Wobble Capabilities	4
Plan for Disposal	4
Total	43

Table 1.7: Patent US6173656B1: Lap table for Children, Ratings

Specification	Rating
Price	3
Portability	3
Durability/ Quality	4
Comfort	4
Size	4
Weight	4
Safety	5
Ease of Use: Seated	5
Ease of Use: Standing	3
Ease of Setup	5
Counter-Wobble Capabilities	4
Plan for Disposal	1
Total	45

Table 1.8: Total Scores and Overall Rankings

Solution	**Total Score**
LapGear: Essential Lap Desk	**48**
Huanuo Lap Desk	45
Patent US6173656B1: Lap Table for Children	45
Patent US6044758A: Foam Lap Desk	44
Patent US3652051A: Foldable Lap Desk	43
Connect-A-Desk	34

Conclusion

We found three products and three patents to compare. These patents introduced us to new ways to approach our problem. After comparing these designs in a Solution Matrix, we found that a LapGear: Essential Lap Desk fit our specifications the best. This will be a product we compare our final design to, and that our design will have to beat to be considered a success.

PORTFOLIO ELEMENT C

PRESENTATION AND JUSTIFICATION OF SOLUTION DESIGN REQUIREMENTS

Solution Design Requirements

Kelvin Lao, Alex Sung, and Michael Youngblood

Introduction:

In this step of the process, our team went into greater detail about the Specifications we developed for the previous Similar Solution Matrix. These specifications explain the goals for our design in more precise language.

Design Specifications:

Portability

- Our product should fit into most backpacks. It can either fit in the computer sleeve, or the main compartment.
- Our product could also attach to the outside of a backpack.
- Our product should be easier than carrying a binder around.

Safety

- The product should be safe to use, especially in transport where it is often shaky and unstable.
- Our design should not have any sharp edges, and preferably will have soft, round edges.

Ease of Setup

- Our design should be easily accessible for seated passengers of Public Transport.
- Our product should allow users to reach the product without moving their bags or bumping into other people.
- Our device should take less than 20 seconds to setup or put away, not including materials on the product.

Ease of Use: Seated

- This design should rest easily on the lap and should not require instructions to learn to use.
- Our design should hold papers or a laptop easily.
- Our design should not protrude into other passenger's personal space.
- Our design should be flat and level in the lap, allowing users to work on materials of their choice.

Comfort

- Our product should be comfortable to use. That includes comfort on the lap and absence of stress on the neck or any parts of the body.

Durability / Quality

- Our design should be able to survive rough treatment of a student’s everyday life.
- Our product should work for a minimum of a year.
- Our product should be able to survive a drop of 5 feet with minimal to no damage.

Price

- Our product should cost between $5 and $15.

Counter-Wobble Capabilities

- The device should stay stable even when the train or bus is shaking, and make it possible to write without movement of the paper.

Size

- The design should have the ability to portable, therefore, the size should be limited.
- The design should be limited 8-14 inches wide and 12-15 inches lengthwise.

Weight

- Our product will weigh less than 3 pounds.
- Ideally our design will weigh less than 1.5 pounds.

Plan for Disposal

- Our product should be recyclable.

Conclusion

Our Design Specifications explain what main ideas our brainstorming and concept development will focus on. Our higher priority points are: Portability, Size, Safety, and Ease of Setup. Any design that does not fit these constraints will be scored much lower than other designs, even if the other design scores higher in other categories.

PORTFOLIO ELEMENT D

DESIGN CONCEPT GENERATION, ANALYSIS, AND SELECTION

Concept Generation and Selection

Kelvin Lao, Alex Sung, and Michael Youngblood

Introduction:

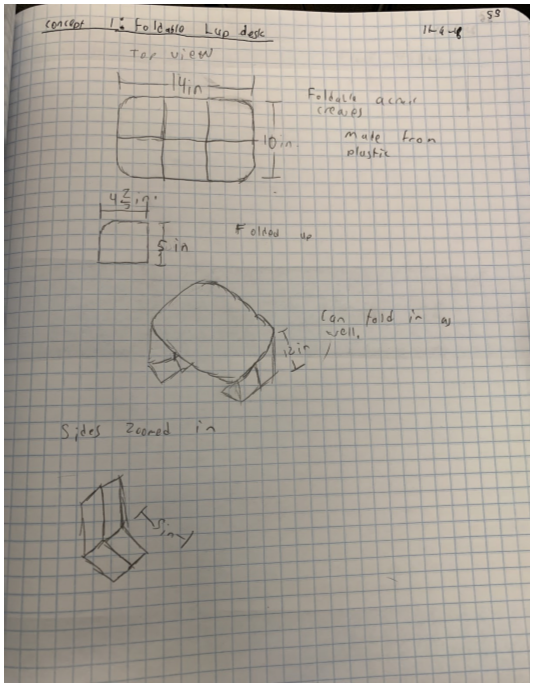
We developed a total of seven ideas to be turned into full designs. We then sketched and wrote about how these designs would work and fit our constraints. Next, the team compared the designs in a Design Matrix, scoring the concepts on a scaled rating system, showing our priorities of Design Specifications. We finished by selecting one design to follow through with and produce for our project.

Concept Development:

1. Foldable Lap Desk

This product will be foldable and made of plastic. The dimensions will be 14 inches long and 10 inches wide. After folding up the lapdesk, the dimensions should be 4 and 2/3 inches long and 5 inches wide. There will be 12 inch long legs and then 5 inch extenders. The user should sit on these extenders to help keep the lapdesk stable at all times. The lapdesk will be made of plastic so it's weight will be under 2 lbs and the lapdesk will last for a long time. The type of plastic will be recycled so the product will be easy to dispose. Because the product is foldable it should be easy to set up and put away and should fit into backpacks after being folded up.

Design, first draft:



2. Backpack Extension Desk:

The homework stand will be similar to a band stand but it will be parallel to the ground instead of slanted at an angel. The height will also be lowered to 30 inches to allow the user to sit and work on homework. The actual stand itself will be 14 inches long and 10 inches wide. The supporting pole will be foldable and will fit into the back of the stand. There are legs that are foldable and will fit into the back of the stand as well. The user is intended to step on the legs so the homework stand keep stable. After being folded up the stand should fit into the laptop compartment of a backpack. The stand will be made of recyclable plastic so it's weight will be under 2 lbs and the lapdesk will last for a long time before recycling it.

Design, first draft:

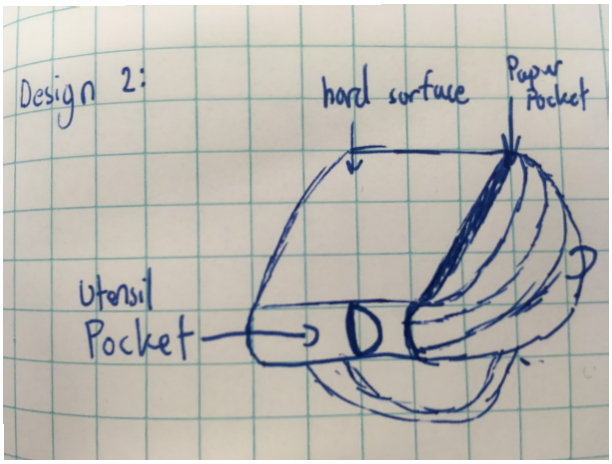
3. External Backpack:

This backpack is designed with a light and hard surface on the outside for writing. There is also a pocket underneath this surface allowing the user of this product to put any work inside to be able

to have easy access to it. There is a zipper pocket on the side of the bag allowing easy access to any utensils.

This bag is completely safe like your average everyday backpack and just a portable allowing easy access and convenience. The table is also very stable containing material that is placed inside the fabric of the bag not allowing the bag to be deformed.

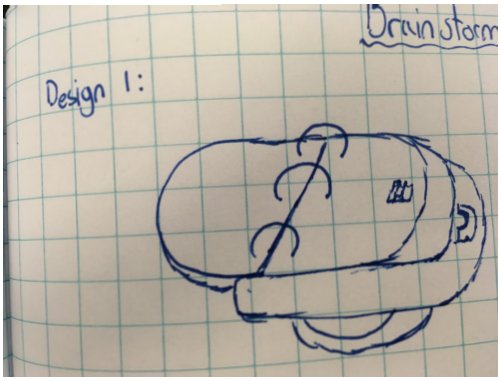
Design, first draft:



4. Internal Backpack:

This is a backpack with a desk in the inside to hold a pencil and have easy access to paperwork. The last zipper to the backpack has a hard cover in the inside with a three ring bind clip to hold hole punched paper. This allows people to prepare themselves to work before hand and pack up in seconds. This backpack is safe and definitely portable. Not putting any extra weight or pressure on your back. The accessibility is quite simple where the bag is just a easy access table.

Design, first draft:



5. Rollable Lap Desk:

The main idea behind this lap desk is that it will be stored in the side water-bottle pocket of a backpack. The lap desk rolls into a small cylinder to be stored in a water bottle pocket. Using the water bottle pocket allows users to reach this when they cannot get into their backpack, such as exiting a train or bus. This lessens the setup time of our product, giving consumers the maximum productive time on their commute.

The lap desk will be 14” in length by 10” in width, and over ½” thick. This is the perfect size to hold a piece of paper or laptop comfortably. When the product is stored, the 14” will ‘roll’ the length into a cylinder that fits in a water bottle pocket. The lap desk will be made of lots of interlocking pieces that can rotate in terms of each other. These pieces will be 10” by 2”, and there will be seven of them. There will be two hinges at each connection of these pieces. The hinges will be on one side of the thickness, not centered. This side will be standard for all pieces. As the two

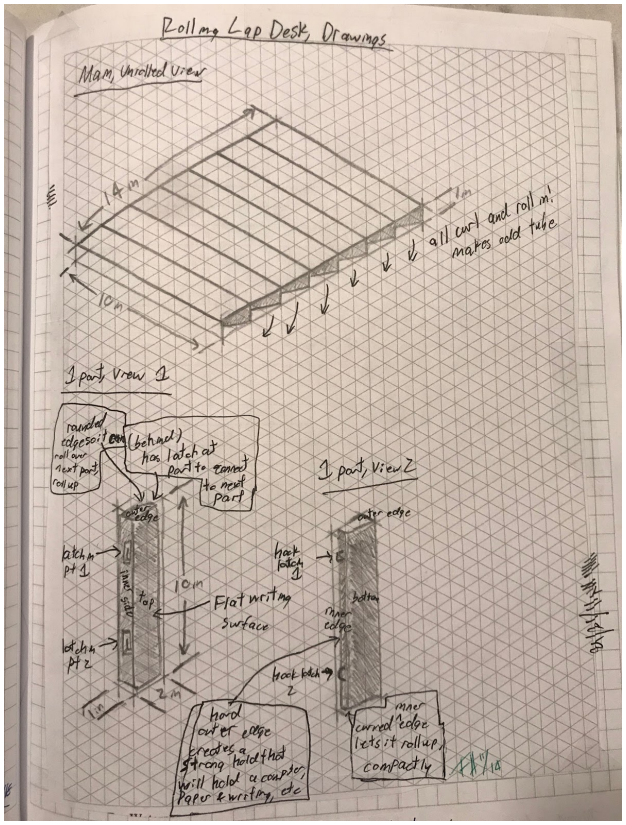
connected pieces begin to touch on the non-hinged side, their forces will counteract each other and they will support weight. This strength is magnified through two hinges and having many connections over the entire desk.

The design will be able to support writing or a laptop over any of the beams that have support from below. This means the lap desk will be limited to the size of your legs. Consumers can position the desk in any orientation to maximize the space available to them, and they will also not take up excess space when they do not have room. They will be able to let the desk roll' up a little bit to take up less space. This design fits our specifications as it is easily portable, supports writing and laptop work, and is easy to set up. The design maximises the space available to the consumer, without taking up excess space when there is little room. One downside to this design is that it may be more prone to breaking. As it is made up of a lot of different moving parts, any of the hinges might break easily. To counteract this risk, we could make the hinges of a stronger material than the rest of the lap desk. Still, the complexity of this design makes it less durable than other, simpler designs.

This design is based off of Lego Hinged Sliding doors, which connect together and are solid on one side (but can roll tightly on the other side when necessary).

Basis for Rollable Design:

Design, first draft:



6. Storage Lap Desk:

The storage innovation of this product is that it will not take up any added room in the backpack, through putting other notebooks, papers, or computers inside of it. This will free up used storage space inside the backpack, and allow our product to easily fit inside. This design also allows users to easily access their materials when they are setting up the product. Instead of reaching inside their backpack, they can simply open the lap desk and take out their products stored inside.

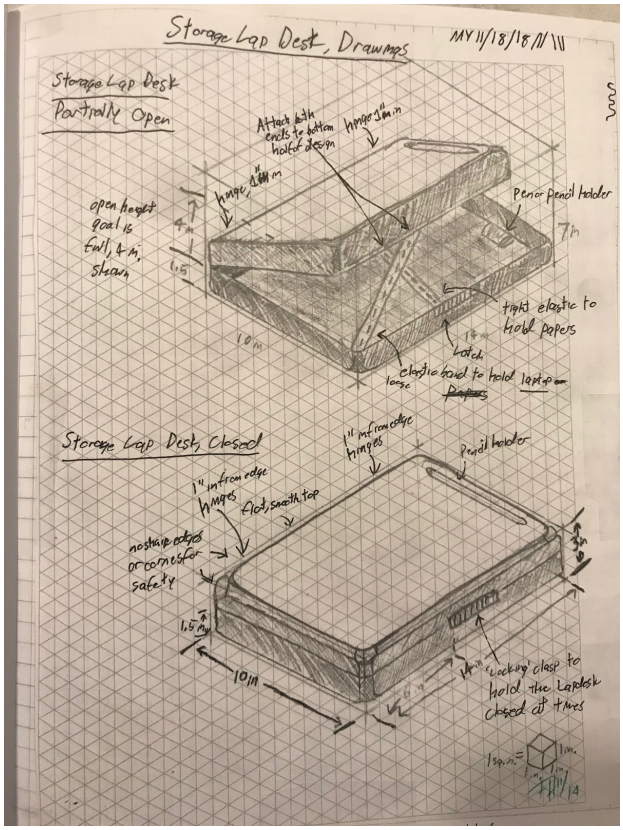
This product will be 14" in length by 10" in width and 2-5" in thickness (still deciding how thick to store laptop and other materials inside). This design will open with a latch similar to laptops, where you slide a small button to the side. Inside, the design will be hollow for storing

anything! There will also be multiple stretchy bands to keep papers and laptops still inside the design. This design will act as an added safety precaution for laptops in backpacks, as the laptop will not move around and have another shell protecting it from falls and any damage.
This design will also feature a pencil holder at the top of the lap desk, so that the consumer can put their pen down without it rolling away.

The lapdesk will open on two hinges on one side of the product, and these will be 1” in length. They will be on the inside of the lapdesk so that it has no extending parts on the outside. The hinges will open the top writing surface to an angle of 25 degrees above the bottom half, carrying and leg surface.This will allow the design to be smooth and sleek. The design will be made out of hard plastic or another durable material. Our goal would be to use something biodegradable so that it is environmentally friendly, but we need to think further on this at the moment. Our durability should also keep people from buying multiple of our lap desks for themselves. One of our products should last them at least 2 years with minimal damage from normal use, so there will be less of an environmental impact from our product.

The design is easy to use and does not take up a lot of new space in a backpack. As it can store papers or a computer inside, it will work around currently used space. This design will be easy to setup: you do not need to look for your work in your bag, using more time, it is already in the desk and ready to use. Finally, our design will be economical to make. This design is not extremely complicated, and will sell at the price desired by our consumers.

Design, first draft:



7. Triangle Folding Lap Desk:

The Triangle Folding Lap Desk is designed based on an iPad case that folds into a triangle to support the iPad at an angle for easier reading. This design will allow the Lap Desk to be storable as a triangle or flat into a backpack. This changing shape will allow the design to easily fit into a the water bottle pocket of a backpack, or fit smoothly in the computer slot (or any large main part) of a backpack.

The lap desk will be 14” in length by 10” in width, and around 1” thick. This is the perfect size to hold a piece of paper or laptop comfortably.
The design will be made of three sections that fit together using hinges that are tight enough on one side (the writing side) to provide a smooth writing surface. This hinging device is similar to that of the “Roll-able Lap Desk,” and is based off of Lego Hinged Doors. The hinges will join the three sections, of varying sizes, together. The three sections are of varying size to fold up into a nicer shape. This variance of size will be based on the dimensions of the iPad case, so that the design can fold nicely into a triangle. On top of that, by only using a few hinges the cost of manufacturing will go down.

The designs thickness will allow for some padding and comfort for the user. The thickness will also allow us to use a sturdier material for the writing surface, ensuring durability and strength. The one downside to this thickness will be that it is harder to fold into a triangle, and will be harder to fit into a backpack.
To counteract this, the design will fold once before fitting in the average backpack. This will make the design the right size to fit, without adding too much depth of the triangle option.

The multi-storage capacity of the design sets it apart from other designs, and helps it fit the design constraints of the project. We came up with this design after hearing feedback from our classmates on our original six brainstorming ideas.

Basis for Triangle Folding Design:

Design, first draft:

First Decision Matrix

This is the first decision matrix we made, to select 3 top choice ideas.
We have translated this Decision Matrix into tables so that it easily fits onto Innovation Portal Formatting.

Table 1.0: Baseline Rating

		Weight	Baseline (Folder or Notebook)	Baseline (Folder or Notebook)
Specifications		Rating	Weighted Score	
Portability	5	3	15	
Durability / Quality	3	3	9	
Comfort	4	3	12	
Size (Working Space)	2	3	6	
Size (Space Taken Up)	2	3	6	
Weight	2	3	6	
Safety	5	3	15	
Ease of Use for Computer	4	3	12	
Ease of Use for Paper	4	3	12	
Ease of Setup	5	3	15	
Counter Wobble Capabilities	3	3	9	
Plan for Disposal	1	3	3	
Total			120	

Table 1.0.1: Scoring Explanation

Score	Meaning
5	Much better than baseline.
4	Better than baseline.

3	No difference from baseline.
2	Worse than baseline.
1	Much worse than baseline.

Table 1.1: Foldable Desk Rating

	Weight	Foldable Desk	
Specifications		Rating	Weighted Score
Portability	5	3	15
Durability / Quality	3	4	12
Comfort	4	5	20
Size (Working Space)	2	4	8
Size (Space Taken Up)	2	3	6
Weight	2	3	6
Safety	5	4	20
Ease of Use for Computer	4	4	16
Ease of Use for Paper	4	3	12
Ease of Setup	5	2	10
Counter Wobble Capabilities	3	3	9
Plan for Disposal	1	1	1
Total			135

Table 1.2: Backpack Extension Desk Rating

	Weight	Backpack Extension Desk	
Specifications		Rating	Weighted Score
Portability	5	4	20
Durability / Quality	3	4	12
Comfort	4	4	16
Size (Working Space)	2	4	8
Size (Space Taken Up)	2	1	2
Weight	2	1	2
Safety	5	1	5
Ease of Use for Computer	4	4	16
Ease of Use for Paper	4	4	16

Ease of Setup	5	1	5
Counter Wobble Capabilities	3	3	9
Plan for Disposal	1	1	1
Total			112

Table 1.3: External Backpack Desk Rating

	Weight	**External Backpack Desk**	
Specifications		Rating	Weighted Score
Portability	5	5	25
Durability / Quality	3	5	15
Comfort	4	4	16
Size (Working Space)	2	4	8
Size (Space Taken Up)	2	2	4
Weight	2	1	2
Safety	5	3	15
Ease of Use for Computer	4	4	16
Ease of Use for Paper	4	4	16
Ease of Setup	5	3	15
Counter Wobble Capabilities	3	3	9
Plan for Disposal	1	1	1
Total			**142**

Table 1.4: Internal Backpack Desk Ratings

	Weight	Internal Backpack Desk	
Specifications		Rating	Weighted Score
Portability	5	4	20
Durability / Quality	3	4	12
Comfort	4	4	16
Size (Working Space)	2	4	8
Size (Space Taken Up)	2	2	4
Weight	2	1	2
Safety	5	3	15
Ease of Use for Computer	4	4	16

Ease of Use for Paper	4	4	16
Ease of Setup	5	3	15
Counter Wobble Capabilities	3	3	9
Plan for Disposal	1	1	1
Total			134

Table 1.5: Rollable Desk Rating

	Weight	Rollable Desk	
Specifications		Rating	Weighted Score
Portability	5	3	15
Durability / Quality	3	3	9
Comfort	4	5	20
Size (Working Space)	2	4	8
Size (Space Taken Up)	2	3	6
Weight	2	3	6
Safety	5	3	15
Ease of Use for Computer	4	4	16
Ease of Use for Paper	4	1	4
Ease of Setup	5	2	10
Counter Wobble Capabilities	3	3	9
Plan for Disposal	1	1	1
Total			119

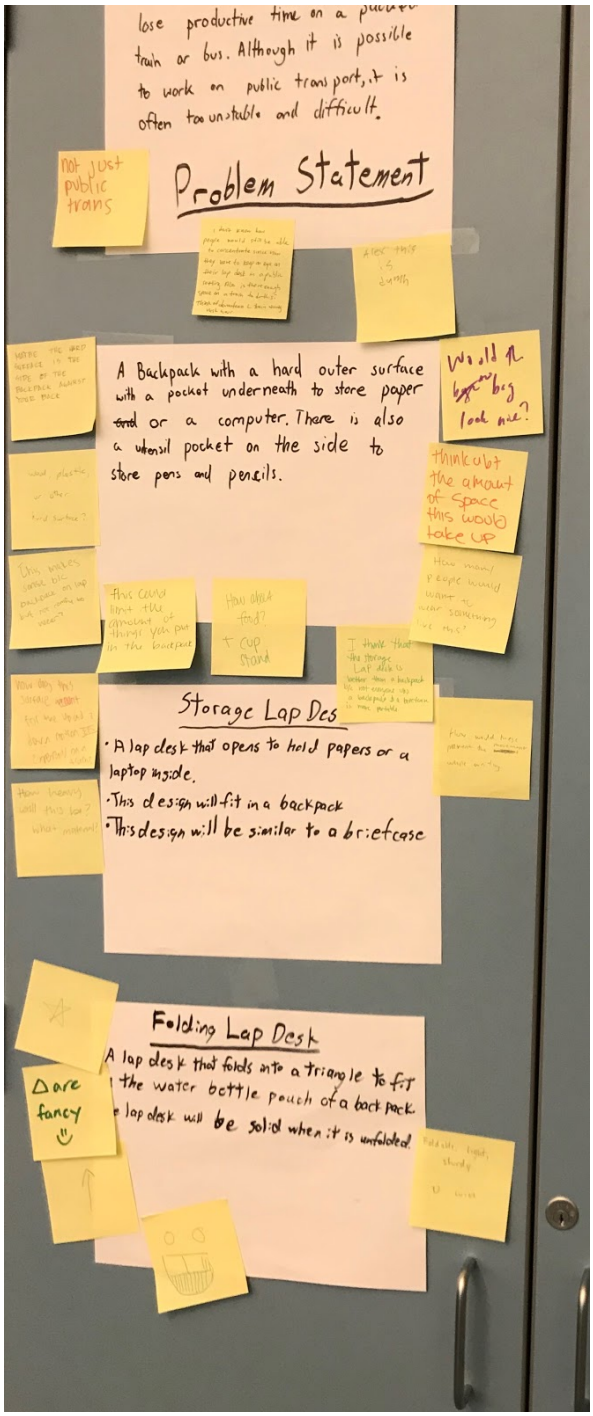
Table 1.6: Storage Rating

	Weight	**Storage Desk**	
Specifications		Rating	Weighted Score
Portability	5	3	15
Durability / Quality	3	5	15
Comfort	4	5	20
Size (Working Space)	2	4	8
Size (Space Taken Up)	2	3	6
Weight	2	2	4
Safety	5	3	15
Ease of Use for	4	4	16

Computer			
Ease of Use for Paper	4	4	16
Ease of Setup	5	3	15
Counter Wobble Capabilities	3	3	9
Plan for Disposal	1	1	1
Total			**140**

Peer Feedback

In class, we hung our current top three ideas on the wall and walked around, commenting on others ideas and problem statements. Our ideas also received comments from other groups, and we have an image of these comments.



We formatted these notes into a chart to help us review what people thought of our designs and ideas.

Table 2.0: Feedback from Poster Activity

Problem Statement	External Backpack	Storage Lap Desk	Foldable Lap Desk
Not just public transit	How about food and cup stand?	I think that the storage lapdesk is better than a backpack because not everyone has a backpack and a briefcase is more portable.	Triangles are fancy :)
I don't know how people would still be able to concentrate since now they have to keep an eye on their lap desk in a public setting. Also is there enough space on a train to do this? Think of downtown L train during rush hour	This could limit the amount of things you put in the backpack	How would these prevent the movement while writing	↑

	This makes sense because backpack on lap, but not comfy to wear?	How heavy will this be? What material?	Foldable, light, sturdy, “you win”
	Wood, Plastic, or other hard surface	How does this surface account for the up and down motion experience on a train?	:)
	Would the bag look nice?		
	Maybe the hard surface is the side of the backpack against your back		
	How many people would want to wear something like this.		
	Think about the amount of space this would take up.		

First Matrix: Added Design

After reviewing our classmates comments, we decided to create another design based off of what they had suggested and thought of our current ideas. We came up with the Triangle Folding Desk. We rated this design on the same specifications and scale as our original six ideas.

Table 1.7: Triangle Folding Desk Rating

	Weight	**Triangle Folding Desk**	
Specifications		Rating	Weighted Score
Portability	5	3	15
Durability / Quality	3	4	12
Comfort	4	5	20
Size (Working Space)	2	4	8
Size (Space Taken Up)	2	3	6
Weight	2	3	6
Safety	5	3	15
Ease of Use for Computer	4	4	16
Ease of Use for Paper	4	3	12
Ease of Setup	5	2	10
Counter Wobble Capabilities	3	3	9
Plan for Disposal	1	1	1
Total			**130**

We then looked at the highest rated and most original ideas to be our new top three ideas. We were able to choose the following top three designs:

Table 1.8: Top Three Design Choices, Explained

Design	Score	Explanation
External Backpack Desk	142	This design scored the highest in our Design Matrix. On top of this, it is a very original design that does not exist on the market today. It is very different from most of the other ideas and designs we came up with.
Storage Desk	140	This was our second highest scoring solution in the Design Matrix. On top of that, it builds on ideas currently in the Lap Desk market. This design adds a new feature to the ordinary lap desk.
Triangle Folding Desk	130	This design was not as highly rated in our Design Matrix: in fact, it scored fifth of our seven designs. However, this design incorporates a new method of storage absent in our other designs, and combines our other “foldable” and “rolling” designs, to create an improved design.

Next, we re-evaluated our three top designs and baseline to choose one final design.

Second Decision Matrix

We created a more detailed Design Matrix, and debated each score in every category. We scored these on the same 1-5 scale.

Table 2.0: Baseline Rating

	Weight	Baseline (Folder or Notebook to write on)	Baseline (Folder or Notebook to write on)
Specifications		Rating	Weighted Score
Portability	5	3	15
Durability / Quality	3	3	9
Comfort	4	3	12
Size (Working Space)	2	3	6
Size (Space Taken Up)	2	3	6
Weight	3	3	9
Safety	5	3	15
Ease of Use for Computer	4	3	12
Ease of Use for Paper	4	3	12
Ease of Setup	5	3	15
Counter Wobble Capabilities	4	3	12
Plan for Disposal	1	3	3
Total			126

Table 2.1: External Backpack Desk Rating

	Weight	External Backpack Desk	
Specifications		Rating	Weighted Score

Portability	5	5	25
Durability / Quality	3	5	15
Comfort	4	4	16
Size (Working Space)	2	4	8
Size (Space Taken Up)	2	2	4
Weight	3	1	3
Safety	5	3	15
Ease of Use for Computer	4	4	16
Ease of Use for Paper	4	4	16
Ease of Setup	5	3	15
Counter Wobble Capabilities	4	3	12
Plan for Disposal	1	1	1
Total			146

Table 2.2: Storage Desk Rating

	Weight	**Storage Desk**	
Specifications		Rating	Weighted Score
Portability	5	3	15
Durability / Quality	3	5	15
Comfort	4	5	20
Size (Working Space)	2	4	8
Size (Space Taken Up)	2	3	6
Weight	3	2	6
Safety	5	3	15
Ease of Use for Computer	4	4	16
Ease of Use for Paper	4	4	16
Ease of Setup	5	3	15
Counter Wobble Capabilities	4	3	12
Plan for Disposal	1	1	1
Total			**145**

Table 2.3: Triangle Folding Lap Desk Rating

	Weight	Triangle Folding Lap Desk	

Specifications		Rating	Weighted Score
Portability	5	3	15
Durability / Quality	3	4	12
Comfort	4	5	20
Size (Working Space)	2	4	8
Size (Space Taken Up)	2	3	6
Weight	3	3	9
Safety	5	3	15
Ease of Use for Computer	4	4	16
Ease of Use for Paper	4	3	12
Ease of Setup	5	2	10
Counter Wobble Capabilities	4	3	12
Plan for Disposal	1	1	1
Total			136

Selecting the Best Solution

Problem Statement:

People who take public transportation lose productive time on a packed train or bus. Although it is possible to work on public transport, it is often too unstable and difficult.

Product Description:

This product will be 14” in length by 10” in width and 2-5” in thickness (still deciding how thick to store laptop and other materials inside). This design will open with a latch similar to laptops, where you slide a small button to the side. Inside, the design will be hollow for storing papers, a laptop, or anything the user wants! There will also be multiple stretchy bands to keep papers and laptops motionless inside the design. This design will act as an added safety precaution for laptops in backpacks, as the laptop will not move around and have another shell protecting it from damage. This design will also feature a pencil holder at the top of the lap desk, so that the consumer can put their pen down without it rolling away.
The design will be made out of hard plastic or another durable material. We hope to use something biodegradable so that it is environmentally friendly, but we need to think further on this at the moment. Our durability should also keep people from buying multiple of our lap desks for themselves.

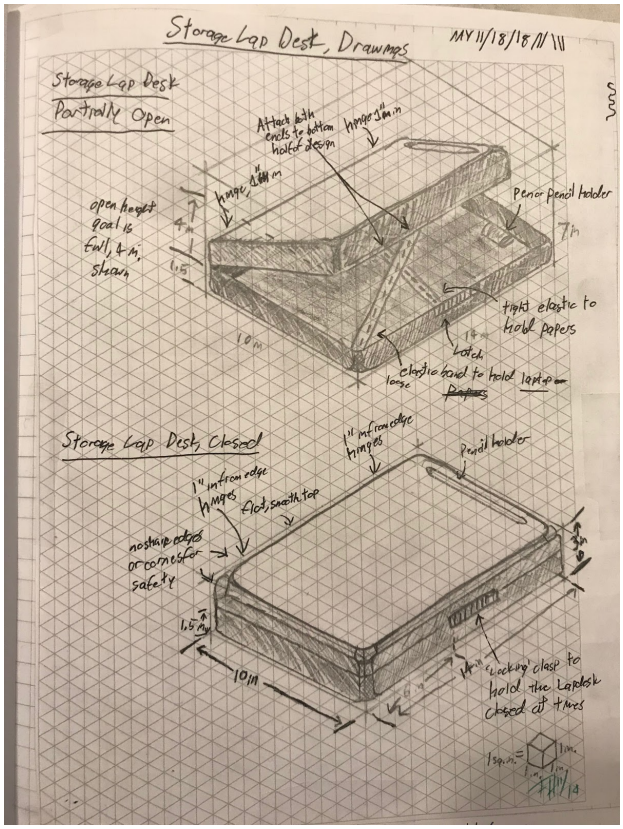
Operation:

The lapdesk will open on two hinges on one side of the product, and these will be 1” in length. They will be on the inside of the lapdesk so that it has no extending parts on the outside. The hinges will open the top writing surface to an angle of at least 25 degrees above the bottom half, carrying and leg surface.

Justification:

In our decision matrix, the external backpack desk design ended up scoring the highest but the storage desk design was only one point behind so we decided to pick between these two options. Ultimately, after reviewing the two ideas and looking at comments from our peers, we decided the storage desk design would be the better option of the two. The storage desk would be easier to implement and would suit our smaller budget better. When we surveyed Jones Seniors, over 65% of people said they would buy the product for around $10. Additionally, many of our peers were skeptical of our external backpack idea. There were many critiques such as the price of the backpack, how

comfortable it would be, and how much space it would take up. For these reasons, we settled on the Storage Desk Design.
The storage innovation of this product is that it will not take up any added room in the backpack, through putting other notebooks, papers, or computers inside of it. This will free up used storage space inside the backpack, and allow our product to easily fit inside.
This design allows users to easily access their materials when they are setting up the product. Instead of reaching inside their backpack, they can simply open the lap desk and take out their products stored inside.
The design is easy to use and does not take up a lot of new space in a backpack. As it can store papers or a computer inside, it will work around currently used space.
This design will be easy to setup: you do not need to look for your work in your bag, using more time, it is already in the desk and ready to use. Finally, our design will be economical to make. This design is not extremely complicated, and will sell at the price desired by our consumers. This will allow the design to be smooth and sleek.
One of our products should last them at least 2 years with minimal damage from normal use, so there will be less of an environmental impact from our product.



Conclusion:

After developing each of our seven designs and comparing them through two Decision Matricies, we selected the Storage Lap Desk Design. We selected this design because it combines the best feasibility with the second highest score in our final Decision Matrix. This comination makes it appealing for our group, as we have a higher chance of completing the project with limited resources. As we do not have easy access to any sewing machines, machine shops, or wood shops, this option makes the most sense for our group.

PORTFOLIO ELEMENT E

APPLICATION OF STEM PRINCIPLES AND PRACTICES

Application of STEM Principles

Kelvin Lao, Alex Sung, and Michael Youngblood

Introduction:

In this phase of the project, we completed calculations related to our design. These helped us relate our other classes into real world problems. After the math was complete, we received expert feedback on our work. we also developed more detailed drawings of our Storage Lap Desk. These designs were reviewed by peers and experts for viability, and we gained lots positive and constructive of feedback.

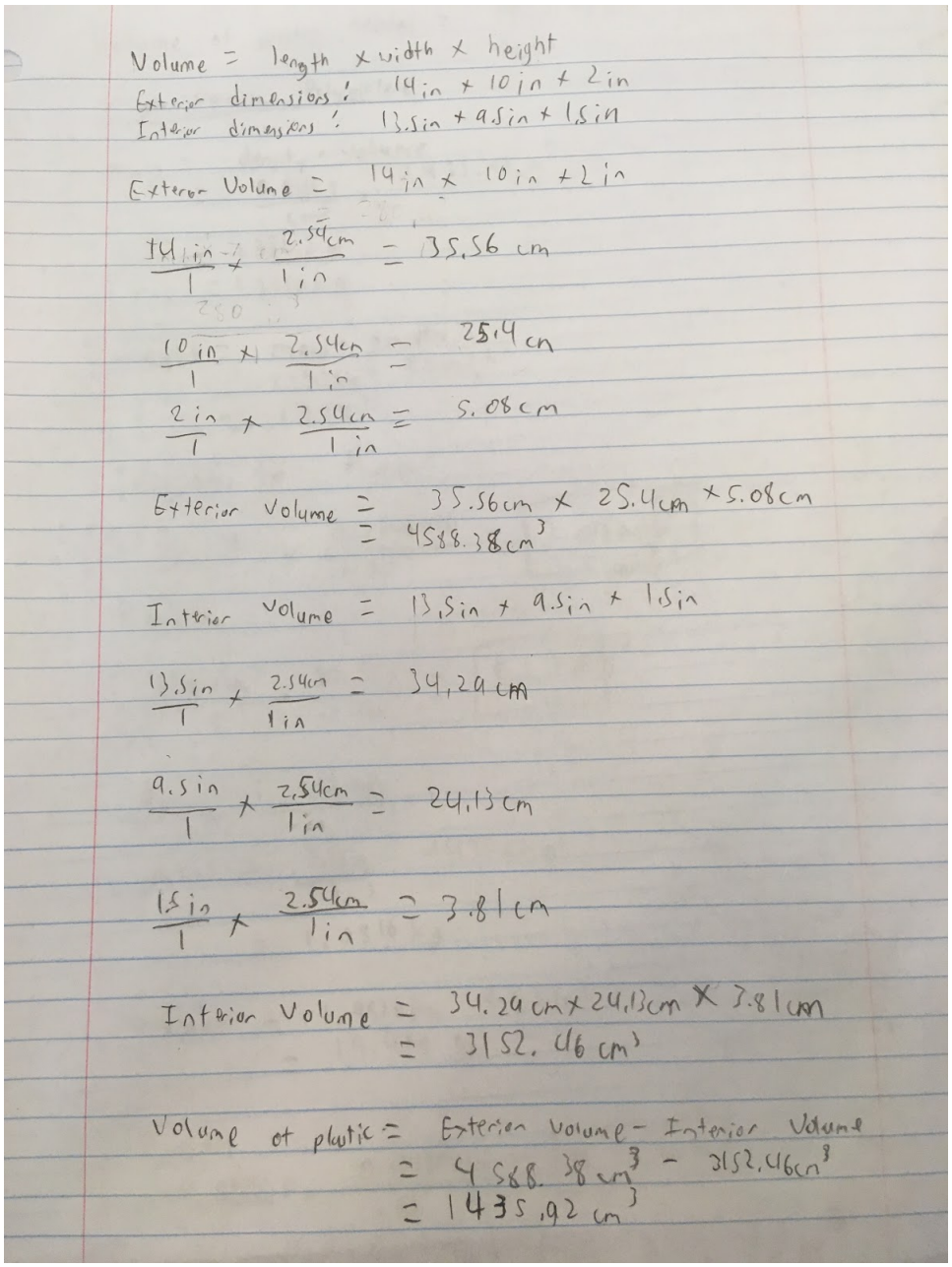
Calculations:

Calculation Reasoning:

Our solution is a lapdesk, so the application of math principles and physics concepts is the focus of our calculations. We solved for the interior and exterior volume, which gives us the volume of plastic needed to manufacture our product. Then, using this volume, we can estimate the final weight our of product when the inside is empty and estimate the total cost of the material needed. The interior volume also gives us an idea of how much the storage desk can store.

Storage Lap Desk Mathematics:

We are designing the lapdesk with the exterior dimensions, 14 in. X 10 in. X 2 in. The interior dimensions we chose were 13.5 in. X 9.5 in. X 1.5 in. We chose these dimensions because they make full use of all the available space when sitting on public transport. Our goal is for the product to be a little shorter than a seat and wide enough for you to write on, but not wide enough to get in the way of others. There should be a small difference between our calculations and the actual volumes because in our calculations we did not take into account the rounded edges and the legs inside the lapdesk to hold it up to use as a writing surface. Overall, the difference should be miniscule and would not ultimately affect our results by much.

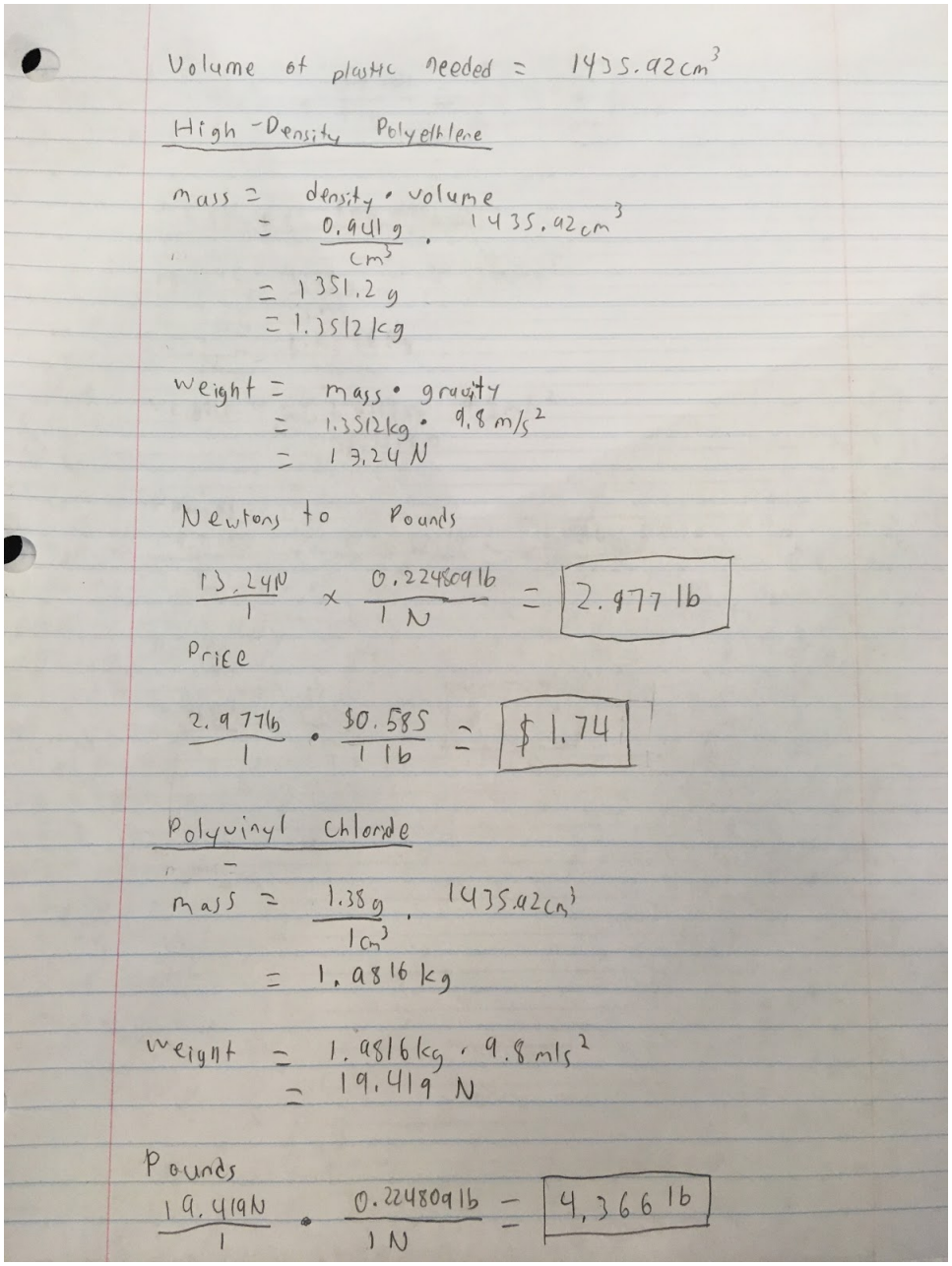


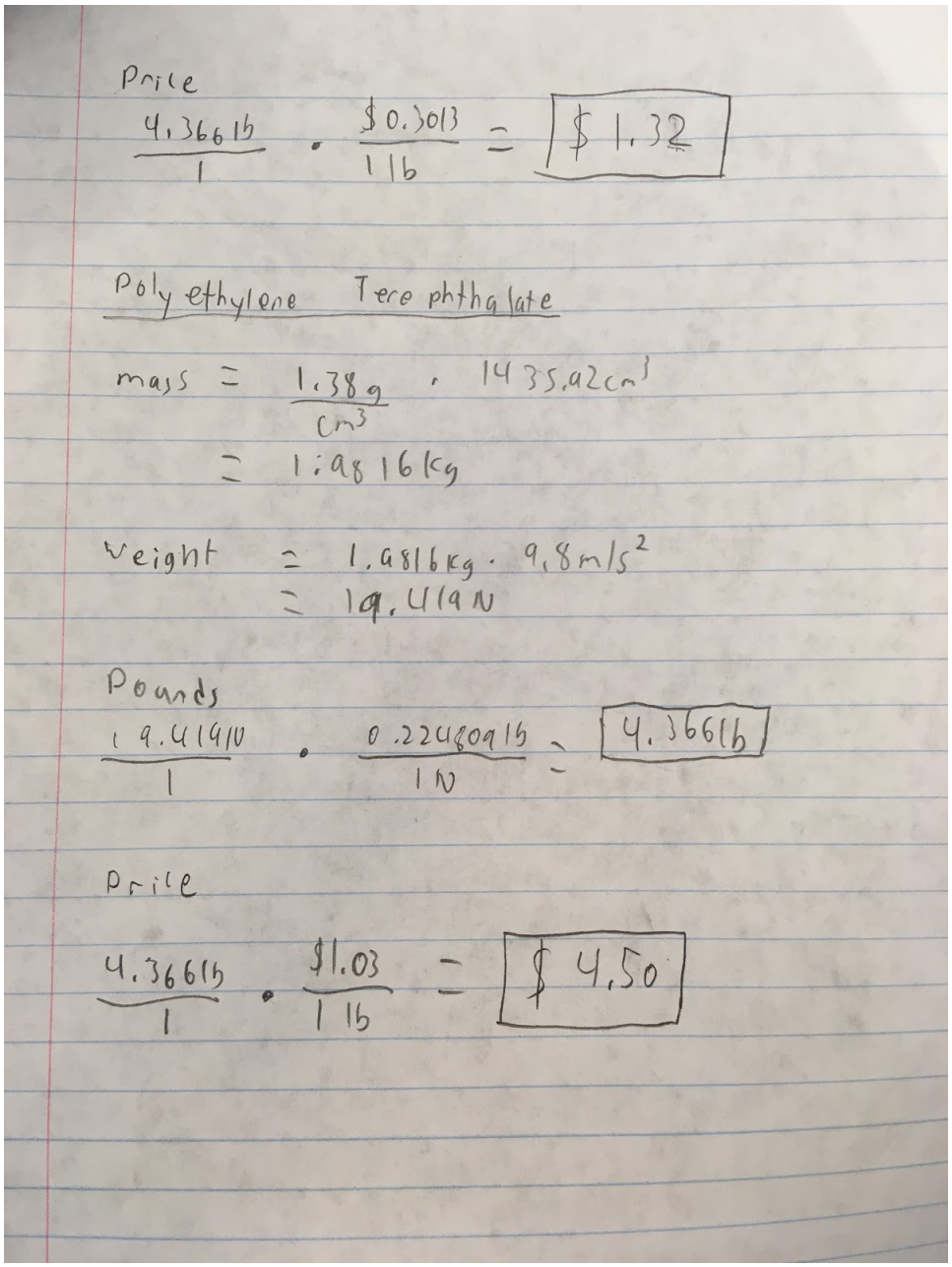
Plastics Research:

Specification	High-Density Polyethylene	Polyvinyl Chloride	Polyethylene Terephthalate
Durability	Very hard, high strength to density ratio	Very hard	Somewhat durable (plastic water bottles)
Looks	White other colors, easily spray painted	White other colors, can be easily spray painted	Clear, can only be colored with paint.
Recyclable	yes	yes	Yes
Access	Easily, comes in sheets of different length and thickness	Easily from home stores(comes in pipes and sheets)	Very hard(can only be found in water bottles)
Density	0.941 g/cm^3	1.38 g/cm^3	1.38 g/cm^3
Price	58.5 cents/lb	30.13 cents/lb	100-103 cents/lb

Cost for Each Plastic:

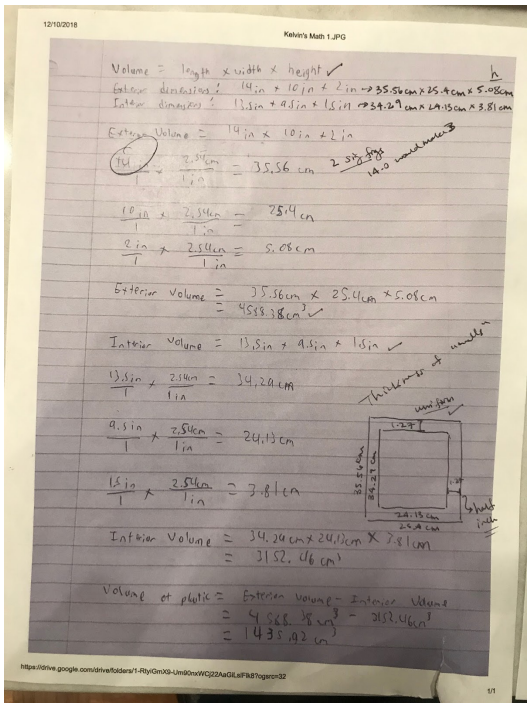
After we found the exterior and interior volumes, we used this to find the volume of plastic needed to manufacture this product. Once again, there should be a small difference between our calculations and the actual volume because in our calculations we did not take into account the rounded edges and the legs inside. Using this volume we found we were able to estimate the weight of the lapdesk and the material cost. We researched 3 types of plastics and used our calculations to help us decide on which type of plastic was ultimately the best choice.

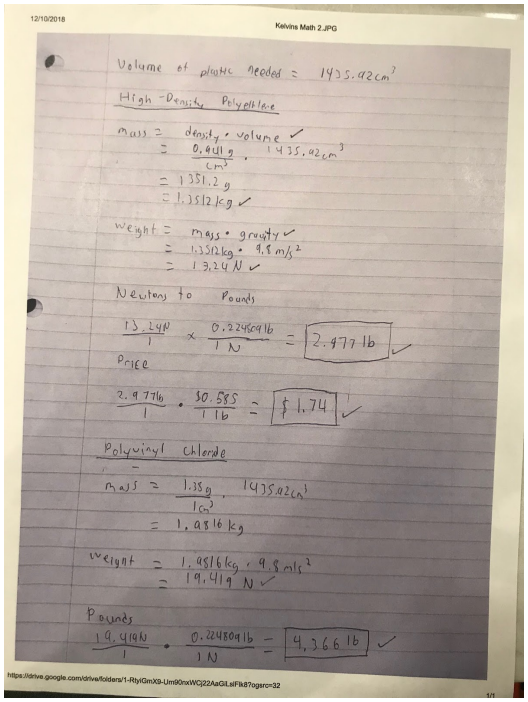


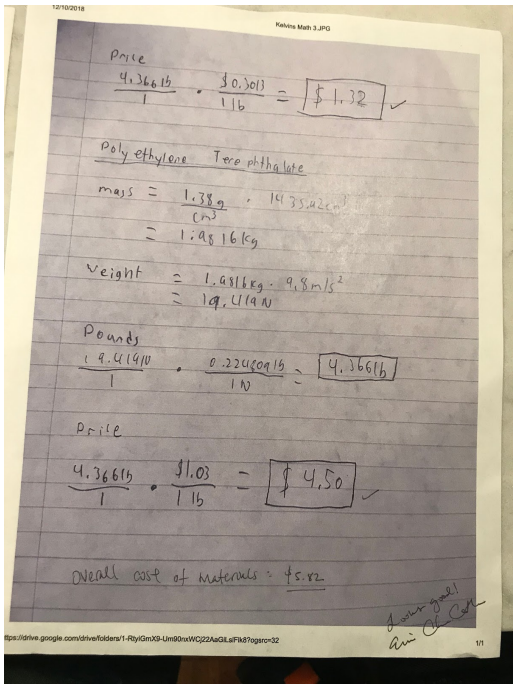


Expert Feedback on Calculations:

Ms. Cathcara:


12/10/2018
Kelvin's Math 1.JPG
Volume = length x width x height
Exterior dimensions: 14in x 10in x 2in → 35.56cm x 25.4cm x 5.08cm
Interior dimensions: 13.5in x 9.5in x 1.5in → 34.29cm x 24.13cm x 3.81cm
Exterior Volume = 14in x 10in x 2in
35.56 cm
25.4cm
5.08cm
Exterior Volume = 35.56cm x 25.4cm x 5.08cm
= 4588.38cm³
Interior Volume = 13.5in x 9.5in x 1.5in
34.29cm
24.13cm
3.81cm
Interior Volume = 34.29cm x 24.13cm x 3.81cm
= 3152.46 cm³
Volume of plastic = Exterior Volume - Interior Volume
= 4588.38cm³ - 3152.46cm³
= 1435.92 cm³
https://drive.google.com/drive/folders/1-RtyIGmX9-Um90rxWCj22AaGILslFlk8?ogsrc=32
1/1


12/10/2018
Kelvins Math 2.JPG
Volume of plastic needed = 1435.92cm³
High-Density Polyethlene
mass = density • volume
= 0.941 g/cm³ • 1435.92cm³
= 1351.2 g
= 1.3512 kg
weight = mass • gravity
= 1.3512kg • 9.8 m/s²
= 13.24 N
Newtons to Pounds
13.24N / 1 • 0.224809lb / 1N = 2.977 lb
Price
2.9776 / 1 • $0.585 / 1lb = $1.74
Polyvinyl Chloride
mass = 1.38g/cm³ • 1435.92cm³
= 1.9816 kg
weight = 1.9816kg • 9.8m/s²
= 19.419 N
Pounds
19.419N / 1 • 0.224809lb / 1N = 4.366 lb
https://drive.google.com/drive/folders/1-RtyIGmX9-Um90rxWCj22AaGILslFlk8?ogsrc=32
1/1

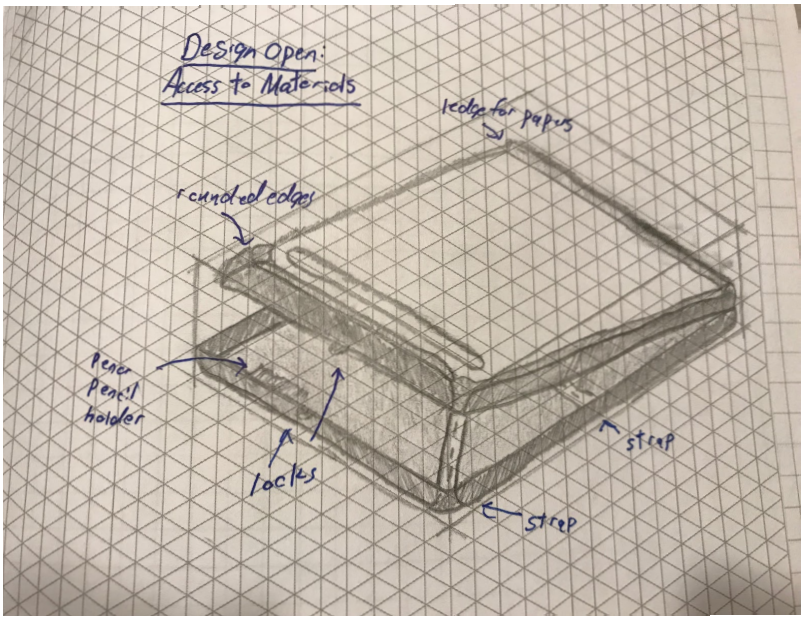


Drawings:

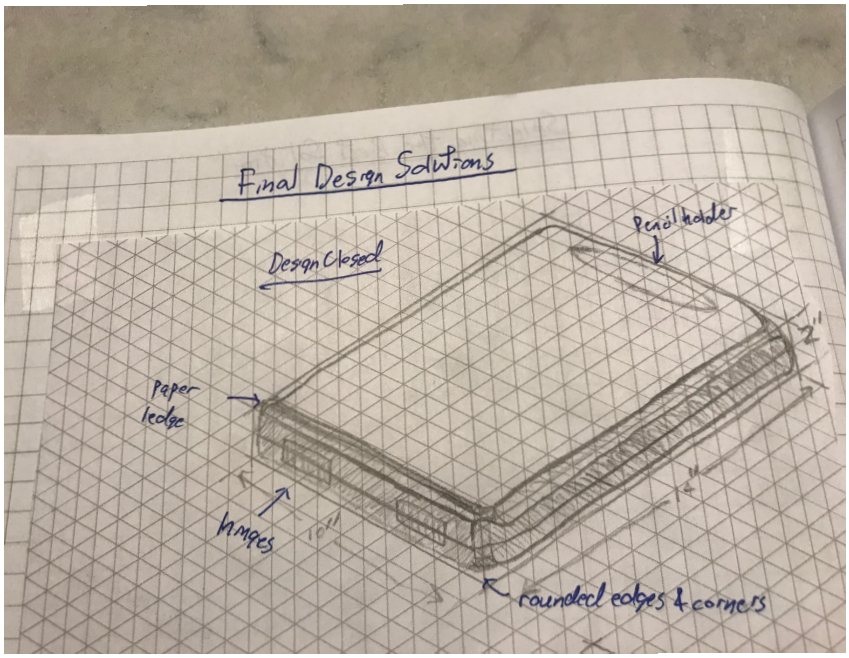
Secondary Drawings:

We started by making more detailed drawings of our solution. We added features based on conversations with experts, such as a lock, writing ledge, vertical-edge hinges, and angled support.

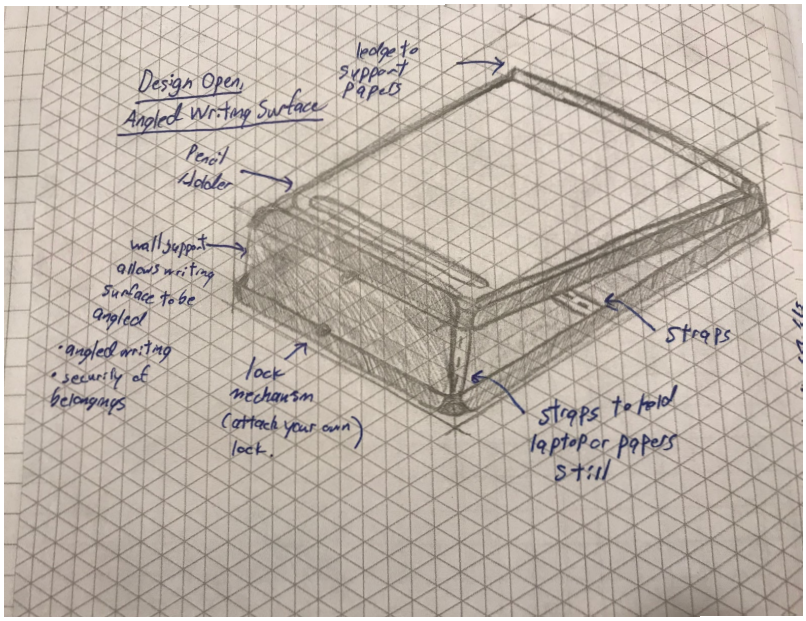
Storage Lap Desk Design 2: Open for Access



Storage Lap Desk Design 2: Closed for Writing or Travel



Storage Lap Desk Design 2: Open for Angled Writing

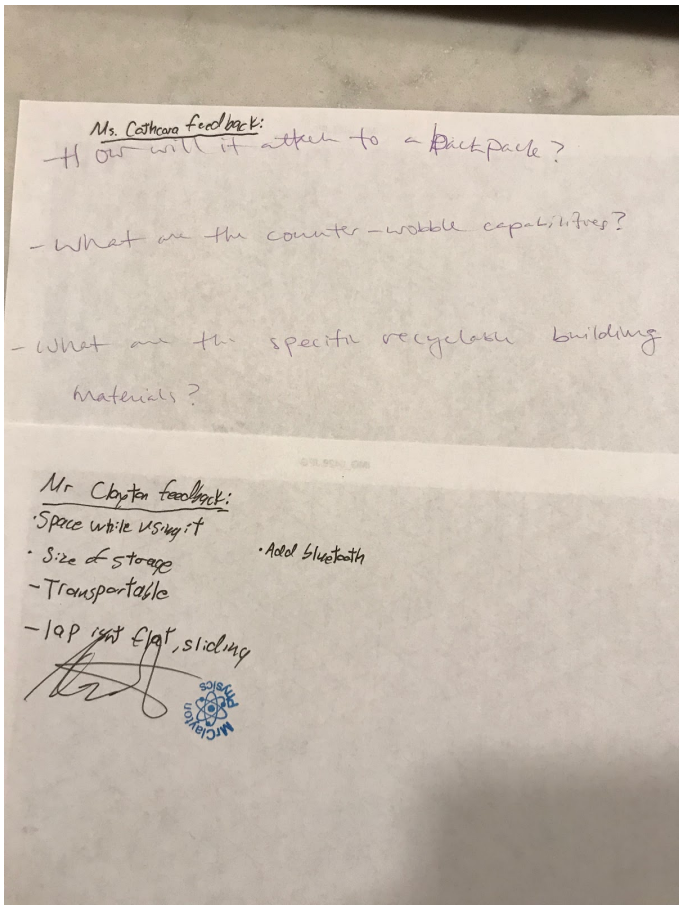


Feedback:

We then received feedback on these drawings from peers, experts, and members of our own team. They commented on photo-copies of our design.

Expert Feedback:

Physics Teachers Ms. Cathcara and Mr. Clayton



Ms Cathcara Commented:

"How will it attach to a backpack?"

"What are the counter-wobble capabilities?"

"What are the specific recyclable building materials?"

Notes from a Conversation with Mr. Clayton include:

"Space while using it?"

"Size of Storage?"

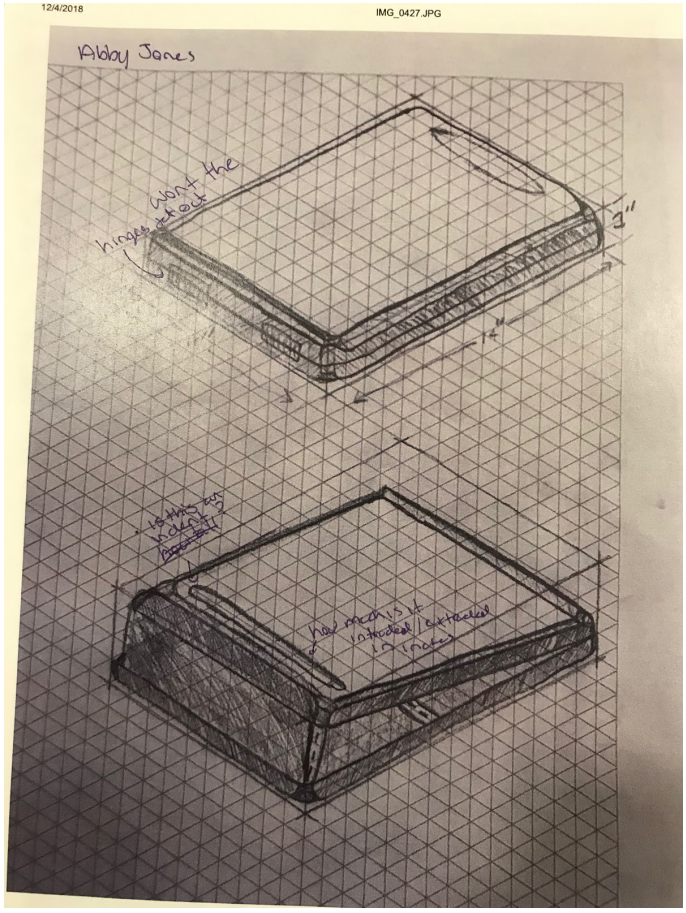
"Transportable?"

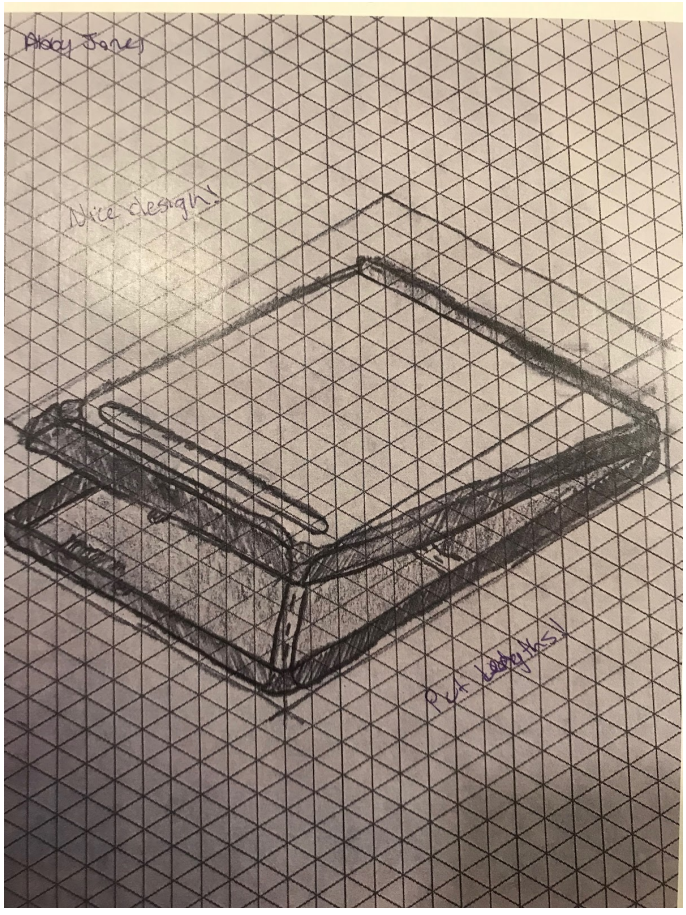
"Lap isn't flat, sliding?"

"Add Bluetooth?" [Meant as a joke]

Peer Feedback:

Abby Jones:





Abby Jones Commented:

"Won't the hinges get out?"

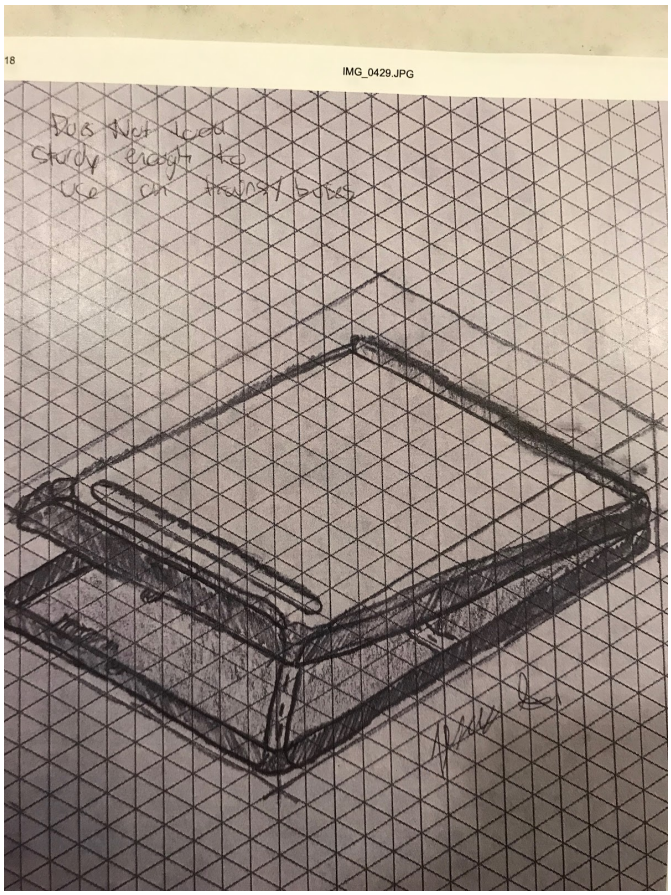
"Is this on indent?"

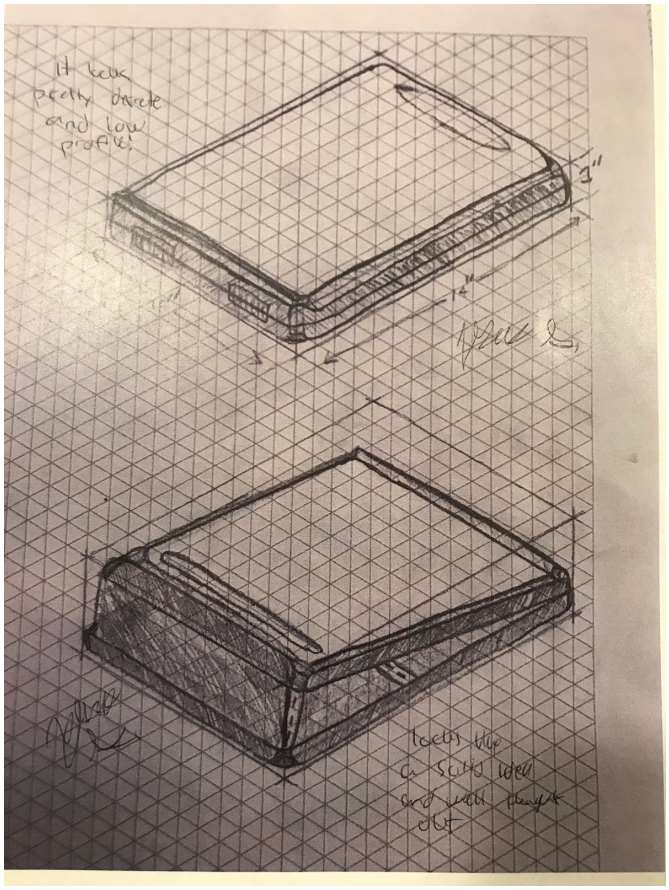
"How much is it intruded/extracted in inches?"

"Nice Design!"

"Put lengths!"

Jesus Gonzalez:





Jesus Gonzalez Commented:

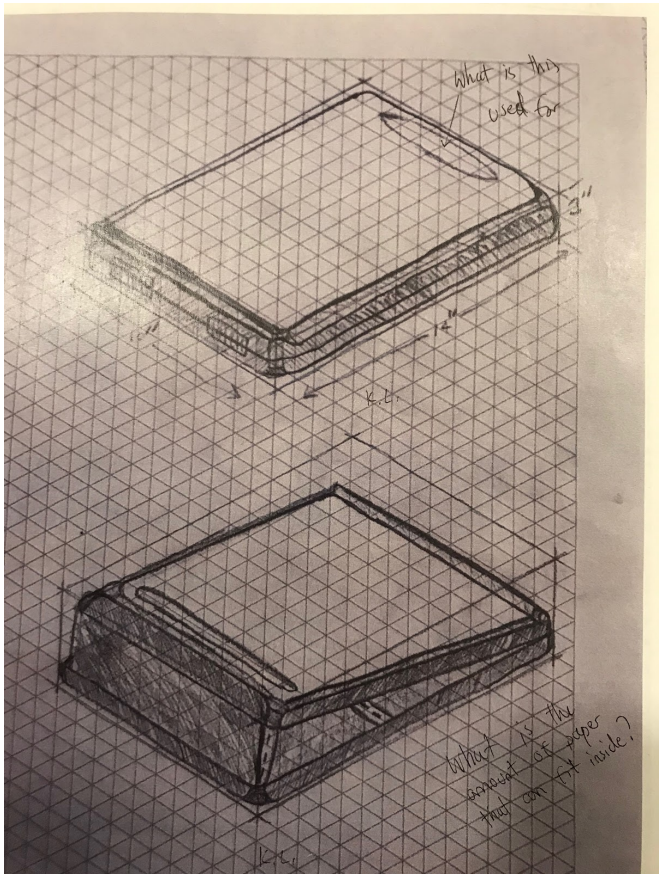
"It looks pretty discrete and low profile!"

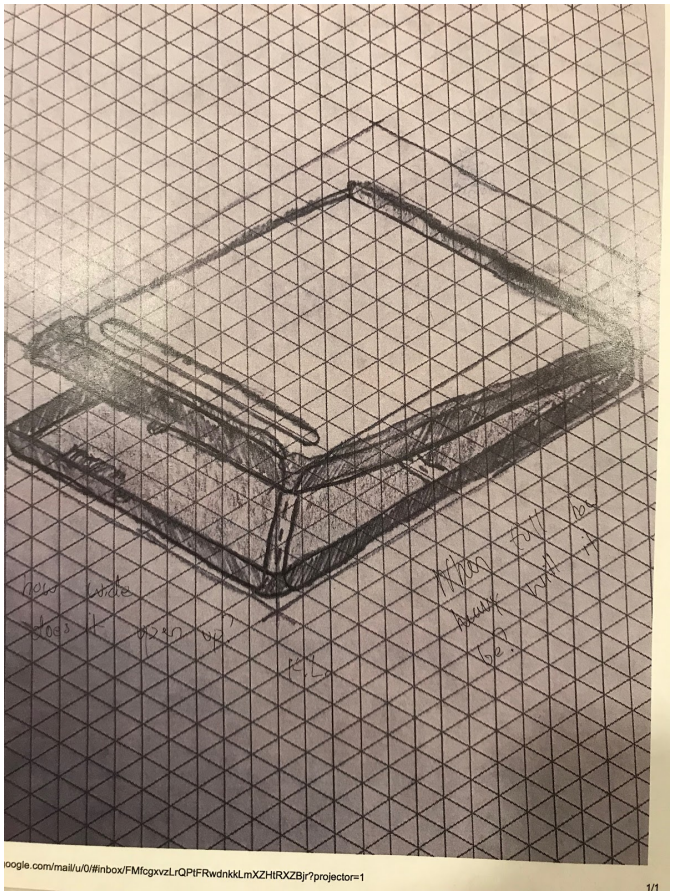
"Looks like a solid idea and well thought out."

"Does not look sturdy enough to use on train/busses."

Our Team's Feedback:

Kelvin Lao:





Kelvin Lao Commented:

"What is this used for?"

"What is the amount of paper that can fit inside?"

"How wide does it open up?"

When full, how heavy will it be?"

Comments Summary:

These comments will help us finalize our design with more detailed drawings and specifications in Element G. One of the main themes throughout the comments were questions about the pencil holder on the front writing face of the product. Our team will debated taking this off, to possibly increase the size of the writing surface. Another topic we will debate is the support system, for writing at an angle. We will enhance this system to be able to cope with the strong shaking and rattling of Trains and Busses.

Conclusion:

Our team solved for the external volume, internal volume, and the amount of material used. This allows us to come up with a base price for our product: how much the plastic, or other material used for a majority of the design, will cost. We also researched into what types of plastic or materials we could use, to figure out what best suits our needs. Using this information, we can make an educated choice on what material to use for our the majority of our design. These calculations were reviewed by Ms. Cathcara, a Physics teacher at Jones College Prep. Our improved designs added more features to the original drawings, and the feedback we received from our commenters was mostly positive. The most frequent constructive feedback was confusion with the "Pencil holder" on the outside of the lap desk. Some reviewers were confused on the purpose, others wanted more detail about the size of this feature. For our future technical drawings, we have decided to remove this feature. Few people would appreciate the detail, and we realized it would lower the usable writing space.

PORTFOLIO ELEMENT F

CONSIDERATION OF DESIGN VIABILITY

Consideration of Design Viability

Kelvin Lao, Alex Sung, Michael Youngblood

Introduction:

In this step, we explored ways we could improve our designs and thought process behind our work. We explored how we could maximize different aspects of design, from Aesthetics to Ease of Maintenance.

Product Improvement and Development:

Function:

Can you simplify the operation of the product?

We discussed adding a handle, but decided it does not simplify the operation, only adding excess weight and not much functionality.

We are debating adding a locking mechanism to the design. We decided to add loops to the outside of the opening side, so that users can attach a lock of their choice.
We are adding a lip to the bottom of the short side opposite the pencil holder, so that papers will stay on the desk easily.

We will also move the hinges from the side to the bottom, when writing on it vertically. This will allow us to create a stand feature, so that the lap desk can stand up and be written on at an angle.

This support feature will be a "lock and pop" where you can lock the legs(2) up or quickly fold them down. These legs will have an adjustable height, so that the user can select the amount of angle they want to write at.

Will the product function properly ever time it is used?

Yes, it should open easily and not break.

Aesthetics.

Can you improve the visual appeal of the product? Keep your target market in mind.

We can possibly make the product in several colors while not changing any of its function.

Ergonomics.

Is the product well suited for human use?

Yes, we designed our product to be used by humans in crowded areas such as the train or bus.

Is it user-friendly?

Yes, the product has rounded edges to ensure the safety of users, and fits smoothly in a backpack.

Can you improve the ease of use?

We can, and are, improving ease of use of the opening mechanism. We want it to smoothly open and close without breaking, while being able to stop at multiple points for users to write on an angled surface.

Safety.

Is the product safe to use?

Yes, we have rounded edges and corners to mitigate damage risks.

Are there any components that may pose a hazard?

There is one minor danger- slamming fingers in the lap desk when closing the device. But this is a minor concern, and the lap desk will latch closed, so it will not open in the backpack or at unsafe times.

Magnets can mess up computers, so we will not use any magnets in our design.

Cost.

Can you reduce the cost by using alternate materials or reducing the amount of materials in the design?

We need to use a strong, heat resistant plastic so that it does not melt under an overheating laptop. This will make the design somewhat more expensive.
The legs inside the lap desk, while being a cool feature that differentiates our product, add to the cost of the design.

Can you change the design to simplify the manufacturing or assembly process of the product?

We need to make the product of as few parts as possible to simplify the assembly process, and lower costs.

Standardization.

Can you use standard tools and parts instead of requiring custom tools or parts?

We can create plastic molds to mass produce our design, and have all of our other materials standardized to easy-to-access tools and materials for the hinges and screws.

Quality Control.

Are there parts or components of the product that will be difficult to manufacture correctly?

The mechanism to prop up the writing surface will be hard to manufacture.

Can you alter the design to better control the quality of the product in the manufacturing stage?

We will make the design using molds so that all of the lapdesks are the same size, which ensures a standard of quality. We can control manufacturing quality by minimizing the work required at this stage, which ties back to lowering cost.

Ease of Maintenance.

Is the product easy to maintain?

Easy to maintain as long as you do not break it. The tools used are standard and easy to access, and the parts for the hinge or screws should be easily available through a hardware store. If the slanting mechanism breaks, you will probably need a new one, or to order a new slanting mechanism, as these will be only made by the company using our molds.

Can you improve the product to reduce the need for maintenance?

The product will not need a lot of maintenance besides cleaning it.

Can the cost of maintenance be reduced by altering the design to require less expensive tools or parts in order to properly maintain the product?

A majority of the parts on the product are easily replaceable or repairable, and users would be able to do this work themselves or through a simple handyman. A few of the parts would require shipping it back to our company, but these are few and we are designing them sturdily to lower the risk of breaking.

Durability.

Will the product function properly for the duration of its design life with minimal maintenance?

Yes, the hinges can be re-inforced and will need minimal or no maintenance(save for replacing them if the product breaks)

Can the product be designed such that all components wear out simultaneously as it reaches the end of its design life?

We can design the hinges to last as long as possible with more reinforcement and securing pieces. This will ensure the hinges go at the same speed when opening, and there is no twisting or bending occurring in the device, lowering the chance of an early maintenance or breaking.

Environment.

Consider the life cycle (as discussed in Lesson 1.1) of your product. Is the manufacturing process harmful to the environment or employees involved in the manufacturing process?

The plastic is not great for the environment, but is not harmful to the workers. We are also using partially recycled plastic, to lessen the impact on the environment.

Does the manufacturing process product excess waste or hazardous material?

Yes, as we are using plastic. Our product will use at least 10% recycled plastic, and be better for the environment.

Will disposal of the product emit toxins?

We will use plastic that can be recycled to lessen the environmental impact.

Can the product or components of the product be reused or recycled?

We will use plastic that be reused or recycled if possible and it fits the rest of our constraints.

Can you reduce the overall impact of the product on the environment?

Yes, by using greener material such as wood. However, this material does not have an acceptable thickness-weight ratio, so we are going to use plastic.

Design Viability Judgment:

We believe that our design is viable because our product was designed with many of the aspects already in mind. Ideas such as Safety, Durability, and Ease of Use were key in our design work. This activity brought new ideas to light, such as maintenance the environmental impacts, were not new to our thinking but brought out new ideas of how we can integrate our product to fit as perfectly as possible in the complex web of manufacturing, environmental impact, function, and cost that is our economy. Our product passed through each of these lenses without any major inconsistencies with the goals expressed, and leads us to believe our design is viable. By continuing the design process and taking these factors into account, we can improve the viability even further, and improve our product's chance of success on the market and in this project.

Conclusion:

Through analyzing our design for possible improvement and development, our team has developed a deeper understanding of our design and how it will reach the goals we have set. We have thought harder on the slanted writing surface capabilities and what pieces this requires. We have thought about how to improve the environmental impact of our design, as well as how to manufacture our product. We will work to add these insights to our design, and complete all of the specifications we have set.

PORTFOLIO ELEMENT G

CONSTRUCTION OF A TESTABLE PROTOTYPE

Construction of a Testable Prototype

Kelvin Lao, Alex Sung, Michael Youngblood

Introduction:

To build a prototype, our team cannot just jump right into the work. We would not have the right materials, the right tools, or know what we were doing. We needed to plan. We created plans on what materials fit our needs for each part and sub-piece of our prototype, how we would gather these materials, and how we would put them together. Our first step was to decide what materials best fit with our Design Specifications from Element C.

Choosing Materials:

Overview:

Our design can be broken down into 6 separate parts: Top, Bottom, Button Hole, Button, Adjustment Clip, and Roller Pin. Many of these parts can use the same materials, because they fit together and are sub-parts of a larger section of the design. The Top and Bottom parts make up the outer shell, so they need a tougher layer for stability, strength, and durability. We will make these parts out of a strong and durable plastic so it is strong and light.

The Button and Button Hole do not need to be as strong, so we will use a lighter material to lower the weight of our product. These are also very detailed designs, so we will 3D print these to easily create the intricate details in these parts.

Possible Plastics Chart:

Specification	High-Density Polyethylene (HDPE)	Polyvinyl Chloride (PVC)	Polyethylene Terephthalate (PET)	PLA (Used in 3D Printers)
Durability	Very hard, high strength to density ratio	Very hard	Somewhat durable (plastic water bottles)	Fairly strong and durable
Looks	White other colors, easily spray painted	White other colors, can be easily spray painted	Clear, can only be colored with paint.	Multicolored, we can choose the color.
Recyclable?	Yes	Yes	Yes	PLA is compostable, but not recyclable
Access	Easily, comes in sheets of different length and thickness	Easily from hardware stores (pipes and sheets)	Very hard(can only be found in water bottles)	This plastic is used in our classroom 3D Printer
Density	0.941 g/cm^3	1.38 g/cm3	1.38 g/cm3	1.25 g/cm3
Price	58.5 cents/lb	30.13 cents/lb	100-103 cents/lb	Free, in class
Website		4' x 4' PVC Sheet Pipe Cheaper PVC sheet		No website, we will use the 3D printer in class

Possible Plastics Analysis:

Polyvinyl Chloride (PVC) plastic fits our requirements the best, and beats the price of the competition by half to triple. However, this material generally requires us to buy in bulk, and is not great for making unique parts like some of our internal mechanisms. PVC would be the best for the outer top and bottom parts, as they could be cut down and sanded to fit our designs. PVC also usually

comes in tubes, and not in sheets. This minor rarity in the item will increase the price, and possibly make the price more comparable to the other plastics we have researched.

High-Density Polyethylene (HDP) is a very strong plastic that would work well for some of our parts that undergo lots of stress and movement in daily use. This includes the slanted-writing adjustment pieces, such as the Adjustment Clip or Roller Pin. However, this plastic is very expensive and would drive up our production costs, making it undesirable for our designs. Its strength is not worth the cost, especially considering when we buy PVC it is in bulk that we can use for these parts for free.

While Polyethylene Terephthalate (PET) is the strongest plastic we looked at, it is also the most expensive. This plastic is double the price of the next most expensive plastic, and can only be found in water bottles. This means that it is very durable, but also harder to find. For the purposes of this project, the price point of this plastic will limit our use of it. As our budget is very minimal and we want to keep the cost down for consumers, we will use this plastic sparingly, if at all.

Analysis of Parts for Special Consideration:

Top Part - PVC

PVC, buy a flat part of pvc and build part of the box with it. Use glue and sanding to get it exact. We will rent a buzz saw from Home Depot to get exact cuts. We will use PVC glue to put this together and ensure it does not fall apart.
HDPE - it does not have the density of PVC, and is much more expensive and hard to find online.

- What are the dimensions of the part? What dimensions are specifically related to failure or success of the part?
  - The part must be large enough to hold a computer or piece of paper.
- Does the material meet the demands of the part?
  - PVC meets our needs, as it is easy to write upon and light.
- Is it a manufactured part that is easily available, such as a common bolt?
  - Moderately, it is sold online, but is fairly expensive.
- Is it otherwise available or easily acquired?
  - Yes, it can be ordered online.
- Should more than one material be used to test?
  - No, as PVC is the cheapest of the plastics we researched. If PVC is expensive and it was the cheapest, none of the other materials will be reasonable for our budget.
- What are vendor choices and approximate costs for the material?
  - US Plastics sell PVC sheets. One 4’x4’ sheet is approximately $20.

Bottom Part - PVC

PVC. Buy a flat part of pvc and build part of the box with it. We can use the same large piece of PVC for top and bottom parts. Use glue and sanding to get it exact. We will rent a buzz saw from Home Depot to get exact cuts. We will use PVC glue to put this together and ensure it does not fall apart.

- What are the dimensions of the part? What dimensions are specifically related to failure or success of the part?
  - The part needs to hold a 14” laptop inside it easily, along with other papers and things.
- Does the material meet the demands of the part?
  - The part needs to be durable in a backpack and to withstand the damage that occurs through transportation in cramped spaces.
- Is it a manufactured part that is easily available, such as a common bolt?
  - Moderately, it is sold online, but is fairly expensive.
- Is it otherwise available or easily acquired?
  - Yes, it can be ordered online.
- Should more than one material be used to test each?
  - No, as PVC is the cheapest of the plastics we researched. If PVC is expensive and it was the cheapest, none of the other materials will be reasonable for our budget.
- What are vendor choices and approximate costs for the material?
  - US Plastics sell PVC sheets. One 4’x4’ sheet is approximately $20.

Button Hole - PVC 3D & Printed PLA Combo

This is our most complex piece, based on its shape. Its size also makes it difficult to 3D Print, so we will 3D Print the “hole” of the part and attach it to a PVC “beam” to reach our desired length and size. 3D Printing is the easiest way to make the truly unique shape of the hole. This is resource intensive and generally does not look as professional, so we will use 3D printing sparingly, but it is important for this part. Using PVC makes it stronger and is more cost effective for our design. Finally, we will connect these pieces using PVC glue and pins and holes to ensure the part stays together and maintains the strength of both of the mini-parts through the joint.

- What are the dimensions of the part? What dimensions are specifically related to failure or success of the part?
  - The button hole must be large enough to fit the Button, and also leave room in the middle of the box for papers or a laptop.
- Does the material meet the demands of the part?

    - Yes, we are using 3D Printing for the complicated piece of this part, and PVC for the piece that needs to be more durable, the beam.
- Is it a manufactured part that is easily available, such as a common bolt?
    - No, we are making this piece ourselves.
- Is it otherwise available or easily acquired?
    - No.
- Should more than one material be used to test each?
    - We should test an all 3D Printed version too, but we are trying the combination piece first because the PVC will be stronger.
- What are vendor choices and approximate costs for the material?
    - There are no vendor choices, aside from the PVC, which we will reuse from the Top and Bottom Parts, bought from US Plastics.

Button - 3D Printed PLA

This is another very complicated piece that we will 3D Print. This piece is very small, so it will be easy to 3D Print on a small 3D Printer.

- What are the dimensions of the part? What dimensions are specifically related to failure or success of the part?
    - The part must fit inside of the Button Hole, or it will not work properly.
- Does the material meet the demands of the part?
    - The Button must be durable and light.
- Is it a manufactured part that is easily available, such as a common bolt?
    - This is not easily manufacturable, as it is a small part with intricate details. To create this part, we will 3D Print it.
- Is it otherwise available or easily acquired?
    - No.
- Should more than one material be used to test each?
    - No, 3D Printing is the fastest and most accessible way to create the part.
- What are vendor choices and approximate costs for the material?
    - 3D Printing at school is free, so we will 3D Print the Button there.

Adjustment Clip - PVC

We can use excess PVC sheeting from the Top and Bottom Parts to create this clip. It requires a little more cutting, drilling, and sanding, but this is easy to do with the tools we will have already rented for the top and bottom parts.

- What are the dimensions of the part? What dimensions are specifically related to failure or success of the part?
    - The larger holes need to fit the Roller Pin through them. But the smaller connection needs to only fit the Button, and not the Roller Pin. This is key to the design, and if we fail to meet this specification the part will not work correctly.
- Does the material meet the demands of the part?
    - The adjustment clip needs to be very strong. We will use PVC for this, as it is the strongest plastic we have.
- Is it a manufactured part that is easily available, such as a common bolt?
    - No, we are making it ourselves at PVC.
- Is it otherwise available or easily acquired?
    - No.
- Should more than one material be used to test each?
    - We should use another plastic if we can find one, or if the PVC does not seem sturdy or strong.
- What are vendor choices and approximate costs for the material?
    - We are using the PVC from US Plastics, because we will have so much of it. If we decide to use another stronger plastic, we will have to buy this from US Plastics or another supplier, and it will likely be expensive, and then not worth the cost.

Roller Pin - PVC

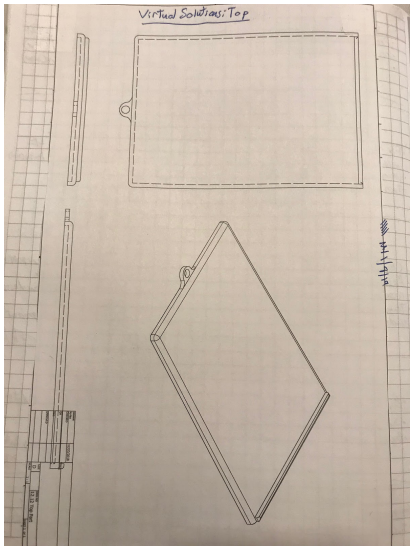
PVC, buy tubes. We will buy one tube at ½" inner diameter and this will be the outer part of the roller pin, and we will find springs that fit inside this PVC that is ½" diameter.

- What are the dimensions of the part? What dimensions are specifically related to failure or success of the part?
    - The part needs to stretch the width of the Top Part, reaching from Adjustment Clip to Adjustment Clip. The springs in the Roller Pin must
- Does the material meet the demands of the part?
    - We will use a PVC pipe for the body of the Roller Pin, but we need to use special springs for pushing against the Button.
- Is it a manufactured part that is easily available, such as a common bolt?
    - The PVC is easily acquired, and is very common. The springs might be more work, but we could try to use pen springs for our first prototype. For our final design we will need professional or springs bought online or in a hardware store.
- Is it otherwise available or easily acquired?
    - The PVC is easily acquired at Home Depot, but the springs will be hard to find.
- Should more than one material be used to test each?
    - No, we will only need the PVC.
- What are vendor choices and approximate costs for the material?

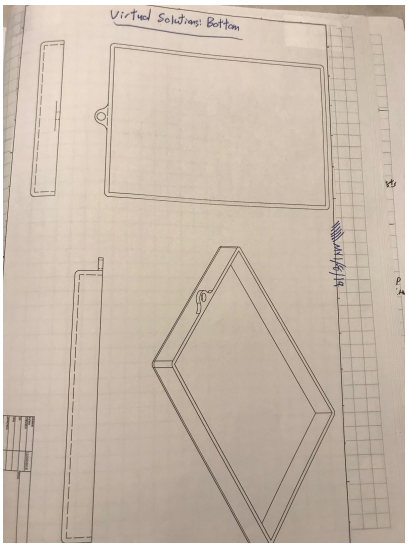
- Home Depot, Lowe's, Mernards. Home Depot has the cheapest PVC.

Drawings of Parts with Dimension

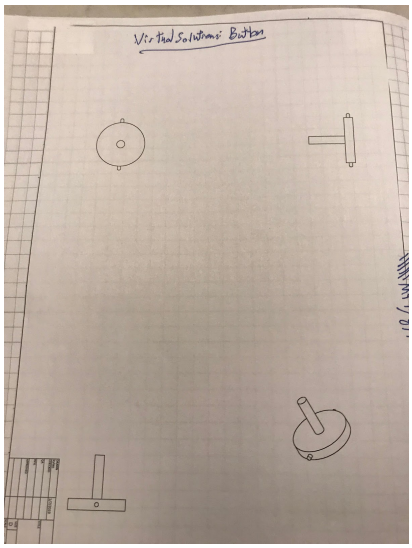
Top Part



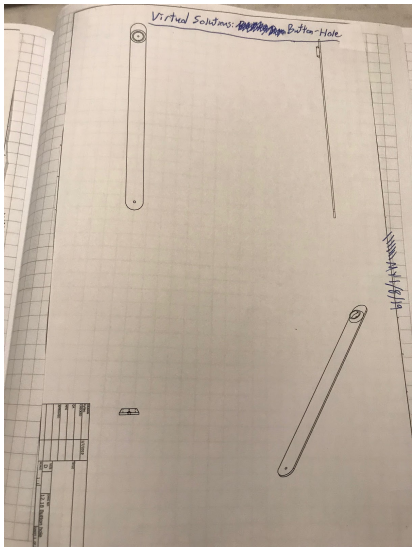
Bottom Part



Button

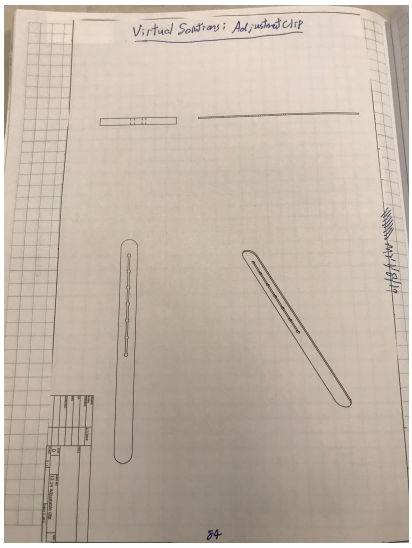


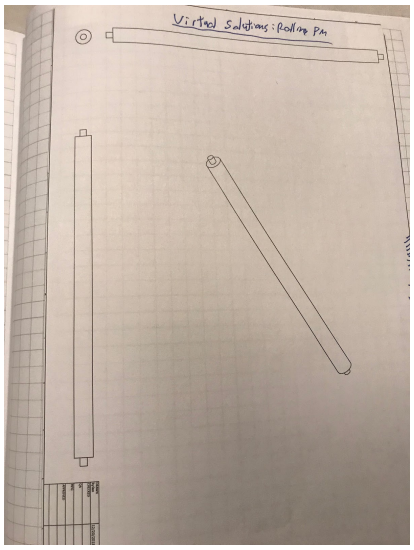
Button Hole



Adjustment Clip

Roller Pin





Special Considerations:

Every part of our design requires special consideration of some sort in our design process. These include the writing surface, hinges between top and bottom parts, the lock mechanism for the lap desk, and the writing surface angle adjustment pieces.

The writing surface and outer sides of the desk need to be strong enough to handle a pencil or pen, and to resist minor scratches, cracks, and breaks. This surface must also be heat resistant, in case an overheating laptop is placed on it. This part, along with all the rest, must be light to keep the weight of the device down.

These moving parts need to handle forces acting on them and movement, so they need to resist bending and twisting. They should also be light to lower the weight of the lap desk for increased comfort and portability.

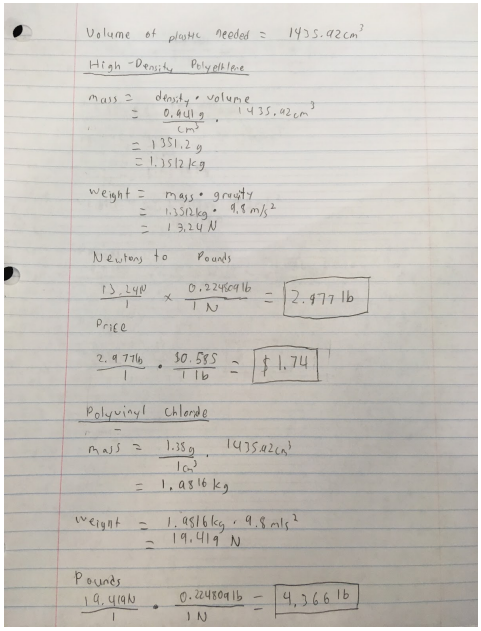
The hinges must be strong and resist twisting or becoming loose. They must also be very durable, as they stick out from the design a little bit in order to open and close. We will probably need to use a metal here, either Steel or Aluminum, to increase the strength of these key parts. We will probably end up buying these parts from another retailer, such as Home Depot, and putting them on our design. These will add a lot of weight for their size, but we can counteract this issue by keeping other parts of our design lower.

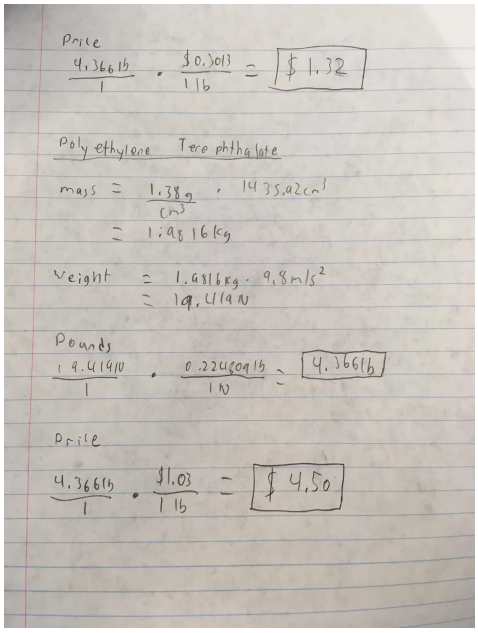
Scientific, Mathematical, & Engineering Concepts:

We need to consider the strength of the plastics we are researching, because we want our design to be durable and strong. We are considering the density of the plastics for their strength, and relating this to the price of the plastic. Through this lens, PVC gives us the best density for the cost.

We completed equations like these for Element E under the Mathematics section. The following images detail how much plastic we really need, but do not factor in how we would buy the plastic. We would not be able to buy these specific amounts of plastic that we need, and have to buy in bulk.

Calculations for Price of Different Plastics:





Preliminary Material and Fastener Choices:

Top Part - This part must have rounded edges, so we must be able to sand it. We will use PVC based on its' weight, durability, and price.

Bottom Part - This part must have rounded edges, so we must be able to sand it. We will use PVC based on its' weight, durability, and price.

Button - We piece is very small, but needs to be strong. If it breaks the angled writing system will not work properly. This piece needs to be very durable and strong, as it is partially supporting the weight of writing when on an angle. We will use 3D Printing for this piece as it is strong and can be made into the intricate shapes we need.

Button Hole - This piece is the actual connector from the writing surface to the Bottom Part, and takes the majority of the weight and load. This piece needs to be extremely strong and durable, but also detailed. We plan on using a combination of 3D Printing and PVC for this part. We will 3D Print the detailed components and attach them to a PVC piece for the area of the piece under more force.

Adjustment Clip - We used geometry and algebra to find the desired angles and slants of the top part that set the writing angle of the Top Part. This part will also be made of two separate pieces, the beam and the hole. We will use PVC glue to attach this, because we will already be using it for the Top Part and Bottom Part assemblies.

Hinges - We will use small hinges bought at Home Depot to connect the Top and Bottom Parts. These will be approximately 3" long and have 2 holes for screws on each hinge. We will use 2 hinges to ensure a solid connection between these parts.

Resource Planning:

Bill of Materials:

Item	QTY	Description	Vendor	Cost	Notes
Screws and Hinges	1	3-1/2 in. Satin Nickel Square Corner Door Hinge	Home Depot	$2.83	Home Depot
PVC sheets	1 sheet	4 ft x 4ft plastic sheet	US Plastics	$23.55	US Plastics
PVC Tube	1	1/2 in. x 10 ft	Home Depot	$1.85	Home Depot
Wood Dowel	1	1/2 in. x 48in.	Home Depot	$1.75	Home Depot
WD40	1 Canister	Lubricant	Michael	$0	From Michael
Springs	2				
PVC Caps	2 caps	1/2 in.	Home Depot	$0.45	Home Depot

Tools and Equipment:

Item	Exists in Lab(Y/N)	Source if not in Lab	Outside Source Notes
3D Printer	Y	Lab, YouMedia	
Circular Saw	N	Home Depot	Rental for $22 with a $24 deposit
PVC glue	N	Home depot	Costs about $2
Sandpaper and orbital Sander	N	YouMedia	Borrowed
Screwdrivers	N	Michael	Borrowed
Drills	N	Science Olympiad	Borrowed

Needed Knowledge:

Item	Need Outside Assistance (Y/N)	Source	Outside Source Notes
How to rent tools from Home Depot	Y	Home Depot	Look through the home depot website to figure out how to rent tools.
How to 3D print our virtual solutions	Y	Francis Hashimoto, Engineering Teacher Youmedia	We can approach these sources to learn how to use a 3D printer and how to print our virtual solutions.
Where and how to acquire springs	N	Internet, our own research. We can also talk to Science Teachers	This just requires lots of research on our own part, and we need to find these parts online.
How to use Circular Saw and	N	Home Depot, Michael taught in Boy	Michael has used buzzsaws and sanders

sander safely		Scouts	before and is confident in these skills.

Building Procedure:

Material List:

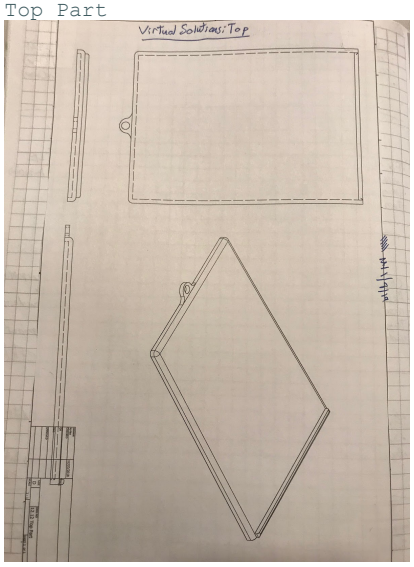
PVC Sheets: 4′ x 4′ x 1/16″
PVC Tubing: ½″ x 10′
Dowel: ¼″ x 2′
Hinges:
Screws:
3D Printing Material: Black PLA Plastic

Tool List:

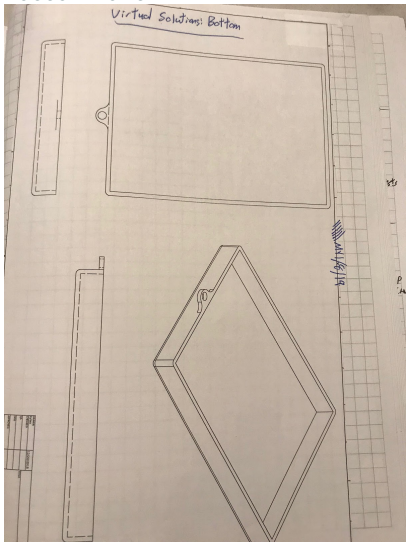
Buzzsaw
Drill
Sandpaper
Orbital Sander
PVC Glue
3D Printer
Screwdriver
WD40

Subsystems to Build:

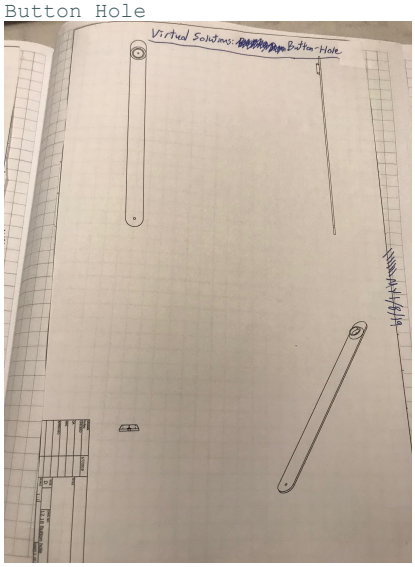
Top Part



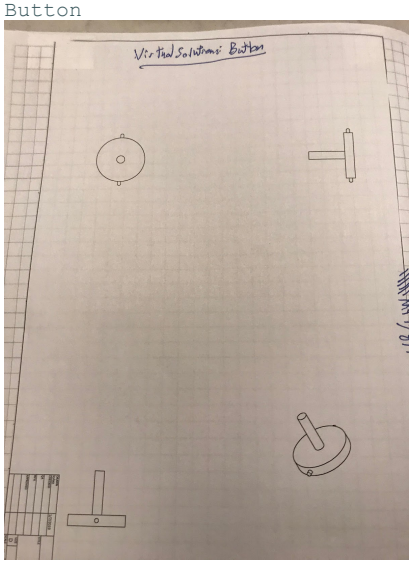
Bottom Part



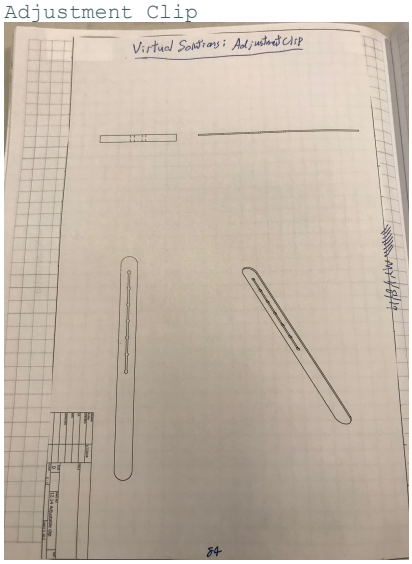
Button Hole



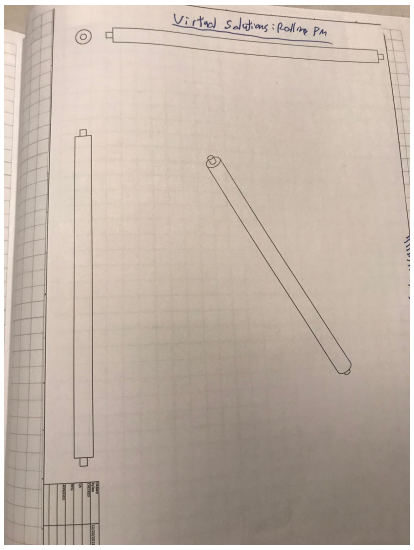
Button



Adjustment Clip



Roller Pin



Hinges/Screws

Building Procedure:

First, gather all materials and tools needed to create the design.

Top Part

We will split the Top Part into seven separate pieces to assemble the top part. These subparts are: the top edge (10” x 14” x 0.0625’’), the four walls (one will be 10” x 0.5” x 0.0625", two will be 14" x 0.5" x 0.0625", and the last side will be 10’’ x 0.25’’ x 0.0625"),the lock mechanism, and the writing ledge(10” x 0.28” x 0.25”).

These parts will be sheets of the PVC Sheeting, glued together to make a box.

Begin work on a full-size paper stencil for each subpart. This stencils measurements will be based on Virtual Solution drawings that we have created for Element E.

Cut out the pieces in PVC using the buzzsaw, using the stencil as a guide. Ensure all measurements are correct before cutting.

We also have a piece with a lock mechanism in it, and for the specific piece we must take it and run a power drill through the hole in the stencil to create a hole for the lock.

Begin assembly of the subparts.

Take the writing surface, the most top part, and flip it upside down.

Then apply PVC glue to the 4 individual parts and glue it to the side of the writing surface.

After all of the glue drys we apply glue to the lock mechanism part and glue it to the bottom of the front side.

After the glue drys we will take the box and flip it right side up and attach the writing ledge on the writing surface farthest away.

After all the glue has dried, sand the edges to a safe and smooth edge. Use sandpaper and the orbital sander for this.

Bottom Part

We will split the bottom part into six separate subparts for the sub assembly. These sub parts are: the floor, the four walls (two will be 10” x 1.5” x 0.0625", two will be (14" x 1.5" x 0.0625"), and the lock mechanism.

Use the same PVC sheet from the Top Part.

Work on an actual size version of these six parts in a paper stencil, using dimensions from Virtual Solutions in Element E to create an accurate stencil of each piece.

Since the stencil for the lock mechanism and top surface has already been made we will reuse that same document.

Cut out the pieces in PVC using the buzzsaw, using the stencil as a guide. Ensure all measurements are correct before cutting.

We also have a piece with a lock mechanism in it, and for the specific piece we must take it and run a power drill through the hole in the stencil to create a hole for the lock.

Begin assembly of the subparts.

Take the writing surface, the most top part, and flip it upside down.

Then apply PVC glue to the 4 individual parts and glue it to the side of the writing surface.

After this glue drys, apply glue to the lock mechanism part and glue it to the bottom of the front side.

After the glue drys, take the box and flip it right side up and attach the writing ledge on the writing surface farthest away.

After all the glue has dried, sand the edges to a safe and smooth edge. Use sandpaper and the orbital sander for this.

Button Hole

Create a 3D model on Autocad. Ensure it is to our proper dimensions, is what we want, and will fit in our other pieces.
In AutoCad, cut out the simpler parts of this piece, the "beam" piece, and create a new document(not saving over the old file) of just the "hole" piece, that has small details. This will be the only part printed, and the "beam" will be made of PVC for increased strength.
The beam should include the area under the hole piece, so all that is being 3D Printed is the detailed and circular "hole," while the beam includes the angle adjustments and goes under the hole, so the Button would go through the "hole" and the "beam"
Transfer the piece into a format the the MakerBot in our Engineering classroom. This may require a change in the orientation of the piece, to fit in the 3D Printer. This is all set up for us to use, and we only have to email our teacher the part for it to be printed. We will choose this part to be printed in black.
Take some of the leftover PVC and cut it into the desired shape for the beam piece of this part.
Drill holes in the beam where they are specified in the drawing on the Beam.
Use PVC concrete to attach the hole onto the beam.
Wait for this to dry before using this piece in the final assembly
This piece is now completed, and is ready to be added to the final step of putting the entire device together.

Button

Create a 3D model on Autocad. Ensure it is to our proper dimensions, is what we want, and will fit in our other pieces.
Transfer the piece into a format the the MakerBot in our Engineering classroom. This may require us to change the orientation of the piece, to fit in the 3D Printer. This is all set up for us to use, and we only have to email our teacher the part for it to be printed. We will choose this part to be printed in black.
Sand the piece so that it fits snugly in the Button Hole
This piece is now completed, and is ready to be added to the final step of putting the entire device together.

Adjustment Clip

Create a 3D model on Autocad. Ensure it is to our proper dimensions, is what we want, and will fit in our other pieces.
Transfer the piece into a format the the MakerBot in our Engineering classroom. This may require us to change the orientation of the piece, to fit in the 3D Printer. This is all set up for us to use, and we only have to email our teacher the part for it to be printed. We will choose this part to be printed in black.
This piece is now completed, and is ready to be added to the final step of putting the entire device together.

Roller Tube

Buy a ½" PVC tube from Home Depot and a wooden dowel ¼".
Wrap the dowel in paper towels so that it fits tightly in the PVC tube, and push it in.
Ensure the dowel is centered in the tube.
Put one spring in each end of the PVC Tube. Tape this to the dowel, so that it stays inside the tube.

Hinges & Screws

Buy these parts from we will buy this from Home Depot. The package we bought includes two 1" hinges and eight screws.
Measure 3-⅓" from the left and place the hinge directly on the gap where the top part and bottom part meet.
Use a electric drill to drill the screws into top and bottom part, attaching the hinge.
Measure out a distance of 3-⅓" from the right and place the hinge directly on the gap where the top and bottom part meet.
Repeat step 8.3

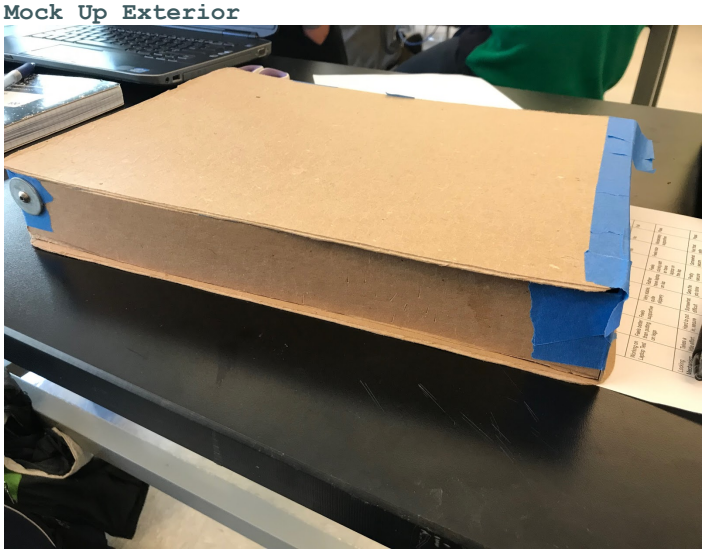
Now you are ready to begin assembly on the full design, combining the six pieces you created in steps 2 - 7. The screws in step 8 are already attaching the Top and Bottom Parts.
Using an electric drill and screws, attach the attachable clips to the ceiling of the top part for both sides.
Attach the rolling pin to the adjustable clip and then attach the buttonhole to the rolling pin. Repeat for the other side.
Attach the Button to the Button Hole. The button slides in snugly into the hole designed for it in the Button Hole part, and push it in here. It should snap in and then twist in to secure it.
Attach the Button Hole to the Bottom Part using screws. Make them moderately tight, but not so tight that it will not move. This attachment has to be 1" from the interior wall that is not used by the hinges, but is attached to the locking mechanism.

This Build Procedure has been read by Sheryl Guzman Ordonez for quality and completion, and has been found satisfactory.

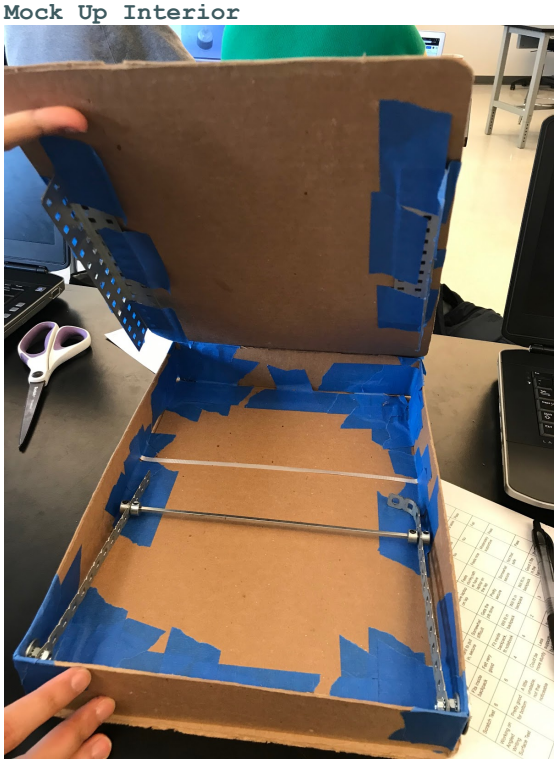
Mock Up Development and Images

Before we worked with our chosen materials and designed our actual prototype, we built a Mock Up of our design following our Build Procedure using cardboard, tape, and other more economical resources availiable in the classroom. We were able to follow our Build Procedure and came up with a mock up that worked how we wanted it to and fulfilled some of our design specifications. The mock up worked well because it allowed us experience following our Build Procedure and showed us more detailed explanations of how our prototype would work. The following images show our mock up in all of its key positions, doing the actions we require of our prototype.

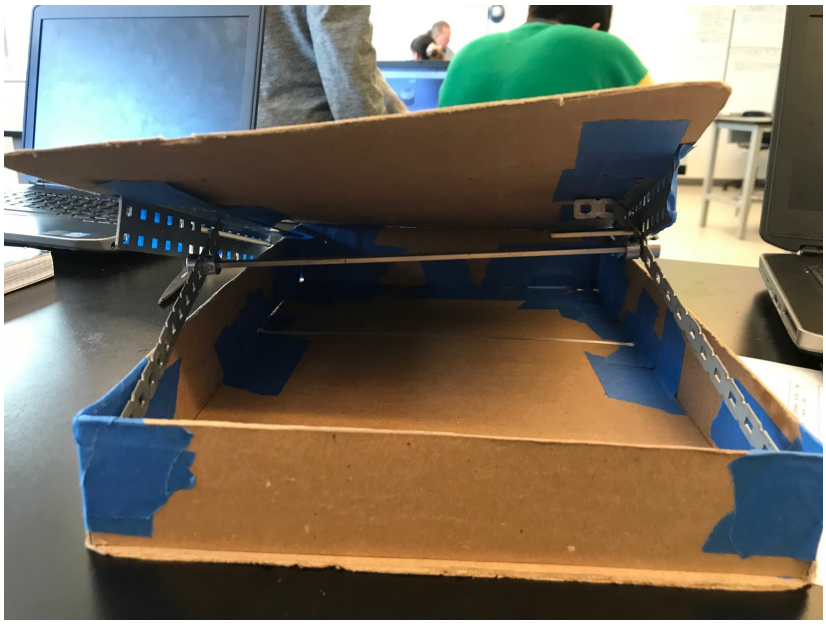
Mock Up Exterior



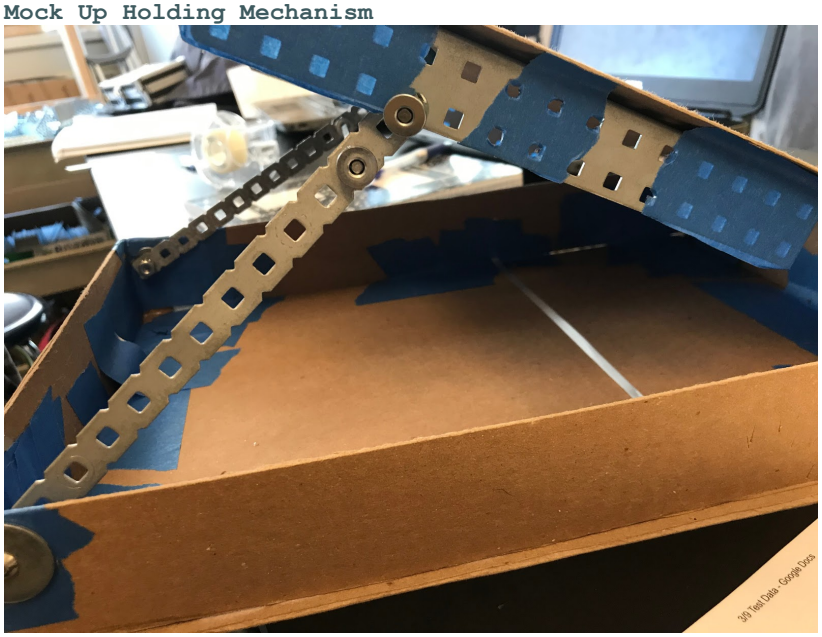
Mock Up Interior



Mock Up at Angle



Mock Up Holding Mechanism



Identifying Opportunities for Incremental Testing:

Parts to test, and what to test on them:

Top Part - Test writing surface usability, test corner safety, test if ledge supports paper, test overall durability. Test locking mechanism

Bottom Part - Test durability of this piece, test locking mechanism.

Button Hole - check if the button fits in here correctly.

Button - check if it fits in the button hole snugly. Check if it fits through the smaller part of the adjustment clip

Adjustment Clip - test if it works correctly with the button and roller pin

Roller Pin - test if the springs push in. test if it moves in the larger part of the adjustment clip. Test if it will stay up, in place with the pins pushed in

Hinges/Screws - test if they unscrew easily, if the hinges move correctly.

Subsystems to test:

Angled writing surface(supporting it) - we need to ensure that the design will support writing or a computer, and that it will stay here when using the product.
Hinges and opening and closing smoothly - we need to ensure that the design can open and close smoothly and quickly. We also need to make sure that this action does not inhibit the storage capacity of the design.

Method of Testing each Part:

Test through moving it ourselves, have others test how it works to see if it is intuitive and works well with new users.

- **Top Part**
  - Test writing surface usability - Have someone writing on paper and put a laptop on it.
  - Test corner safety - Test the roughness and sharpness of the corners by feeling it with the palm of the hand for resistance.
  - Test overall durability - We will do a 5 feet drop test to see if there are any deformation. We will also do a scratch test on the interior of the part, so it does not impact the visual appeal of our design.
  - Test locking mechanism - Have someone attempt to open the lapdesk while it is locked. Have someone try to break the section of the locking mechanism that attaches to the top part.
  - Writing ledge - Put paper on it and see if it slides off the ledge at different angles.
- **Bottom Part**
  - Test durability of this piece - Drop test from 5 feet and check for deformation, also a scratch test.
  - Test locking mechanism - Have someone attempt to open the lapdesk while it is locked. Have someone try to break the section of the locking mechanism that attaches to the bottom part.
- **Button Hole**
  - Check if the button fits in here correctly - We will push the button into the button hole, and ensure that it does not pull out easily of this piece.
- **Button**
  - Check if it fits in the button hole snugly - We will push the button into the button hole, and ensure that it does not pull out easily of this piece.
  - Check if it fits through the smaller part of the adjustment clip - Attaching the button to the button hole with the adjustment clip attached.
- **Adjustment Clip**
  - Test if it works correctly with the button and roller pin - We will do a deformation test, bending the part to see if it bends, snaps, or shatters.
  - Test of compatibility with the button - We will ensure the button fits through the Adjustment Clip by running the button through the Adjustment Clip.
- **Roller Pin**
  - Test if the springs push in - Have someone attempt to push the ends of the roller pin in. If the ends go in it passes this test, otherwise it fails.
  - Test if it moves in the larger part of the adjustment clip - Attach the roller pin with the button and clip to see if it has mobility.
  - Test if it will stay up, in place with the pins pushed in - Have someone open the lapdesk and ensure that it maintains it original form for 1 minute after setting an angle.
- **Hinges/Screws**
  - Test if screws loosen during damage, dropping, and shaking - Have someone drop the lapdesk and shake the lapdesk around. If the screws do not fall out it passes this test, otherwise it fails.
  - Test if they move correctly - Have someone attempt to open the lapdesk. If the lapdesk is able to open to its maximum angle with no resistance, it passes this test. Otherwise it fails.

Conclusion:

Through these activities, our team developed a workable plan to create our prototype. Preparing our materials, tools, and where we would get them took the daunting task of creating a full prototype into smaller, do-able goals for us to accomplish each week. We followed our own guidelines and those of the course, and made progress towards a prototype. After we gathered the materials, we planned a work day over a weekend and began following our Build Procedure as close as we could, making adjustments where it was necessary. This work was the perfect preparation to building a prototype, and set us up for success in the next crucial part of our Design Process.

PORTFOLIO ELEMENT H

PROTOTYPE TESTING AND DATA COLLECTION PLAN

Prototype Testing and Data Collection Plan

Kelvin Lao, Alex Sung, Michael Youngblood

Introduction:

For our testing procedures, we want to test our design as thoroughly as possible. We want to ensure that our design meets a vast majority, if not all, of our Design Specifications outlined in Element C. First is our Testing Criteria, around which our product will be tested. These criteria set the groundwork for each of our tests, and corresponded to a Design Specification. As we begin building our prototype, we are going to complete incremental testing to make sure we are on the path to fulfilling our Design Specifications. This incremental testing is described in our Testing Procedure. Finally, we have outlined a full Testing Procedure complete with 14 different tests and 7 human reviewers, both quantitative and qualitative, to decide if our prototype is successful or not.

Test Criteria:

Overview

Our Design Specifications included Price, Portability, Durability, Comfort, Size, Weight, Safety, Ease of Use: Seated, Ease of Setup, Counter-Wobble Capabilities, and a Plan for Disposal. Of these, we can test Portability, Durability, Comfort, Weight, Ease of Use, and Ease of Setup. We will use quantitative data for Portability, Durability, Size, and Weight. We will take qualitative data for Durability, Comfort, Ease of Use, and Ease of Setup. These tests will aim to see if we have reached our goals for the design. Our tests will show the viability of our design, and we will brainstorm more tests if we come up with inconclusive data. We will organize this data in the Data Tables at the bottom,

Quantitative:

- Drop test
- Papers held inside test(quantity,)
- Weight test(glue strength test)
- Pressure on lever arm test
- Scratch Test(nail, screws, keys, pens, use constant force with each object)
- Laptop support test
- Deformity test(twisting the top and bottom parts, at the hinges)
- Portability Test

Qualitative:

- Writing surface test, sitting still not on train(left hand and right hand)
- Working on laptop test
- Writing on angled surface test
- Lock mechanism usability test
- Comfort on lap, with weight
- Aesthetic appeal of design

Criteria/Benchmark	Description of Data Needed	Qualitative or Quantitative	Degree of Accuracy
Aesthetic Test: The visual appearance of the Lapdesk should look nice enough to use anywhere without seeming out of place.	The product looks appealing to the eyes and the consumer should not be ashamed to use it in public.	Qualitative	A very appealing design, a good design, an ok design, a bad design, a terrible design
Comfort on Lap Test: The force applied to the lap by the Lapdesk should feel comfortable and not irritating.	The comfort of the Lapdesk when placed on the lap when you are moving and sitting still.	Qualitative	Very comfortable, comfortable, uncomfortable, painful.
Writing Surface Test: The ability for both left and right handed people to write on the Lapdesk with ease.	The ability to write on a piece of paper without difficulty or any hindrance from the Lapdesk.	Qualitative	As good as a normal desk, as good as a notebook, as good as your lap, writing on air.

Paper Amount: The amount of paper the lapdesk is able to contain inside is 500 pages which is about 5 lbs.	The amount of paper the lapdesk is able to contain inside.	Quantitative	+/- 20 pages
Laptop Support Test: The Lapdesk is expected to fit a 14” laptop inside of the storage.	The laptop can fit inside of the Lapdesk.	Qualitative	Pass or Fail
Working on Laptop Test: A person should be able to work on their laptop on the Lapdesk without struggling.	The user will work on a laptop while it is on the Lapdesk.	Qualitative	As good as a normal desk, as good as a notebook, as good as your lap, writing on air.
Locking Mechanism Test: The lock mechanism should be able to fit a combo lock and other standard locks.	The width of the lock fitting into the hole of the Lapdesk to close the Lapdesk shut.	Qualitative	Pass or Fail
Portability Test: The Lapdesk fits in a backpack, or does not fit	The Lapdesk should fit into the laptop slot of multiple styles of backpack.	Quantitative	Pass or Fail
Scratch Test: The Lapdesk should be resistant to light scratches from metal.	Any indentation on the Lapdesk caused by sharp or blunt objects.	Quantitative	1-10, 1 being unmarked and 10 being deeply scratched.
Impact Test: The Lapdesk should be able to withstand any impact that will cause the individual parts to separate due to a weak glue.	An impact from any side of the Lapdesk affecting the glue in the Lapdesk.	Quantitative	Pass/Fail Max of 5 N of Force
Working on Angled Surface Test: The user of the Lapdesk should be able to work on the desk and any selected incline they want with ease.	The user will write on the Lapdesk at varities of angles of their selection.	Qualitative	Any angle can be used, most angles can be used, few angles can be used, none of the angles can be used.
Deformity Test: The Lapdesk should withstand side drops of 5 feet that can potentially separate the top and bottom part without deformities.	Any impact to the side of the Lapdesk affecting the ability of the hinge holding the parts together.	Quantitative	+/- 2ft
Drop Test: The Lapdesk is able to survive a 5 feet drop upright without breaking and becoming dysfunctional.	The Lapdesk will be dropped and checked for and dysfunctions.	Quantitative	+/- 2ft
Force on Lever Arm Test: The lever arm should be able to withstand a downward force of a person writing on the	A downward pressure will be applied to the end of the lever arm where the distance from the pivot point is the greatest.	Quantitative	+/- 20N

surface at different angles.			

We hope to confirm the viability of our design and look for areas for improvement using these tests. Our tests are designed to confirm the prototype will meet our Portability, Durability, Comfort, Size, Weight, Safety, Ease of Use: Seated, Ease of Setup, and Counter-Wobble Capabilities design specifications. We are doing our tests in order of least damaging to most damaging. Tests such as the aesthetic test, which do no harm to the prototype, are conducted first. The tests that will test the limits of our prototype are saved for last so we can get through all the tests before our prototype falls apart.

Test Procedure

Overview:

For all the testing procedures we will attempt to complete the tests we came up with in Testing Criteria in the order of least destructive to most destructive because we do not want our product to break on the first few tests. We have split the tests into qualitative and quantitative, most of our qualitative tests will be completed first due to the simplicity and the amount of destruction to the box is next to none. We will use the earth to our advantage by dropping the box from set heights to measure the force applied to the box since most of the tests that we will do are due to impact.

Incremental Testing Summary

Top Part

Test writing surface usability:
We tested the usability of the top part as a writing surface by writing notes on it. It worked well when it was on a flat table or other surface.

Test corner safety:
We tested the sharpness of the corners by running our hands over the corners and edges, seeing how sharp it felt on our palms.

Test overall durability:
We tested the flexibility and bendability of the part. It did not bend too much and was not very flexible. We chose not to do a drop test because we are not sure of the structural stability of this part by itself. We will test a drop test of the entire part.

Test locking mechanism:
We attempted to bend the locking mechanism with our hands of the lap desk to see if it would break. It did not break under the force of our hands, so it passed.

Test writing ledge utilization:
We put a piece of paper on the lapdesk and the paper did not fall off at angles between 0 and 75 degrees. This range includes most, if not all, angles that users would write at, so it works.

Bottom Part

Test durability of this Piece:
We did a scratch test: the piece is marked by sandpaper and by moderate to heavy scratches by an Exact-o knife. The piece is moderately durable.

Test locking mechanism:
We attempted to bend the locking mechanism with our hands of the lap desk to see if it would break. It did not break under the force of our hands, so it passed.

Button Hole

Check if the Button fits correctly:
We needed to ensure the button and button hole fit together as perfectly as possible. In our first build of this, we made the hole too small with a 5/64” drill bit. We tested this size and found the button did not fit through the button hole at this size. To fix this, we re-drilled with a larger drill bit. We found that a 9/64” drill bit worked best. We used every drill bit available to us in between these sizes, because we did not want the hole to be too big. We intentionally started with a small drill bit to not over-size the hole. This method worked well, and we were able to complete our incremental test. The button also fit snugly into the holding part of the button hole, so the piece worked well in both of these tests.

Button

Check if the Button fits in the Button Hole:
We did this test similarly in testing the button hole, and these pieces both passed.

Check if it fits through the smaller part of the Adjustment Clip:
The Button originally did not fit through the smaller parts of the adjustment clip, so we drilled and sanded this part again. This resulted in a working button, and we passed our test after one adjustment.

Adjustment Clip

Works correctly with Roller Pin:
We tested how they worked together. This helped us visualize how the parts worked together, and how they fit. We found the parts worked well together, and that they will fulfill our goals. We needed to do some minor adjustments and sanding to the Adjustment Clip to get it to work with the roller pin properly, but after sanding and drilling the holes larger the parts moved together seamlessly.

Test the Adjustment Clip with the Button:
We made sure the Button fit through the Adjustment Clip in the right places, and after the sanding and sizing of the previous tests, these parts worked well together on our first try.

Roller Pin

Test if the springs push in and if the Roller Pin fits the dimensions we need:
We went through this step multiple times to get the springs to go out the right amount, and to always fit with the Button and Adjustment Clip. We put the springs in twice because the first time they did not go in properly. We took the springs out, fixed our alignment, and proceeded to glue the springs in properly. The next hardest step with the strings as the end caps. The end caps needed to be drilled and fit in properly with the larger button inside the roller pin. The larger button needed to be sanded to fit through smoothly, and this improved our situation. Next, we sanded the end caps of the Roller Pin to allow it to fit inside the Top Part with greater ease. However, this resulted in the larger buttons extending too far outside of the Roller Pin. Finally, we cut down the larger buttons to the correct size and filled them partially with glue to allow the Button to rest smoothly and to be connected to the Roller Pin. The Roller Pin was the most time-intensive subsection and piece of our design.

Test if the Roller Pin moves in the larger part of the Adjustment Clip:
We wanted to make sure the larger button worked in the system with the Adjustment Clip as we needed it to. We ensured the larger button fit through the larger holes in the Adjustment Clip, but did not fit through the smaller holes. This worked well due to our previous sanding, drilling, and shaping of the Adjustment Clip and Button.

Test if the Roller Pin will stay up, in place with the pins pushed in:
We wanted to make sure the Roller Pin ran smoothly along the Adjustment Clip when the larger buttons were pushed in by the Buttons. We tested this after the Adjustment Clips were in the Top Part, and we made sure the Roller Pin fit between these, that the Button and Button Hole parts could fit between the outer edge of the Adjustment Clip and the inside wall of the Top Part, and that it would all run smoothly. Due to our sanding of the Roller Pin and cutting the larger buttons in the Roller Pin, this step almost worked well. Our main problem was that the roller Pin had too large a diameter to fit in the Top Part and align with the Roller Pin. To fix this we sanded the side of the end caps of the Roller Pin, so that it would all fit well. After we did this, the subsystem worked perfectly and we were ready for our final assembly steps.

Hinges/Screws

Test if screws loosen during damage, dropping, and shaking:
To test the screws, we closed the lapdesk and shook the lapdesk around. The screws did not fall out it, so it passed this test.

Test if the hinges move correctly:
We opened the lapdesk. We tested to see if the lapdesk could open to all angles of the Adjustment Clip. The design passes the test because it was able to open to all of these angles.

Testing Dates:

3/15/19

Testing Location:

Engineering Room 4039 at Jones College Preparatory

Purpose:

The purpose of our testing is to see if our prototype fits the design parameters we came up with. We need to make sure that we have accomplished at least some and hopefully all of our goals with the design. This will dictate the success or failure of the prototype.

Initial Condition:

The prototype is complete, the lock mechanism is installed, the adjustment mechanism is installed, and the prototype is intact. The lapdesk supports

Materials:

- Pen/ Pencil
- Exacto Knife
- Paper
- Laptop
- Phone
- 2 1kg weights
- People, testers
- Lock
- Jones Stairs

Pass or Fail Criteria:

If there are any signs of failure on a test, then it will be counted as a fail. If it doesn't have any signs of failure, then it will be counted as pass. We will know through careful observations whether it fails or passes. The Pass/Fail criteria for each test we will do are in the Procedures section of this document. Specifically, the Pass/Fail criteria is the final bullet point of each test. This bullet point is offset by one line from the procedural steps, to greater emphasize it as a result of the procedure and make the criteria easier to find.

Procedure:

Aesthetic Test:

The visual appearance of the Lapdesk should look nice enough to use anywhere without seeming out of place.

- Select 7 people to survey. Ask each person if they would feel comfortable using the prototype on the train.
- This test will be looking for qualitative data. The prototype looks appealing to the eyes and the consumer should not be ashamed to use it in public.
- The prototype will pass this if the majority would feel comfortable using it on the train. It fails this test if the majority does not feel comfortable using it on the train.

Comfort on Lap Test:

The force applied to the lap by the Lapdesk should feel comfortable and not irritating.

- Select 7 people to survey. Ask each person if they feel comfortable after placing the prototype on their lap. Ask each person to slight shift from side to side and reevaluate.
- This test will be looking for qualitative data, the comfort of the prototype when placed on the lap when you are moving and sitting still.
- The prototype will pass this if the majority would feel comfortable having the prototype placed on their lap and shifting. It fails this test if the majority does not feel comfortable having the prototype placed on their lap and shifting.

Writing Surface Test:

The ability for both left and right handed people to write on the Lapdesk with ease.

- Select a left handed and right handed person to write a sentence on the prototype. Ask the two people to write the same sentence on a desk. Compare the two sentences, one written on the prototype and one written on a desk.
- This test will be looking for qualitative data, the ability to write on a piece of paper without difficulty or any hindrance from the prototype.
- The prototype will pass this test if both testers can write the sentence on the prototype as well as when it is written on a desk. Otherwise the prototype fails the test.

Paper Amount Test:

The amount of paper the lapdesk is able to contain inside is 500 pages which is about 5 lbs.

- Take 500 sheets of printer paper and put it inside of the lapdesk and close it.
- This test will be looking for quantitative data, the amount of sheets of paper the lapdesk is able to contain inside.
- The prototype will pass this test if it can fit 500 sheets, plus or minus 20, within it. Otherwise it fails this test.

Laptop Support Test:

The Lapdesk is expected to fit a 14" laptop inside of the storage.

- Take a standard laptop of 14” and put it inside of the lapdesk, then close the lid to see if it fits and closes at the same time.
- This test will be looking for qualitative data, if the laptop can fit inside of the prototype.
- The prototype will pass this test if a laptop can fit inside. Otherwise it fails this test.

Working on Laptop Test:

Of our 7 human testors, over half should be able to work on their laptop on the Lapdesk without struggling.

- Take a laptop and place it on top of the lapdesk. Ask the user of the lapdesk to work on the laptop while it is on top of the lapdesk and collect their opinion.
- This test will be looking for qualitative data, the user will work on a laptop while it is on the prototype.
- The prototype will pass this test if the user can use the laptop without any trouble on the lapdesk. Otherwise it will fail this test.

Locking Mechanism Test:

The lock mechanism should be able to fit a combo lock and other standard locks.

- Take a combo lock and fit it into the lock mechanism.
- This test will be looking for qualitative data, if the lock fits into the hole of the Lapdesk and can successfully keep the Lapdesk shut.
- The prototype will pass this test if the lock fits and the lapdesk stays shut. Otherwise it fails this test.

Portability Test:

The Lapdesk fits in a backpack easily.

- Put the Lapdesk in an empty backpack and see if it can fit inside of the bag.
- This test will be looking for qualitative data, we will see if the Lapdesk fits in the backpack with an added binder(3” ring binder) in the backpack.
- This test will look for qualitative data, as we are finding if the Lapdesk can fit in a backpack or not.
- The prototype will pass this test if it can fit inside the backpack by itself. If the backpack can fit the Lapdesk and a binder, the Lapdesk will pass “with flying colors”. Otherwise it will fail the test.

Scratch Test:

The Lapdesk should be resistant to light scratches from metal.

- While wearing goggles, use an Exacto knife and run the tip of the knife into the bottom of the lapdesk to test for scratches. Rate how badly scratched the surface is on a scale of 1-10.
- This test will be looking for qualitative data, the test will return a result on a scale of 1-10, with 1 being unmarked and 10 being deeply scratched.
- This prototype will pass this test if it is rated under 5. Otherwise it will fail this test.

Impact Test:

The Lapdesk should be able to withstand any impact that will cause the individual parts to separate due to a weak glue.

- Set the Lapdesk on the floor on its side. Take a 5 lb object and drop it from 2 ft. above the Lapdesk on the side of the lapdesk.
- Set the Lapdesk on its’ top, on the Writing Surface. Drop a 5 lb. object from 2 ft. above the Lapdesk on the rear of the bottom, near the hinges.
- Set the lapdesk on its’ bottom and drop a 5 lb. object from 2 ft. above the Lapdesk onto the center and corners of writing surface(drop to different areas of the writing surface on different tests).
- Repeat each of these drops three times, videoing at least once of each drop.
- This test is looking for quantitative data, as we are finding if the Lapdesk breaks from impacts or if it survives.
- The Lapdesk will pass if it survives in working condition through all of the drops. Working condition means the Lapdesk works as well as or better than it did in its’ Initial Conditions. Else, the Lapdesk will fail this test.

Working on Angled Surface Test:

Over half of our 7 testers of the Lapdesk should be able to work on the desk at any selected incline they want with ease.

- Get pen and paper. Ask the user of the Lapdesk to write on the surface on an incline and get their opinion.
- This test will be looking for qualitative data, the user will write on the Lapdesk at varieties of angles of their selection.

- If the users feels comfortable writing on the prototype at most angle settings, the prototype will pass this test. Otherwise it will fail this test.

Deformity Test:

The Lapdesk should withstand side drops of 5 feet that can potentially separate the top and bottom part without deformities.

- Measure out 5 feet from the ground. Drop the box at 5 feet where the side of the box will be at 5 feet. Take a video of the box dropping so that we can better analyze the test, to see what failed if things go wrong. The video will also be a good visual showing the tests we completed for our project.
- This test will be looking for any impact to the side of the Lapdesk affecting the ability of the hinge holding the parts together. This will be quantitative data.

- The prototype will pass this test if it can drop from a height of 5 ft, plus or minus 2, remain glued together.

Drop Test:

The Lapdesk is able to survive a 4 feet drop upright without breaking and becoming dysfunctional. We will also do a test at 8 feet. The box should survive the 8 foot test with minimal to no damage, and still be technically usable.

- Measure out 4 feet up from the ground. Drop the box at 5 feet where the bottom of the box will be at 4 feet. Take a video of the box dropping, to see what failed if things go wrong. The video will also be a good visual showing the tests we completed for our project.
- This test will be looking for quantitative data, the Lapdesk will be dropped and checked for dysfunctions.
- Repeat the previous steps for the 8 foot test.

- The prototype will pass this test if it can drop from a height of 4 ft, plus or minus 2, and remain functional.

Force on Lever Arm Test:

The lever arm should be able to withstand a downward force of a person writing on the surface at different angles.

- Take the prototype and set the adjustment clip at its lowest level and apply a 20N force on the top part, with the . We are applying this force through putting a 2kg weight on the top of the lap desk, starting closest to the hinges and moving it parallel to the length of the Lapdesk. We will do a total of 7 tests at every 2 inches, beginning touching the Writing Ledge.
- This test will be looking for quantitative data, a downward pressure will be applied to the end of the lever arm where the distance from the pivot point is the greatest.

The prototype will pass this test if it can withstand a force of 20N, plus or minus 5. Otherwise it will fail this test.

Safety Considerations:

- We must be careful of any projectiles coming from the Lapdesk when dropped or struck.
- In order to avoid any danger, stand at least 5 feet away and wear long sleeve shirts and long pants that covers any exposed skin.
- Stay alert when using the lap desk, do not do anything you think is unsafe with the lapdesk.
- We will wear goggles to avoid any contact or irritations with the eyes.

Data:

- The data will be qualitative and quantitative. The quantitative data will be measured in feet, inches sheets of paper, and Newtons depending on the test. The qualitative data will be taken as direct quotes and summaries of the opinions of our reviewers when they are asked a question relating to the test.

Data Tables:

We will be taking survey data from our human testers for the qualitative data. For this, we will use 2 tables, one for qualitative data and one for quantitative data.

Qualitative:

Test Name	Tester 1:	Tester 2:	Tester 3:	Tester 4:	Tester 5:	Tester 6:	Tester 7:	Pass / Fail
Aesthetic Test								
Comfort on Lap Test								
Writing Surface Test		`						
Laptop Support Test								
Working on Laptop Test								
Locking Mechanism Test								
Portability Test								
Scratch Test								
Working on Angled Writing Surface Test								

Quantitative:

Test Name	Trial 1:	Trial 2:	Trial 3:	Pass/Fail
Paper Amount Test (Sheets of Paper)		X	X	
Impact Test (side dropped on)				
Deformity Test (inches)				
Drop Test (ft)				
Force on Lever Arm Test (N)				

Expert Feedback:

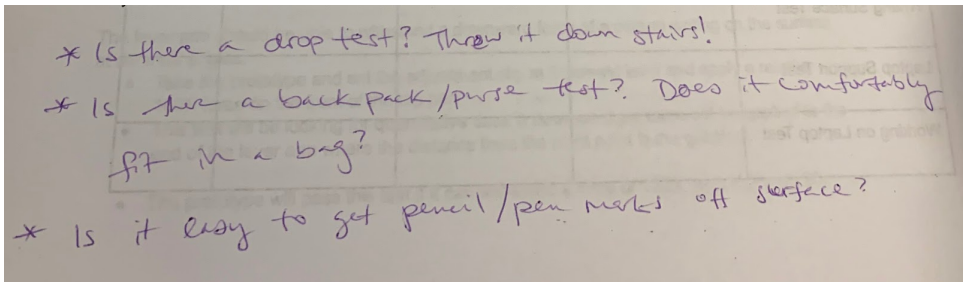
We received expert feedback on our tests from Ms. Cathcara and Mr. Clayton. They are both Physics teachers at Jones College Prep, and have reviewed our project before.

Comments from Ms. Cathcara:

“Is there a drop test? Throw it down stairs!”

“Is there a backpack/purse test? Does it comfortably fit in a bag?”

“Is it easy to get pencil/pen marks off surface?”



Edits based on Ms. Cathcara's comments:

In response to these comments, we have the Portability Test and the Drop Test. based on Ms. Cathcara's comments, we modified the Drop Test to have trials at 4 feet instead of 5 feet and we added an 8 foot trial as well. This added detail will give us more descriptive results for the durability of our product, and improve our testing procedures.

Comments from Mr. Clayton:

On the Incremental Testing Summary of the Top Part:
"How did you test this?" "What force?" "Can you add degrees? 0°-45°?"

On the Aesthetic Testing Summary:
"Only 3 people?"

On Working on Laptop Test:
"How many people?"

On Working on Surface Test:
"How many people?"

On Deformity and Drop Test:
"Why take a video?"

On Force on Lever Arm Test:
"How are you applying the 20N?"

Edits based on Mr. Clayton's comments:

In response to his comments on the Incremental Testing Summary, we re-tested the top surface by writing more notes on it, and explaining how we did this. We tested this with the force of our hands and at angles between 0°-75°. For the Aesthetic Testing, we changed the number of human testers and analyzers to 7 people instead of 3. This will get us a greater survey data, and make our data more reliable. Next were the Working on Laptop Test and Working on Surface Tests. Here, we clarified that there would be 7 testers and if the majority agrees that the prototype is comfortable to use, it will pass these two tests.

In response to the comments on the Deformity and Drop Tests, we explained that we were taking a video for proof of testing, for if the Lapdesk breaks. We want to show how thoroughly we tested our device and to have something eye-catching in our final presentations.

Finally for the Force on Lever Arm Test, we reviewed the entire test. We decided to complete multiple trials of this test so that we are testing the 20N force every few inches, making the test more detailed and informative about the strength of our product.

Instructor Comments and Signature:

Mr. Hashimoto has reviewed this document as of 3/15/19, and found our testing to be appropriate and extremely thorough.

Conclusion:

Our plans for taking data about our Prototype are very thorough and will report solid and accurate data. Our Testing Criteria helped us hone our product tests to show us if we have fulfilled our Design Specifications. Our Incremental Testing will make sure our prototype develops in the way we want it to, and that each subsystem works properly. When it is time to test our completed prototype, the Test Procedure will allow us to take data easily and with assurance that we are recording the right information. The expert comments we received allowed us to add depth to our Test Procedure that fully completes the plan. Through our varying preparations and plans for taking data on our prototype, we have developed the materials we need to successfully take important and worthwhile data about our design.

PORTFOLIO ELEMENT I

TESTING, DATA COLLECTION AND ANALYSIS

Testing, Data Collection and Analysis

Kelvin Lao, Alex Sung, and Michael Youngblood

Introduction:

For this stage of our project, we completed the tests that we came up with in Element H. These tests allowed us to find the limits of our design, and gave us insight as to whether or not our design met the desired specifications we outlined in Element C. We started by taking data from actual people, and this was our Qualitative Data. Next, we took Quantitative Data, which included more rigorous tests to discover the durability and physical limits of our prototype.

Testing Data Tables

Qualitative:

Test Name	Tester 1: Liam	Tester 2: Johnathan	Tester 3: Sheryl	Tester 4: Adrian	Tester 5: Giggles (Adam)	Tester 6: Juan	Tester 7: Abby	Pass / Fail
Aesthetic Test	Looks like a modified briefcase	Would feel awkward to use on train	Would use on the train	Looks Good	Looks fine, kind of bulky	Looks nice, likes the dark colors	Looks fine, would use on the train	Pass
Comfort on Lap Test	comfortable	comfortable	Somewhat comfortable	comfortable	Somewhat comfortable	comfortable	Great	Pass
Writing Surface Test	Same as desk	Felt good	Good	Feels good better than than legs	Better than lap and folder	Better than a table, feels nice	Like a table	Pass
Laptop Support Test	Doesn't fit	Failed	Apple laptop fits	No	No	No	No	Fail
Working on Laptop Test	Feels better than putting on legs	Feels supportive	Very stable, quite slippery	Rather have laptop on lap	Feels clunky,rather have laptop on the lap	Feels nice	Moderately supportive	Pass
Locking Mechanism Test	Takes a little effort	Hard to put in, secure	Somewhat difficult	Gets the job done	Pretty secure	Somewhat secure	Not that safe	Pass
Portability Test	Fits inside backpack	Felt very good	Fit inside backpack, fit notebook	Will fit in backpack	Will fit in backpack	Will fit in backpack	Good it fits in the backpack	Pass
Scratch Test	6	6	4	4	2	3	3	Pass
Working on Angled Writing Surface Test	Pretty good for bottom	A little unstable, not that noticeable	Could be more sturdy	Less supportive, but the angle feels great, slightly wobbly.	Needs some work	Quite unstable,	A bit wobbly	Fail

Quantitative:

Test Name	Trial 1:	Trial 2:	Trial 3:	Pass/Fail
Paper Amount Test (Sheets of Paper)	(Printer Paper) 250 sheets	Lined Graph Paper: 400 sheets	X	Pass
Impact Test (side dropped on)	Bottom: Broke Corner: X Center: X	Bottom: Broke Corner: X Center: X	X	Fail
Deformity Test (inches)	Back: Detached Bottom: Partially Detached (bottom from back edge)	X	X	Fail

Drop Test (ft)	No added Damage	X	X	Pass
Force on Lever Arm Test (N)	X	X	X	Fail

Test Result Analysis:

Aesthetic Test:
Our design passed the Aesthetic Test. This means that users feel comfortable with the simple design of our Lap Desk. They would feel comfortable using this on Public Transportation, and the Aesthetic does not limit sales of the design. The visual appearance is not a high priority for our design, we are going for function not beauty, so a good but not perfect result of the test means it passes.

Comfort on Lap Test:
The lapdesk passed the comfort on lap test. Some of our testers mentioned that the design slid off their laps, and they would like more grip on the bottom. This is due to our use of PVC in all parts of the design: it is a smooth and durable writing surface but it does not have a lot of grip. Overall, the results of this test were positive, and our design passed.

Writing Surface Test:
In the "down" position, our testers found our Lapdesk to be a good writing surface. The lapdesk worked similarly to a table, and was much better than writing on a leg or folder. The testers views of the lapdesk as similar to a table mean that the design passed this test.

Paper Amount Test:
The lapdesk held around 250 sheets of printer paper, and 400 sheets of lined graph paper in notebooks. These two numbers are around or above our goal number of 300 sheets of paper, and is a reasonable number of sheets of paper a user may want to hold in the Lapdesk. As the paper that fit in the lapdesk was at our goal amount, the Lapdesk passed this test.

Laptop Support Test:
The lapdesk failed the Laptop support test, it was only able to fit Apple Mac laptops inside it and failed to fit any bulker laptop the testers had. When originally designing the prototype we did not account for the space the adjustment clips would take inside the box which is what caused for the lapdesk's interior room to be reduced and cause most laptops to not fit.

Working on Laptop Test:
When working on a laptop on the Lapdesk,most of testers found the lapdesk to be as good as just a laptop on their legs. One tester even said it was better than just their legs. However, there was also a strong contingent of people who said they preferred a laptop just on their legs. Their reasoning for this varied, from the grip of the lapdesk on their legs causing instability to the Lapdesk adding too much space under the laptop. However, these people were in a minority from our testing group, so the design passed this test.

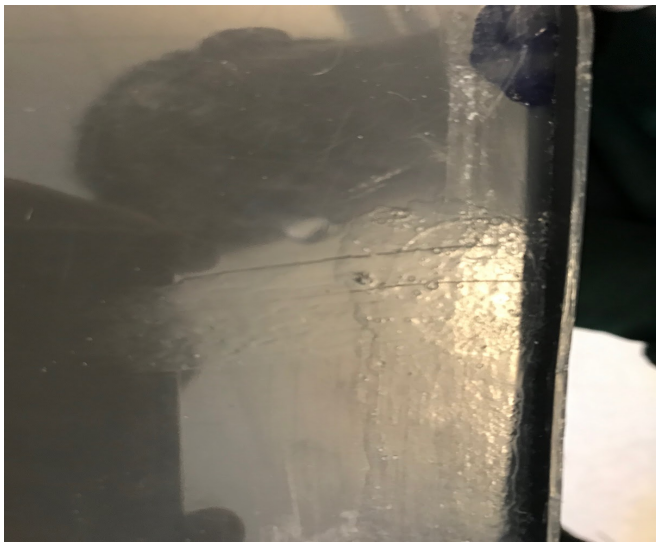
Locking Mechanism Test:
Most testers agreed that the locking mechanism was relatively safe but it took a little effort to put the lock on. The criteria was the majority of testers agreed that the locking mechanism worked and was safe. As the majority of testers did feel this way, the lapdesk passed this test.

Portability Test:
Of our testers, 7/7 said the design would fit in their backpack. This means the design is very portable and fulfills this design specification. The design passes the Portability Test with ease, and fulfills this key design specification.

Scratch Test:
For the scratch test, testers attempted to mark the lapdesk with an Exacto knife, keys, pens, and pencils. Of these, the Exacto knife was the only tool to make lasting marks on the design. All other marks were nonexistent or could be brushed off, showing they were only surface marks. The average "scratchability" rating of our design was a 4/10, meaning the design was not very scratchable and passed this test.

Impact Test:
We attempted the Impact Test 2 times and the design broke both times. The impact test caused many parts of the box to detach and crack. These included:

- Top part-crack near the back end

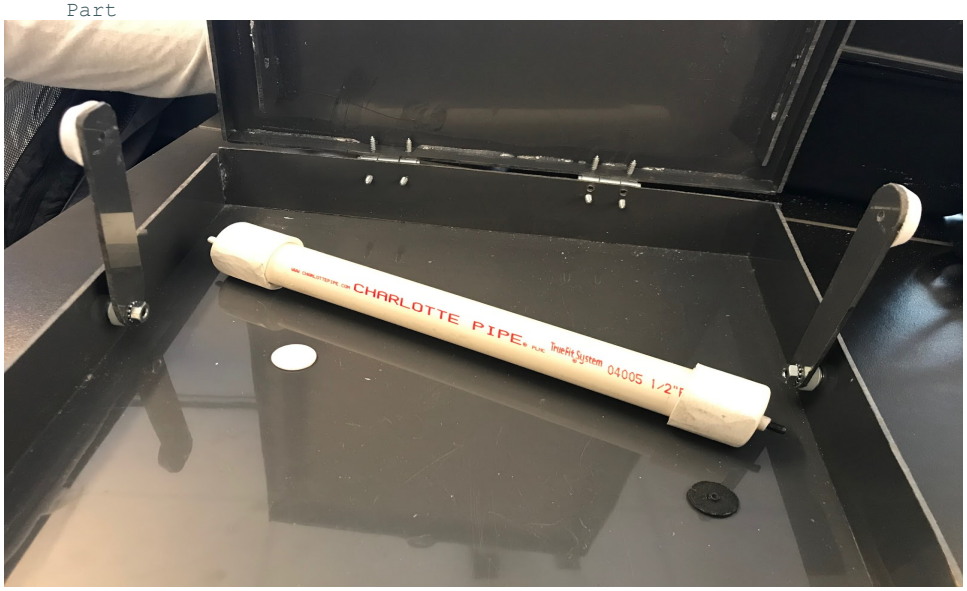


- Left hinge broke- the plastic snapped off with the hinge and screws

- Left adjustment clip- the clip detached from the top part
- The left side of the bottom part- Half of the side detached

- The bottom lock mechanism- detached on the right side
- The back edge of the Bottom Part detached from the rest of the Bottom Part

- The buttons snapped at a weak point, and the Roller Pin came out of the Adjustment Clips and Top Part



This damage means that the lapdesk could not withstand the damage required to pass the Impact Test, and it fails this test. However, the failure of this test does not mean the design is not durable or that the test is a complete failure. The test provided valuable data as to what impacts the box might be able to endure, and the limits of the box. This test is repeatable, as the desk is likely to break in a similar or the same place on future impacts. The point of failure of the design was the glue. For future fixes or designs, we will use a stronger glue. Furthermore, the likelihood of a user dropping 2 lbs from 4 ft onto the Lap Desk is low probability, and the lapdesk withstood the drop test with no added damage, meaning that the Lap Desk is fairly durable. The main flaw was not the design or the design specifications, but the toughness of the test procedure.

Working on Angled Surface Test:

Six of our seven testers agreed that the angled surface was very wobbly and not stable near the top end. Because of this, the working on angled surface test has failed. The unstableness came from the adjustment clips being able to flex and move side to side. We now know that we have to find a way to tighten the clips and also fix the roller pin which had the tendency of falling out. This test is not a flaw of testing procedure or of design specification, but of design. Sadly, our idea for the angled writing has too many moving parts and requires a level of precision difficult to achieve without a full workshop. This is a material failure and a construction failure, as the plastics we used were not as strong as we hope while the complexity of the Angled Writing Mechanism was above our level of expertise. We learned that to make a better prototype, simpler is better, and that we need to keep plausibility in mind, not just the ideal setup of our design.

Deformity Test:

The deformity test failed because the key glue points that hold the top part and bottom part together in the back detached. The box was not in a the condition of being used because of the damage. The way that the box detached showed us that for the major key points need to be glued on tighter than the others. From this test, along with the impact test, we learned we need to use more durable and stronger materials. While this means we could use a stronger plastic, most of the damage inflicted occured at the glued points. This means we have a construction failure of design, and need to use a stronger glue for future designs or repairs. While the prototype failed this test, it provided us with invaluable knowledge about the weakness of our design: glue.

Drop Test:

The prototype passed the drop test because it did not cause any extra damage to the box. All it did was show that the previous damage done by the impact test on the side of the box was extreme. It highlighted that the side of the box should be glued better.

Force on Lever Arm Test:

This test has failed because we were not able to complete this test due to previous tests that has dismantled our lever arm. The lever arm broke during the impact test. Although we were not able to complete this test, this tells us that the damage caused shows that our prototype would not pass this test even if it were to be completed.

Data Analysis:

The prototype passed the majority of the qualitative tests, only failing the Laptop Support Test and the Working on Angled Surface Test. The prototype passed the Aesthetic Test, Comfort on Lap Test, Writing Surface Test, Working on Laptop Test, Locking Mechanism Test, Portability Test, Scratch Test, Paper Amount Test, and Drop Test. The prototype mainly passed all the user comfort tests and a few design tests. The tests the prototype failed were the Laptop Support Test, Working on Angled Writing Surface Test, Impact Test, Deformity Test, Force on Lever Arm Test. These tests tested the limits of the durability of the lapdesk. From the failure of these tests we can deduce that our lapdesk is not durable and sturdy enough yet. This is most likely a result of bad design and bad construction of the prototype. For example, the hinges were evenly installed which caused there to be higher levels of tension than normal near the hinges. During the impact test, the area where the hinges were uneven was the area that broke. Reviewing our design, improving on the design, and constructing the prototype with more attention to detail will help us improve on the prototype. Overall, the design passed the testing we put it through.

Conclusion:

Based on our test results, our prototype passes a majority of the tests we developed. The design passed our visual design tests, the portability tests,and usability when flat, and storing paper. Our lapdesk did not do well in the durability tests, storing a laptop test, or working at an angle tests. It appears that our system of supporting the writing surface at an angle limits the capabilities of our design in all of these other tests. However, these tests are not as important as the portability or general writing surface tests, and we can say our design passed our rigorous testing requirements. All of these tests show that our prototype is a good first design for solving our Problem Statement and completing our Design Specifications.

PORTFOLIO ELEMENT J

DOCUMENTATION OF EXTERNAL EVALUATION

Expert Evaluation of Testing Results

Kelvin Lao, Alex Sung, Michael Youngblood

Introduction:

For our expert review of our testing and data analysis, we turned to all of our stakeholders and experts to review and analyze our conclusions. We reached out to Professor Wayne, a UIC Professor of Business focusing in Managerial Studies, to analyze the effectiveness of our testing and compare it to her views of our project from earlier in the year. We also reached out to Mr. Clayton and Ms. Cathcara, two Physics teachers at Jones College Prep. These teachers have reviewed almost every step of our design process, build process, and testing procedure development. They will analyze the results of our testing

Expert Analysis:

Comments by Professor Wayne:

- Professor Wayne was confused on how it opened in the beginning. Once we explained how it opened through verbal explanations, pictures of our design, and our technical drawings. We should make it more clear where the lapdesk opens through added drawings or even a video of the lapdesk opening.
- We were also advised that human evaluations would be more important than the quantitative tests we did such as the Impact test. This reiterates our belief that the design passes our overall testing procedure, as the lapdesk passed a vast majority of the tester evaluations.
- We were advised that one of the most important things we should work on was laptop support, as we have to focus on catering to laptops more. We need to support more types of laptops and make it easier to work with a laptop by adding some support functions like an edge on one side to keep it in place.
- Overall, she felt the design was substantially improved from the initial design. We were told the idea of an adjustable writing angle was a novel concept for our lapdesk. It was a good idea to focus on the sitting aspect instead of dividing our attention to using the lapdesk while sitting or standing like we had originally planned to.
- Prof. Wayne described our tests as “Very comprehensive tests”. She liked how we did a lot of different tests, and believes that the tests prove the design fits multiple of our design specifications.
- Prof. Wayne also recommended some future tests for us to do if we continue testing oru design. These include:
  - What price people would be willing to pay for the design now that they have seen it.
  - If they would not purchase, why they would not purchase the design. (and use this information to help improve the design, and get a larger user base)
  - Talk about tests she recommended we do if we were to continue testing.
  - What the user believed the most important feature of the lapdesk is.

Professor Wayne liked our design, our testing procedures, and was happy with the results of our tests.

Comments by Ms. Cathcara:

Ms. Cathcara’s comments included:

- “Is there a handle so it can be carried like a briefcase?” on the results of our Aesthetic Test
- “Address the issue of the the lapdesk surface being slippery.” on the Working on Laptop test.

At the end of the Data Analysis, Ms. Cathcara offered these general comments:

- “What ideas for improvements?”
- “Are there other materials more suited for this gadget?”
- “Can you add floral decals as a stylistic option?”
- “Great experimenting and data collection.”

In response to Ms. Cathcara’s comment about the handle, we discussed adding a handle to future designs. Currently, there is no handle on the side of the box to be carried as a briefcase. Our group have taken in consideration on putting a handle on the side for simple and easy carrying.

The lapdesk sometimes slips down the lap when placed on the legs. This problem was brought up by multiple testers, and is something we need to address in our next design. In order to fix this problem we need to increase friction between the leg and the lapdesk. We will try to attach rubber on the bottom of the box to help support this issue.

Some ideas for improvement we have are designing a more easily installed mechanism to help angle the lapdesk. During our testing we found out that the adjustment mechanism was poorly designed and broke very easily. An idea for improvement would be to create a new adjustment design and to include grips for the bottom of the box.

If the user wishes to do so, they can easily install vinyl decals to the pvc surface. These decals can be in any style the user wishes.

We are appreciative of Ms. Cathcara's notice of our level of detail in our design. We tried to take extensive data and create truthful, detailed analysis of this data and what it means in terms of our Design Specifications and the degree to which our prototype passes these goals.

Comments by Mr. Clayton:

Mr. Clayton commented that "On 'Test Analysis' Portion I would include quantitative stats. Instead of saying "most" say 5/7 or 68%."

In response to this comment, we edited our Testing Analysis to include more detailed explanations of exactly how many of our testers approved or liked each feature. This was a productive comment by Mr. Clayton, because it improved the specificity of our analysis.

Conclusion:

The reviews of our test results and analysis supported the conclusions we came to about our design. They helped us add detail and edit our Testing Analysis. These comments were confirmation that our analysis of the data is correct and that our conclusions are justified by the data. The comments provided by our experts are valuable because they improve our writing and how professional we sound, and they are important to our design process.

PORTFOLIO ELEMENT K

REFLECTION ON THE DESIGN PROJECT

Reflection on the Design Project

Kelvin Lao, Alex Sung, and Michael Youngblood

Introduction:

Overall, we enjoyed this project. The organization and resources availiable made it easy to work quickly on the project. But while all steps were helpful to some degree, some stood out as key to the success of our project.

Major Steps:

Business Plan

Prior Solution Attempts

Solution Design Requirements

Concept Generation and Selection

Stem Concepts and Design Viability

Construction of a Prototype

Test Criteria, Test Procedure, and Test Data Analysis

Lessons Learned

Business Plan

This element was important for showing us the type of work we would have to do for this project. We researched markets to discover if our problem was actually something that affected other people outside of our group. This element was important, but I think more guidance early in the project would be helpful. We struggled to find quality sources with research about our topic. I believe that if we had sit-down meetings with our teacher in this stage, we could have found research that was more focused on our topic. It was also difficult to find experts that were willing to work with us as high schoolers. This element helped us develop our thinking for the project as a whole and plan what we would do for the next few months on the project.

Prior Solution Attempts

In this element, we looked through for patents and products that are related to our problem. Although none of these products and patents could solve our problem they all had aspects we could pull from for our design. This element was helpful in helping us start to gather ideas for design. While looking through for patents and prior products we were able to pull ideas from many different places. Some of these ideas, such as rounding the corners for safety, stuck with our design until the end. The biggest struggle in this element was figuring out how to look for prior solutions. We weren’t able to find different varieties of solutions and ended up focusing all our research on one are which influenced our final solution.

Solution Design Requirements

This element was very important for our project as a whole. This is when we decided what was going to be important to our design and calling our prototype a success. We were very detailed through this step, and we believe it led to greater success in the later stages of our project. We do not think this step needs improvement, as it is very self explanatory and the goals of Element C are easy to understand.

Concept Generation and Selection

This step in our process was very fun, and created lively debate in our team about which direction to continue with our design. We developed 6 different concepts, and through 2 decision matrices we chose one design to create. These decision matrices were very helpful for quantifying our thoughts on each design. This step was well designed, as the main work we did was developing concepts and not trying to understand the requirements. We received adequate support and assistance from our teachers and expert team to help us choose the right concept that we could complete and would best fit our design specifications.

STEM Concepts and Design Viability

This part of the project was confusing. The explanations on Innovation Portal were moderately confusing, and we had to ask for lots of clarification. Once we understood the required activities for this element, it was not extremely difficult. Approval of the design by our experts gave us greater confidence in our ideas, and motivated us to work harder and faster. The other part of this element, involving STEM concepts in our design, was not as helpful or important in our design process. While we were able to get helpful data, some of it felt forced. By this, we mean that the data was obvious or not helpful to our design process, and we found it to fill a quota of the amount of calculations we had to do. We believe this is due to a lack of understanding of where to go with this element. If we had a longer conversation with our experts or teachers, we may have understood which calculations would be more helpful. This element needs more clarity or explanation for it to be valuable and truly impactful in our design process.

Construction of a Prototype

This element was extremely important in showing us how the idea needs to be made and improved on. Our design contained a top part, bottom part, adjustment clip, button, button hole, and roller pin. When cutting the pieces out, the cuts were not that straight because we were using a hand saw. If there was a way to cut straighter the building process will definitely be more simple. When building we ran into a problem with time, every part took longer than expected. We feel like we could have planned this better in order to achieve quality and productivity. The button kept snapping into two pieces. We should have made out of metal or stronger materials so that it doesn't break when using it. The glue that was used to bond the parts together also was not that strong as some pieces tend to fail off or wobble slightly. Stronger glue or a better cohesion process would be advised when building the Lapdesk.

Test Criteria, Test Procedure, and Test Data Analysis

This element was very important in showing us which parts failed and the weak point in the Lapdesk. The first few test are the qualitative test. Each qualitative test demonstrated the probability our product would be used by people.

Aesthetic Test: This test was important and helpful for ensuring our design is marketable and is at least moderately appealing. This test is not the most important one we did, but it is valuable information nonetheless.

Comfort on Lap Test: This test helped us determine whether or not the user felt comfortable using it. For the most part many people said it was comfortable, but the lapdesk does slip when on the lap. Therefore in order to improve upon the comfort we decided that we should rubber grips to the bottom.

Writing Surface Test: The Writing Surface test is one of the most important tests we did for our prototype. This test fits the Ease of Use tests, which is our main selling point. That our design passed this test means it works as a writing surface, which is the simplest goal.

Laptop Support Test: This test is another very important test, as the Lapdesk should support papers and laptops. This test is basic, as it is testing a basic idea, so it does not need added depth or detail.

Working on Laptop Test: This test was important for seeing if users liked to use the design with a laptop. The Lapdesk passed this, but not as handily as we would have liked. This information is valuable, and provides insights to how we can redesign our prototype to improve user experience. For this reason, the test should not be changed.

Locking Mechanism Test: This test was adequate in seeing if the specific locking mechanism worked, and the only flaws were in our design. The test showed us that the locking mechanism was not perfect, and needed improvement. The goal of this test was basic, as the design was straightforward, so it did not need a complicated test.

Portability Test: This test was another very simple but important test. The lapdesk had to be portable so it could be carried around. Portability was one of our design requirements and this test helped us confirm that our product was met this requirement.

Scratch Test: This test help us see the quality of the material we were using. The lapdesk was not prone to regular scratches by objects such as a key, but is prone to scratches caused by extremely sharp object. This showed us that this material is pretty solid because of the ability to not scratch as easy.

Working on Angled Writing Surface Test: This test was difficult to complete as the holding mechanism is moderately finicky and requires time to work it properly. This test showed us the instability of writing on papers at the top of the Lapdesk, and this was what the test was designed to do. For this reason, the test does not need improvement.

Paper Amount Test: This test was a very basic test that simply tested how many papers could fit into the lapdesk. There should have been ample space for the user to store any papers they might need.

Impact Test: This test was one of the most important tests. In this test we dropped a bottle full of water onto the lapdesk from a height of two feet. This test was intended to test the durability of the product. In hindsight, we may have overestimated the durability capabilities of the product and underestimated the weight of the bottle and the impact it would have from a drop of 2 ft. This led to a failure which tells us our product was not durable enough. In the future, if we were to ever improve on this prototype this test would be viewed with great scrutiny in order to improve the flaws that were apparent in this test.

Deformity Test: This test provided us with invaluable knowledge about the weakness of our design: glue. Most of the damage inflicted occured at the glued points on the lapdesk. This means we have a construction failure and need to use a stronger glue for future designs or repairs.

Drop Test: This test did not do much damage to our box. The 3ft drop only showed us the amount of flexibility the box actually has. We believe that the material showed great results, but we could possibly have used better glue because some parts did start to fall apart due to the deformity test.

Force on Lever Arm Test: This test wasn't able to be completed because the parts broke apart in the previous tests. The lever arm broke during the impact test. Although we were not able to complete this test, since the lever arm broke so easily, the product would have probably failed this test if it was conducted. This test is another test that must be looked closely at for future improvements.

The comments from our stockholders and experts also helped us see our shortcomings in the tests and further improve on them. Their comments were also very helpful in thinking about our next steps and where we could improve the prototype in the future.

Conclusion:

Through the process, we were able to successfully plan and complete our project. The planning stages of Design Specifications, and the Build Plan were key ot developing a good prototype and succeeding in this work.

PORTFOLIO ELEMENT L

PRESENTATION OF DESIGNER'S RECOMMENDATIONS

Recommendations for Future Designs:

By Kelvin Lao, Alex Sung, and Michael Youngblood

Introduction:

When we were working on our project, there were things that went wrong. This happens with every project, and we looked at them as learning experiences to take with us in life and as lessons for others who might want to do our project. These recommendations are the lessons we have learned.

Recommendations:

If we were to redesign our prototype there are multiple different paths we would take. The following list is our ideas for other ways to develop a portable desk suited for public transportation or people working without a writing surface available.

- We recommend using a small stand for the adjustment mechanism that can go at varying heights. This would probably be more reliable and stable than the method we used.
- Make a lapdesk that is very thin and does not hold items inside. This portable desk would be easier to make, more portable, and possibly sturdier than our existing design.
- Create a design that is similar to "Slap Bracelets," that can roll up tightly for simple transportation but also extend and hold papers or whatever is desired.
- Make a folder aspect so the design opens like a folder, but is sturdy and can be a writing surface. Use a strong cloth like material for the seams, and the walls of the folder are a sturdy plastic or light aluminum.
- Add a handle or make the design more portable on its own.

If we were to improve the project planning, timing, our ideas for the design, here are our recommendations:

- We should allocate more time to building the prototype. We originally thought we would be able to finish in 2 days which was not nearly enough time. Next time we would not overestimate our abilities and give a more realistic time period to finish the work.
- With more time allocated to building we would be able to polish it up more. Because of the rush, we ended up not aligning the hinges right which caused more stress in the material than necessary.
- It would have been better to have more adjustment mechanisms to choose from. The one we choose to do is slightly too difficult to use.
- We would redesign the buttons that were 3D printed. The buttons we used broke off really easily. We went through 4 buttons and even the final buttons we used ended up breaking.
- Different materials should have been used that is strong enough to take impact from outside forces.
- Everytime we touched the box to many times the glue would undo itself. The amount of glue we applied needed to be greater and stronger.
- We should have used better tools in order to achieve more precise cuts and screws.
- We could have used better alternatives, such as more hinges and screws, to glue to help hold the lapdesk together.

Conclusion:

We learned a lot from this project. Our recommendations are for different approaches to our specific project, and how to do any project better. Some of our best ideas include changing the adjustment mechamism, better time management, and using stronger materials in general.