Project Deliverable Report

GNG2101

GROUP NAME & A4.5

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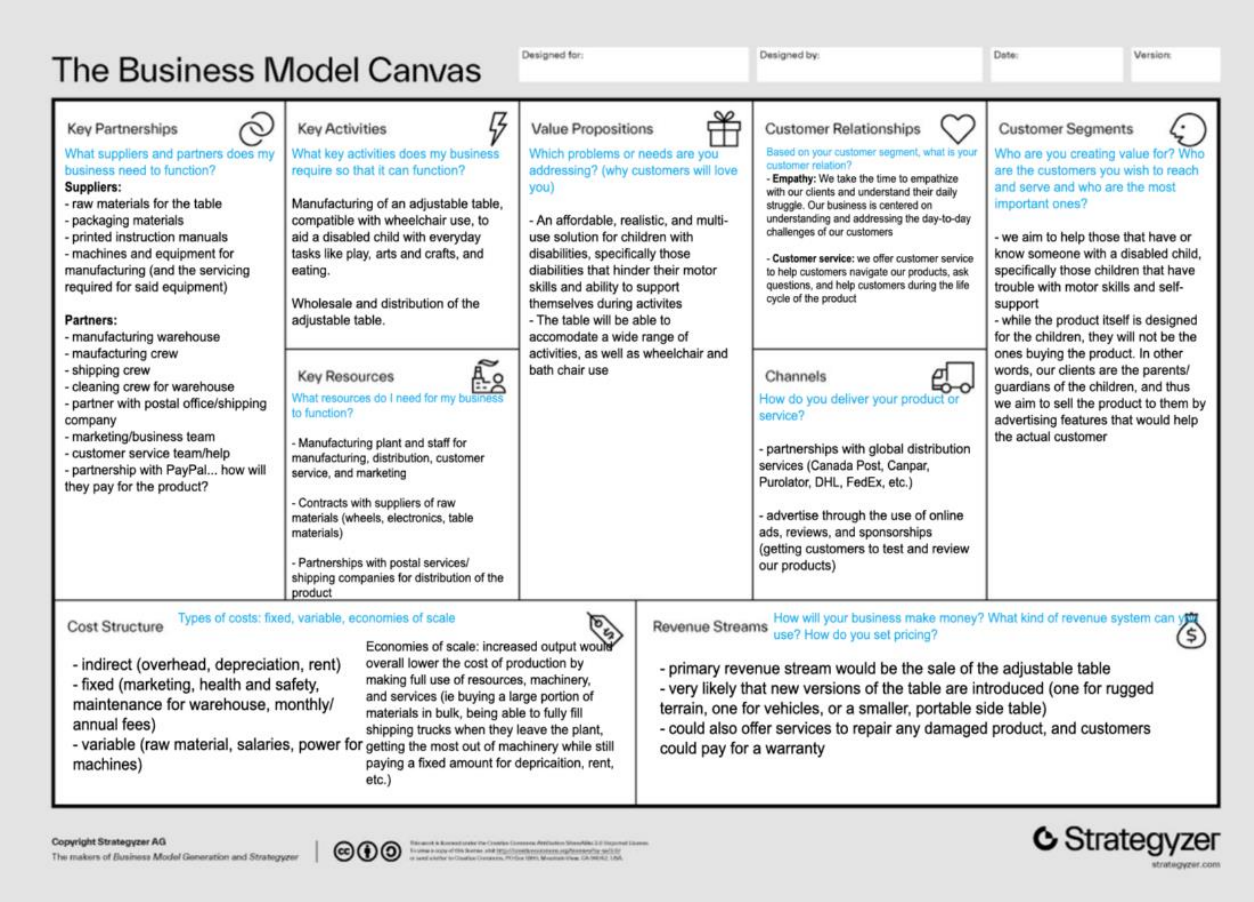
2 Business Model Canvas and DFX

This section explores the business aspect of our product. Here, we outline a business model proposition, as well as a business model canvas, and outline the social and economic implications of our potential business model. Our value proposition is based on our key product, which is an adjustable and multi-use table for children with mobility challenges. The factors that drive our business model are inclusivity, adaptability, and safety, with special attention to keeping costs low. Finally, we identify the five most important factors in designing for our intended audience, the factors being: adjustability, safety and durability, portability, versatility, and ease-of-use.

2.1 Business model and sustainability report

1.
    a. Value Proposition: Our adjustable table, designed for children with mobility challenges, offers a safe, sturdy, and easily adjustable platform that grows with your child. The table is stable enough to be played on without worry of it being tipped over as it can support over 100lbs and is designed with stability in mind. It is built to last, empowering children to play, learn, and engage with confidence.
    b. Reasons:
        i. Inclusivity: It meets the unique needs of children using wheelchairs or bath chairs, providing a convenient and comfortable surface for various activities. We're filling a vital gap in the market, promoting social good.
        ii. Adaptability: It can be easily customized from 1ft to 4ft, accommodating a child's changing needs as they grow. This adaptability ensures long-term use, making it a cost-effective choice for parents and caregivers.
        iii. Safety/Durability: Its sturdiness and weight capacity are crucial. Parents can trust it to keep their child safe during playtime and daily activities for years.

2.1.2 Business Model Canvas



The Business Model Canvas

Designed for: | Designed by: | Date: | Version:

Key Partnerships

What suppliers and partners does my business need to function?

Suppliers:
- raw materials for the table
- packaging materials
- printed instruction manuals
- machines and equipment for manufacturing (and the servicing required for said equipment)

Partners:
- manufacturing warehouse
- maufacturing crew
- shipping crew
- cleaning crew for warehouse
- partner with postal office/shipping company
- marketing/business team
- customer service team/help
- partnership with PayPal... how will they pay for the product?

Key Activities

What key activities does my business require so that it can function?

Manufacturing of an adjustable table, compatible with wheelchair use, to aid a disabled child with everyday tasks like play, arts and crafts, and eating.

Wholesale and distribution of the adjustable table.

Key Resources

What resources do I need for my business to function?

- Manufacturing plant and staff for manufacturing, distribution, customer service, and marketing

- Contracts with suppliers of raw materials (wheels, electronics, table materials)

- Partnerships with postal services/ shipping companies for distribution of the product

Value Propositions

Which problems or needs are you addressing? (why customers will love you)

- An affordable, realistic, and multi-use solution for children with disabilities, specifically those diabilities that hinder their motor skills and ability to support themselves during activites
- The table will be able to accomodate a wide range of activities, as well as wheelchair and bath chair use

Customer Relationships

Based on your customer segment, what is your customer relation?

- **Empathy:** We take the time to empathize with our clients and understand their daily struggle. Our business is centered on understanding and addressing the day-to-day challenges of our customers

- **Customer service:** we offer customer service to help customers navigate our products, ask questions, and help customers during the life cycle of the product

Channels

How do you deliver your product or service?

- partnerships with global distribution services (Canada Post, Canpar, Purolator, DHL, FedEx, etc.)

- advertise through the use of online ads, reviews, and sponsorships (getting customers to test and review our products)

Customer Segments

Who are you creating value for? Who are the customers you wish to reach and serve and who are the most important ones?

- we aim to help those that have or know someone with a disabled child, specifically those children that have trouble with motor skills and self-support
- while the product itself is designed for the children, they will not be the ones buying the product. In other words, our clients are the parents/ guardians of the children, and thus we aim to sell the product to them by advertising features that would help the actual customer

Cost Structure

Types of costs: fixed, variable, economies of scale

- indirect (overhead, depreciation, rent)
- fixed (marketing, health and safety, maintenance for warehouse, monthly/ annual fees)
- variable (raw material, salaries, power for machines)

Economies of scale: increased output would overall lower the cost of production by making full use of resources, machinery, and services (ie buying a large portion of materials in bulk, being able to fully fill shipping trucks when they leave the plant, getting the most out of machinery while still paying a fixed amount for depricaition, rent, etc.)

Revenue Streams

How will your business make money? What kind of revenue system can you use? How do you set pricing?

- primary revenue stream would be the sale of the adjustable table
- very likely that new versions of the table are introduced (one for rugged terrain, one for vehicles, or a smaller, portable side table)
- could also offer services to repair any damaged product, and customers could pay for a warranty

Strategyzer
strategyzer.com

2.1.3 Core Assumptions

3. As more and more research come about, the requirements and needs of people who live amongst the vast spectrum of non-verbal communication. Based on our business model, there are various core assumptions to consider for non-verbal persons with various mobility challenges to have a safe environment to be in. Since there is an increase in technology regarding inclusive design and accessibility, we can provide quality and safety in our assumptions. Our primary goal is to increase inclusivity and accessibility to improve the quality of life for our customers. To achieve this goal, there will be a need to work closely with distributors and suppliers by creating a close relationship through active communication and agreement in values. One of our keenest goals is to focus on keeping a close eye on costs. Since there is a need to focus on the budget, there is a need to not sacrifice the quality of the budget as well. The way to manage this goal is to monitor all expenses, this requires closely monitoring the sourcing materials and communicating with the target audience. There is also a key importance in focusing on sustainability, the goal Is either to upscale second-hand products or utilize various eco-friendly materials; this is to be as environmentally friendly as possible under the conditions. Finally, there is a target budget of 100 dollars per unit – there is a need to keep costs at the highest efficiency to produce the highest quality product. For the target customer, the primary assumption is defining the target customer segments that the business intends to serve, for the feasibility of this assumption

depends on the accuracy of market research and the ability to reach and engage the identified customer segments effectively.

2.1.4 Sustainability Report

Our product will have a major social impact as it will allow people in wheelchairs to access any surface height they desire. This will stop them from being left out from activities because of their disability and promote inclusion. As well we want to try and encourage independence and allow the users to change the height by themselves. The ability to do this will help empower users and make their disability more manageable and less of a hinderance. These social impacts, overtime, aim to further enable people in wheelchairs to have the same accessibility we have, and we are trying to help break the gap.

This industry tends to be extremely pricy and as soon as the word "accessibility" is slapped on, the price skyrockets. As our client said, they must decide what equipment to buy next. We do not want this to be an issue economically. As such our product is low cost but made with stability and functionality in mind. This product should also be built to last, thus keeping sustainability in mind as the client will not have to buy a new one frequently. This will play a positive role economically by providing a low-cost alternative that will help the user without breaking their wallets. The product's low cost also allows a greater audience to access the product. This also helps socially as it helps more people in wheelchairs reach the same accessibility (or closer to it) as someone without that disability.

2.2 Design for X

1. **Adjustability (Height Range):** The client's unique needs require an adjustable table to accommodate her wheelchair, standing chair, or other devices, promoting autonomy. We put this as the number one factor influencing our design as it is the main goal and use for the device. Without achieving this goal, the client probably won't even use the device in the first place.
2. **Safety and Durability:** Ensuring a sturdy table that won't fall over when pushed and is stable enough for her daily uses, is crucial for The client's safety and long-term value.
3. **Portability:** Portability enables the table's use in various locations, both indoors and outdoors, supporting The client's participation in diverse activities, and means the client can use this table for all The client's needs.
4. **Versatility of Surfaces:** Adaptability to different surfaces ensures The client's comfort in various environments and easy maintenance.
5. **User-Friendly Controls and Ease of Use:** Simple controls like large buttons or switches empower The client to adjust the table independently, enhancing her engagement.

3 Problem Definition, Concept Development, and Project Plan

3.1 Problem definition

We have defined the following client needs:

1. **Adjustability:** The client's unique needs require an adjustable table to accommodate her wheelchair, standing chair, or other devices, promoting autonomy. We put this as the number one factor influencing our design as it is the main goal and use for the device. Without achieving this goal, the client probably won't even use the device in the first place.

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4. **Versatility of Surfaces:** Adaptability to different surfaces ensures The client's comfort in various environments and easy maintenance.

5. **User-Friendly Controls and Ease of Use**: Simple controls like large buttons or switches empower The client to adjust the table independently, enhancing her engagement.

3.2 Problem Statement:

Our objective is to design an adjustable, versatile, & cost-efficient table for children with disabilities, specifically those with hindered motor skills, that can accommodate everyday tasks & be compatible with a wheelchair.

3.3 Metrics & Target Specifications:

3.3.1 Needs

User Needs	Importance Ranking (Out of 5)
Adjustable table within certain height parameters	5
The table needs to be easily transported to other locations outside of the client's house	2
The table needs to be portable around the house	4
Easily cleaned	3
Adjustable table angle	3

Adjusted by the user	2
Stable enough so that the user doesn't push the table over	5
Needs to be safe for the user	5
Limit loud noises	4
Needs to be big enough to play on and use for daily activities	4
Needs to be budget friendly	4
Needs to be adjustable with a certain precision	4
Table needs to change heights easily with minimal effort	3

3.3.2 Metrics

Metric	Measurement Units	Measurement Method
The table should have the ability to adjust the height	Inches (in)	Measure
Should be able to be taken apart in a required time frame	Minutes (m)	Timing activity
Not fall over when the user pushes the table	Pounds (lbs.)	Carry weight without breaking
Should be big enough to use for daily activities	Inches^2 (in^2)	Measurement
Should be budget friendly	Dollars ($)	BOM Examination
Should be adjustable within increments	Inches (in)	Measure increments
Should be relatively quiet when changing heights	-	User verification – will test with user
Wheels on device should be cleaned easily	-	User / client verification – will test with user / client
Wheels on device should be mobile	Degrees (°)	Testing

3.3.3 Benchmarking

Metric	Product 1	Product 2	Product 3
The table should have the ability to adjust the height	27 ½ in - 47 ½ in	23" - 33"	24"-28"
Should be able to be taken apart in a required time frame	30 minutes – 50 minutes	20 - 40 minutes	20minutes-40minutes
Not fall over when the user pushes the table	**Max. load:** 50 kg (110 lbs.)	Max. load: 500lbs	Max.load: undetermined
Should be big enough to use for daily activities	**Depth:** 70 cm (27 1/2 ") **Width:** 120 cm (47 1/4 ")	48' x 36'	36" X 30"

Should be budget friendly	$359 (out of budget)	$1.3k (out of budget)	$1295.00 (out od budget)
Should be adjustable within increments	27.5”(70cm) and 47.25” (120cm): 1-inch increments	1-inch increments	6 cranks per inch
Should be relatively quiet when changing heights	Squeak Noise	Squeak Noise	Quiet Squeak Noise
Wheels on device should be cleaned easily	N/A	N/A	N/A
Wheels on device should be mobile	N/A	N/A	N/A

Product 1: https://www.ikea.com/ca/en/p/trotten-desk-sit-stand-white-s99429578/

Product 2: https://www.specialneedscomputers.ca/index.php?l=product_detail&p=75

Product 3: https://www.lucindatech.com/collections/wheelchair-accessible/products/equity-adjustable-activity-computer-table-with-tilt

3.3.4 Target Specifications

Target Specifications	Ideal Range	Importance (1-5)
The table should have the ability to adjust the height	11 in to 48 in	5
Should be adjustable within increments	1 in to 2 in	4
Not fall over when the user pushes the table	Support 100lbs when height locked in	5
Should be big enough to use for daily activities	40 in by 30 in	3
Should be budget friendly	<= $100	4
Should be able to be taken apart in a required time frame	Less than or equal to 2 mins	2
Wheels rotate freely	= 360° rotation	3
Slanting angle of tabletop	0° to 45°	4
Increments of tabletop angle	10° to 15°	4

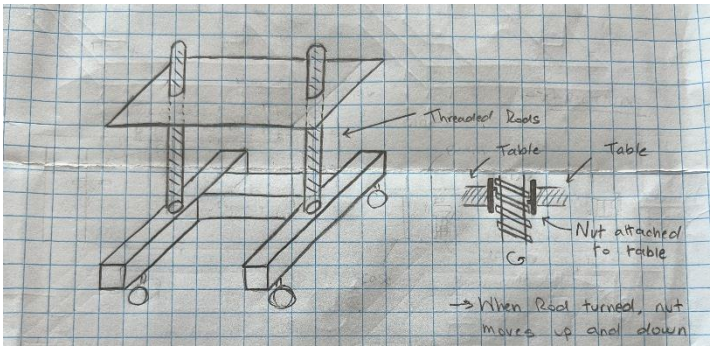
3.2 Concept development

This device will be broken down into 3 subsystems:

1) Table adjustability and frame
2) Tabletop material and adjustability of angle
3) Wheels and locking mechanism.

3.2.1 Subsystem 1: Table Height & Frame

1)



This design uses two threaded rods attached to the base frame. Then screwed onto the rods are two nuts which are attached to the tabletop. This means whenever the rods are rotated, the table moves up and down the rods. To rotate the rods, the ends are attached to a gear and a motor located inside the connecting beam in the middle of the base frame. This would spin both 'legs' and one motor for each leg. We could then use an Arduino or another microcontroller to control the motors and use a buddy button or something of the sorts to control the motors. This design would be automatic; however, it would also be costly and complicated to manufacture.

Target Specifications	Range	Importance (1-5)
The table should have the ability to adjust the height	1ft – 4ft	5
Should be adjustable within increments	Increments 1 in – 2 in	4
Not fall over when the user pushes the table		5
Cost	Less or equal to $100	4
Should be able to be taken apart in a required time frame	Less than or equal to 2 mins	2

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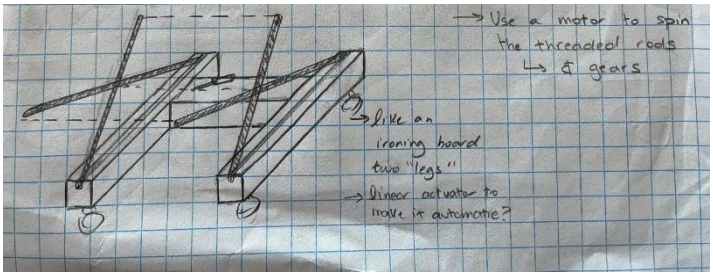
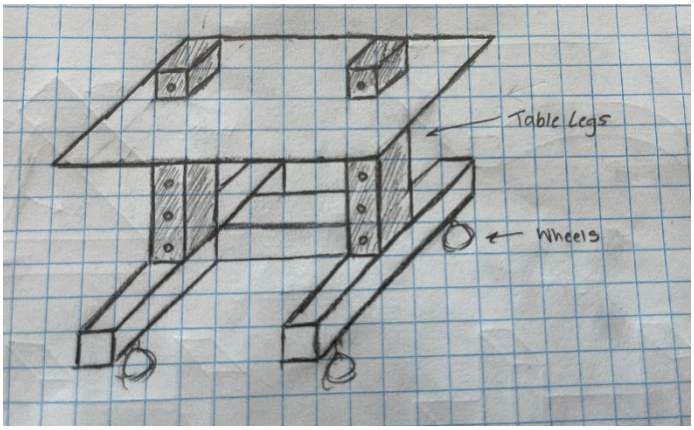
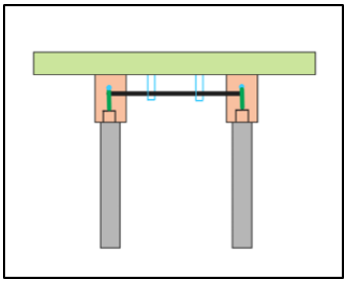


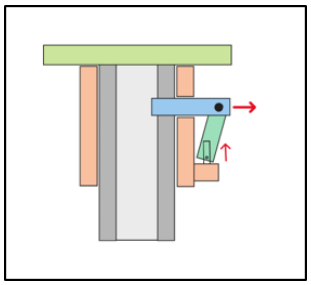
This design uses the same 'H' shaped base frame but instead with built in sliders. Like an ironing board or a scissor lift, we would make use of two rods connected in the middle that form an X. Then when the rods are moved apart the table moved down. This design would most likely need a longer base frame and wouldn't be as stable as some of the other designs. The way to change the height could be changed, however one way to do it automatically would be to use a linear actuator to push a beam that connects the two rods. This would require lots of prototyping to make work however and may also cause issues when the user wants to sit under the table when the table is at its lowest height as the user may hit their legs on the beam connecting the two sides.

Target Specifications	Range	Importance (1-5)
The table should have the ability to adjust the height	1ft – 4 ft	5
Should be adjustable within increments	Increments of 1 – 2 in	4
Not fall over when the user pushes the table		5
Cost	Less than or equal to $100	4
Should be able to be taken apart in a required time frame	Less than or equal to 2 minutes	2

3)







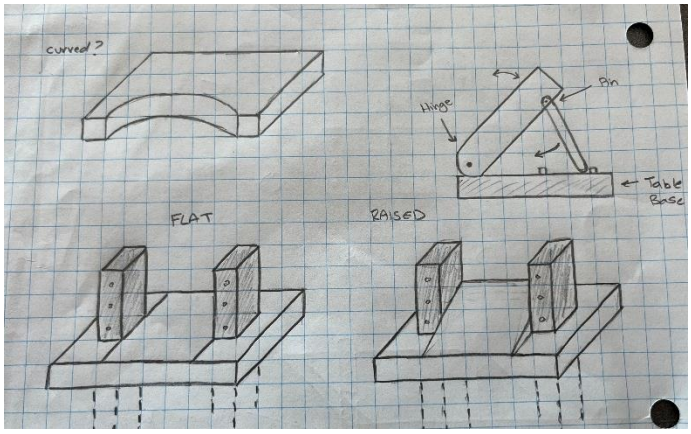
This design also uses a similar H shaped base frame, but then uses a similar square shaft as legs. These two legs would also have holes located at any increments of our choosing. Then the table would move up and down the legs and use a pin system to keep the table in place. However constantly taking out and putting in two pins would be tedious and undesirable, so we created a mechanism that allows the user to simply pull a handle located under the table (black line on 1st digital drawing) which would release the pins. Then when the user has it in the right spot, they can release the handle and slot the pins back in place. This design is slightly complicated but uses easy to understand physics and mechanics to solve the problem. Some parts would have to be 3D printed and others made from sheet metal or metal beams.

Target Specifications	Range	Importance (1-5)
The table should have the ability to adjust the height	1ft – 4 ft	5
Should be adjustable within increments	Increments of 1 – 2 in	4
Not fall over when the user pushes the table		5
Cost	Less than or equal to $100	4

Should be able to be taken apart in a required time frame	Less than or equal to 2 minutes	2

3.2.2 Subsystem 2: Tabletop

These tabletop designs only raise one part of the table. We will have to talk to the client before proceeding to see if this design works for them. There are two versions, one is manual where you simply flip the middle section up and a leg will fold out, this can be positioned in a notch to keep the tilt secure. This is simple and most importantly cheap; it is used for most common drawing tablets and for similar uses. We could also raise the middle section using a linear actuator that would be positioned under the table, from there it would push the middle section up and keep it secure with the angle.



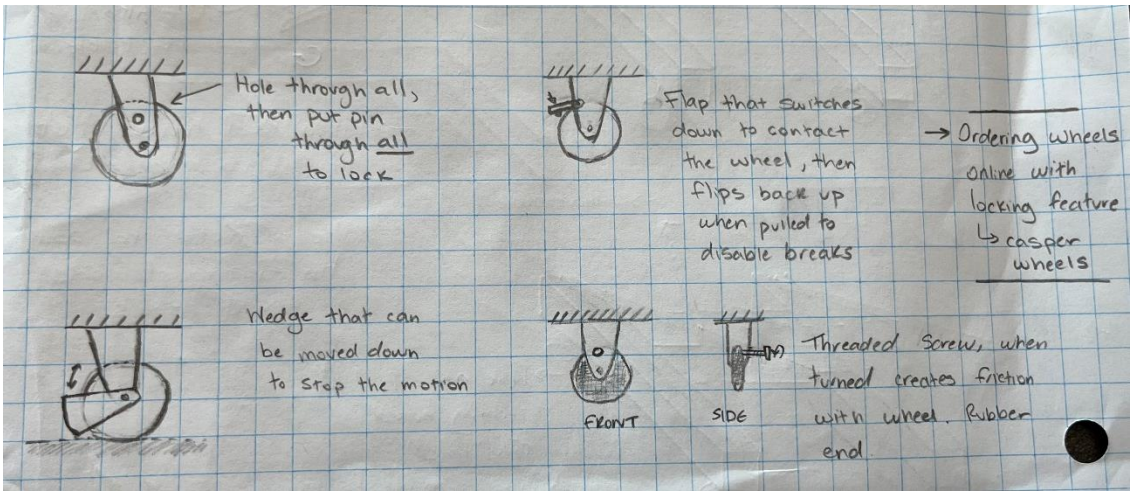
Manual

Target Specifications	Range	Importance (1-5)
Adjust angle	0° to 45°	4
Increments of angles	~15° increments (prototyping required)	3
Cost	~ $15	4

Automatic (Linear Actuator)

Target Specifications	Range	Importance (1-5)
Adjust angle	0° to 80°	4
Increments of angles	~5° increments (prototyping required)	3
Cost	~ $70	4

3.2.3 Subsystem 3: Wheels



Target Specifications	Range	Importance (1-5)
The table should have the ability to adjust the height	1ft – 4 ft	5
Should be adjustable within increments	Increments of 1 – 2 in	4
Not fall over when the user pushes the table		5
Should be big enough to use for daily activities	Minimum tabletop dimensions: 36 in x 18 in maximum 100 cm	3
Should be budget friendly	$20 - $30	4
Should be able to be taken apart in a required time frame	Less than or equal to 2 minutes	2
Wheels rotate freely	360 degree rotation	3

3.3 Primary Design Concept

The final design is a combination of various subsections designs. Our main concepts opt for the 3rd design for subsystem 1. It will use the H base frame and two legs with holes in them. Then the table will move up and down the legs. The table design will have the adjustable tabletop and the wheel will be bought from an

external supplier. The reason why we are opting for wheels from an external supplier is cheaper and easier than making our own wheels. They will save us time and money as they also already come with their own braking system which saves time in designing and any time and effort manufacturing.

3.4 Project plan

WrikeSnapshotPDC

4 Detailed Design and BOM

4.1 Detailed design

1. During our second client meeting (Client Meet 2), we received feedback on our initial design for an adjustable table for our client, The client. Here are the key points of feedback and the changes or improvements needed in our design:

- Initial Design Evaluation:
  The client found the overall idea of the design to be fine. There were no concerns regarding the adjustment mechanism. However, there were concerns about the possibility of The client hitting her head on the table, especially when the table height is adjusted to the lowest point. The client suggested putting a soft cover or cap on top of the table to prevent injuries in case another child falls on it. The priority is to make the table suitable for both indoor and outdoor use. The client emphasized the importance of making the table as compact as possible, as it needs to fit into a Prius for transportation. Even if it takes more time to disassemble, compactness is worth it. There was a request to include a safety latch to prevent the rod from moving, like a safety pin on The client's current wheelchairs. The client's family members, including her 9-year-old sister, grandmother, and mom, should be able to adjust the table easily, so keeping it lightweight is crucial.
- Alternative Designs Considered:

  The client mentioned two alternative designs, but they were not deemed feasible for various reasons. The first alternative with a motor was considered too costly and complicated to maintain. The client was unsure how to fix motor-related issues. The possibility of incorporating a gear system was suggested but was seen as adding bulk and creating potential hazards. The client preferred a crank system, possibly located on the side of the table to avoid interference with The client's wheelchair. The second alternative involving ironing board or scissors-like legs was discussed, but concerns were raised about stability and the possibility of fingers or objects getting stuck during collapse.

- Tabletop Design:
  The idea of a curved/cutout tabletop design was well-received, as it allows The client to wheel herself in and be closer to the table. The client emphasized the importance of maintaining portability, so it was suggested to explore options like pull-out sleeves on the table to extend it when needed. The client might only need a section of the table at an angle for activities like drawing, with a latch to lock the table at the preferred position.
- Wheel Selection:
  Castor wheels that lock automatically and are easy to clean were found at Home Depot and were within the budget. The client approved of these wheels, and alternatives from Amazon were also considered.

- Summary:
    - The key changes and improvements needed in the design include:
        - Incorporating safety measures to prevent The client from hitting her head on the table.
        - Adding a soft cover or cap to the top of the table.
        - Ensuring the table is lightweight for easy adjustment by The client and her family.
        - Exploring a crank system for height adjustment, possibly located on the side of the table.
        - Considering pull-out sleeves to extend the table while maintaining portability.
        - Implementing a latch for locking the table at preferred angles.
        - Ensuring the chosen wheels are both safe and within budget.

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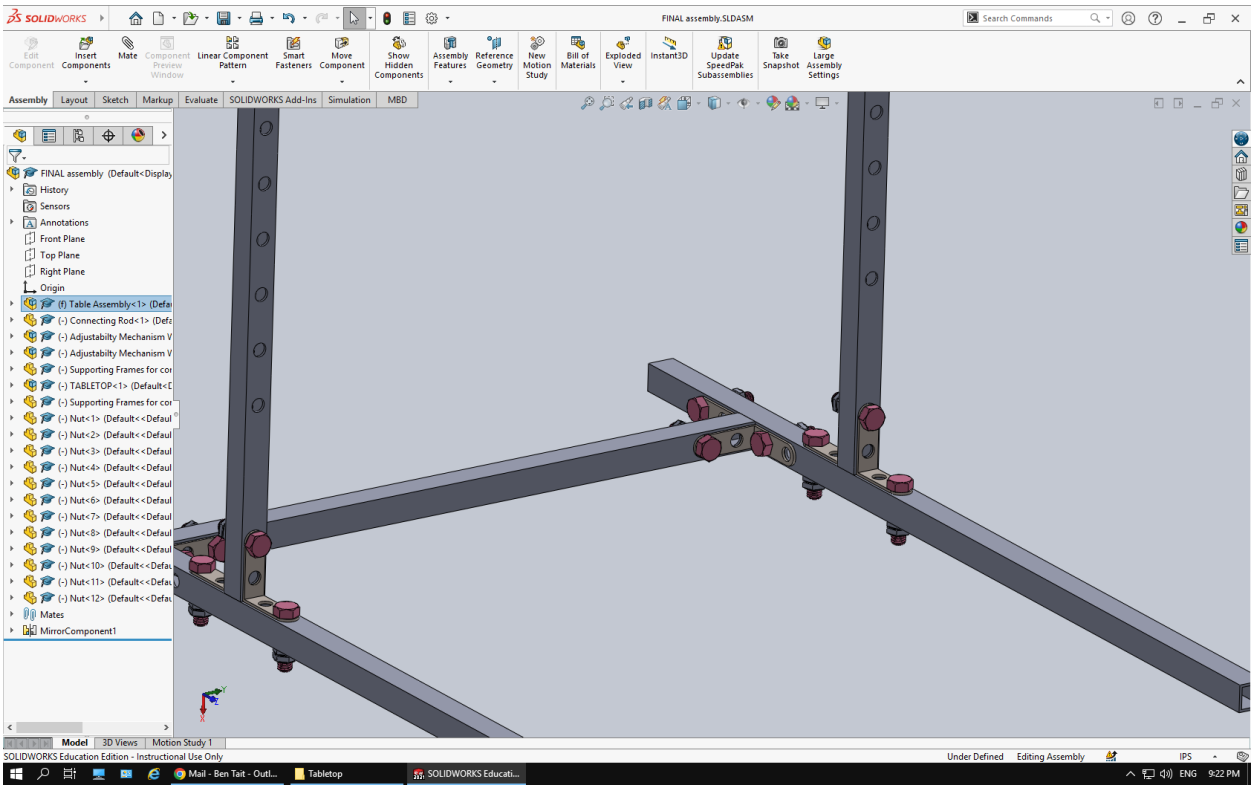
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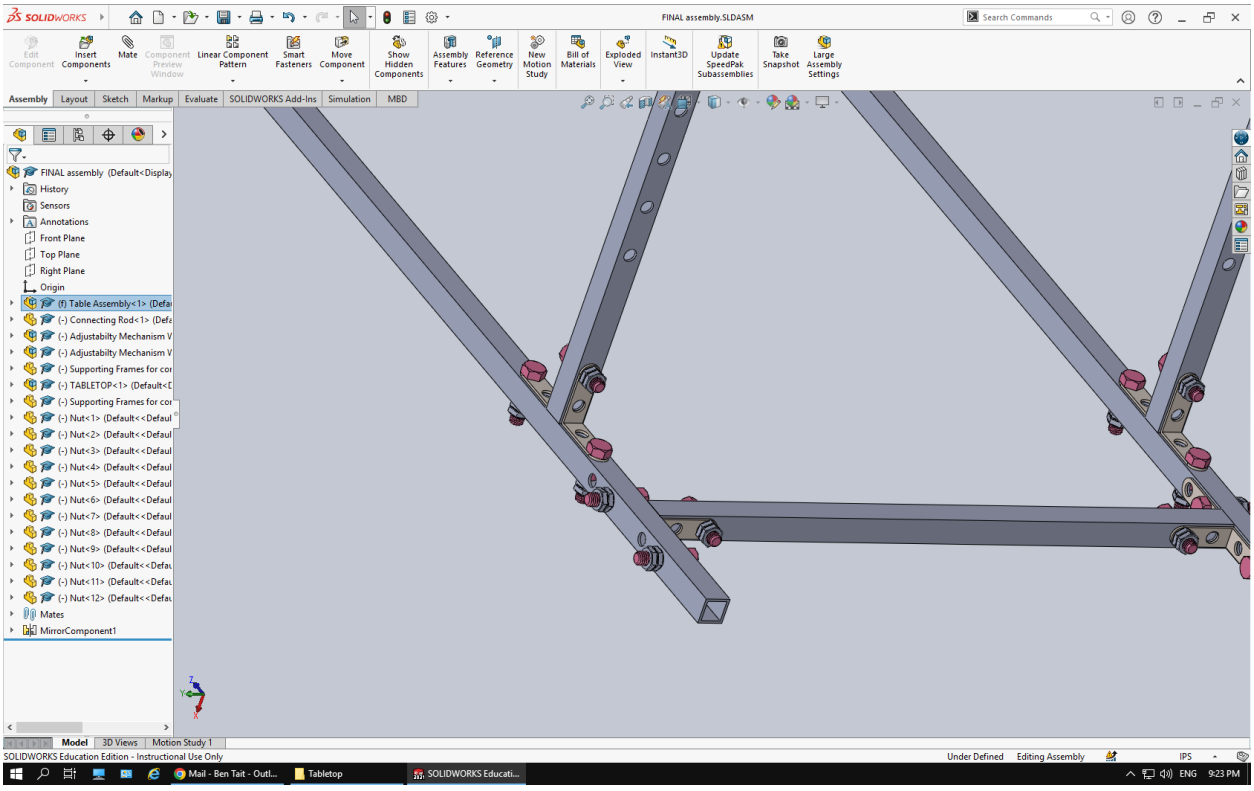
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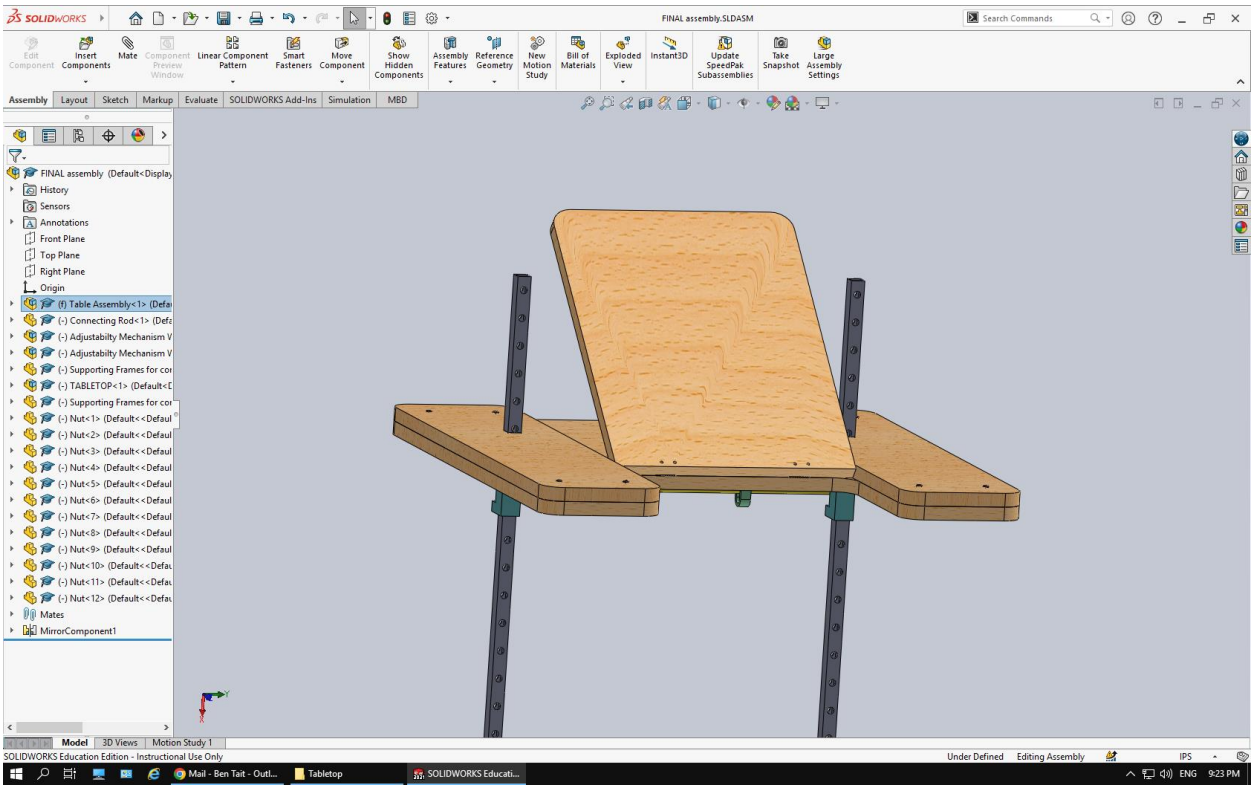
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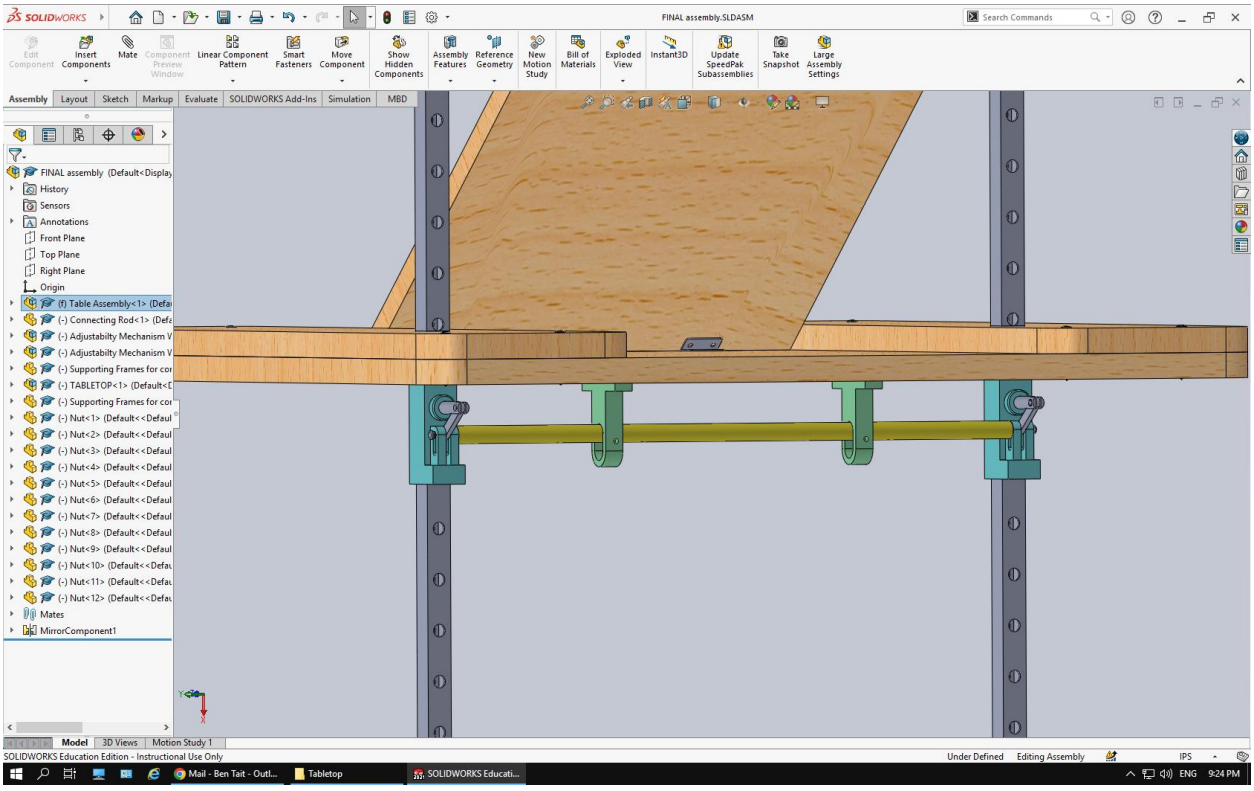
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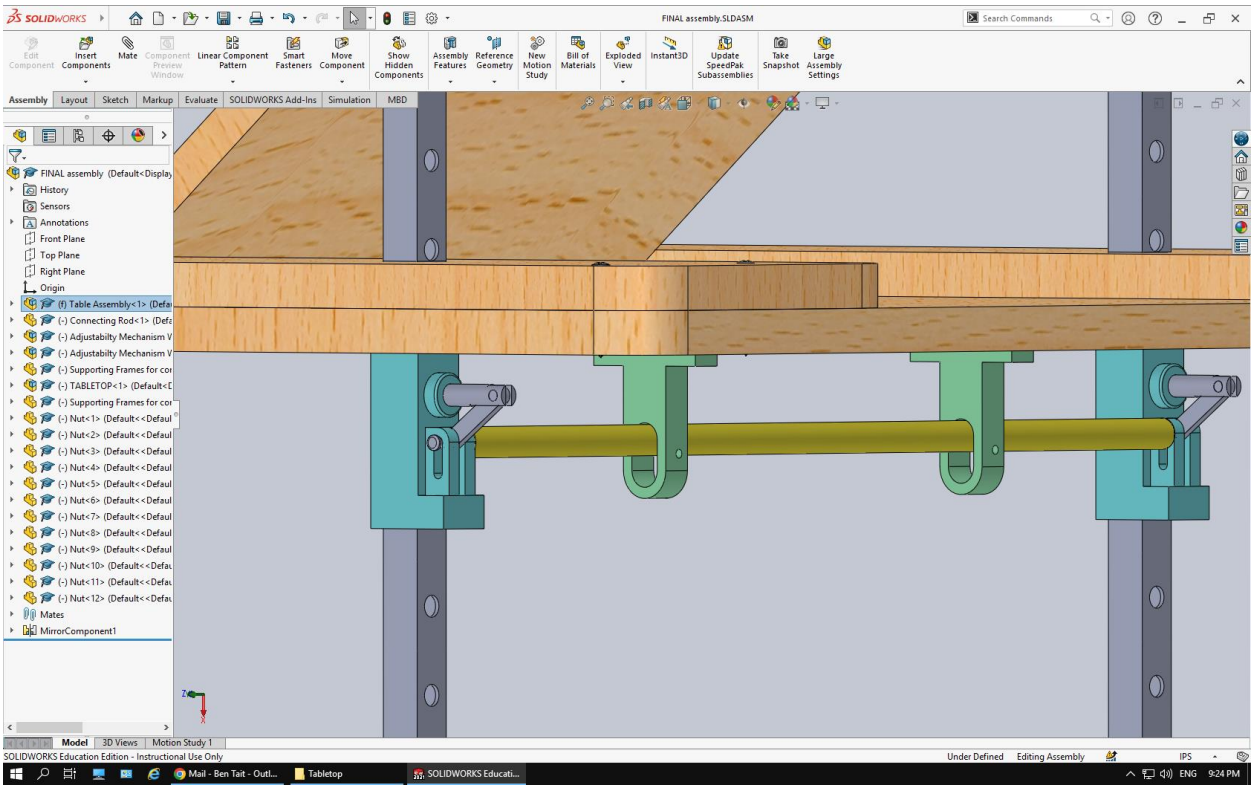
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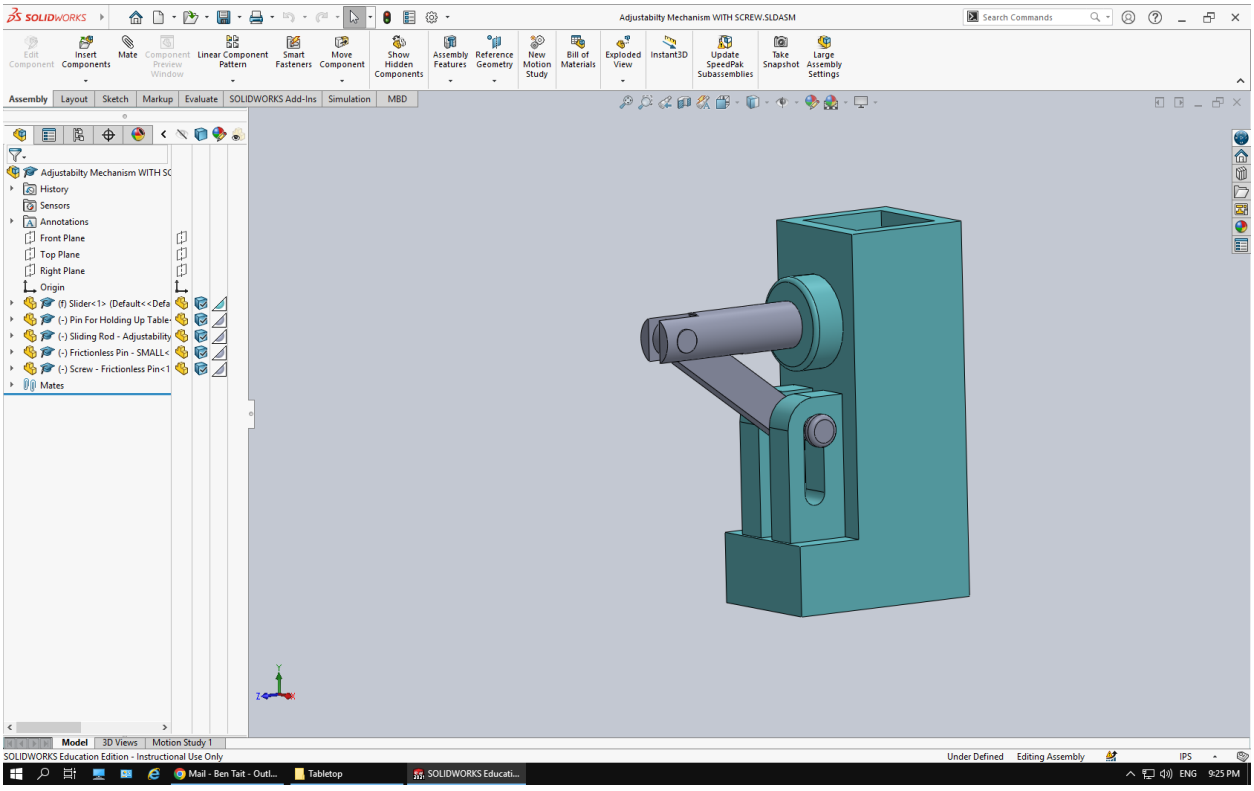
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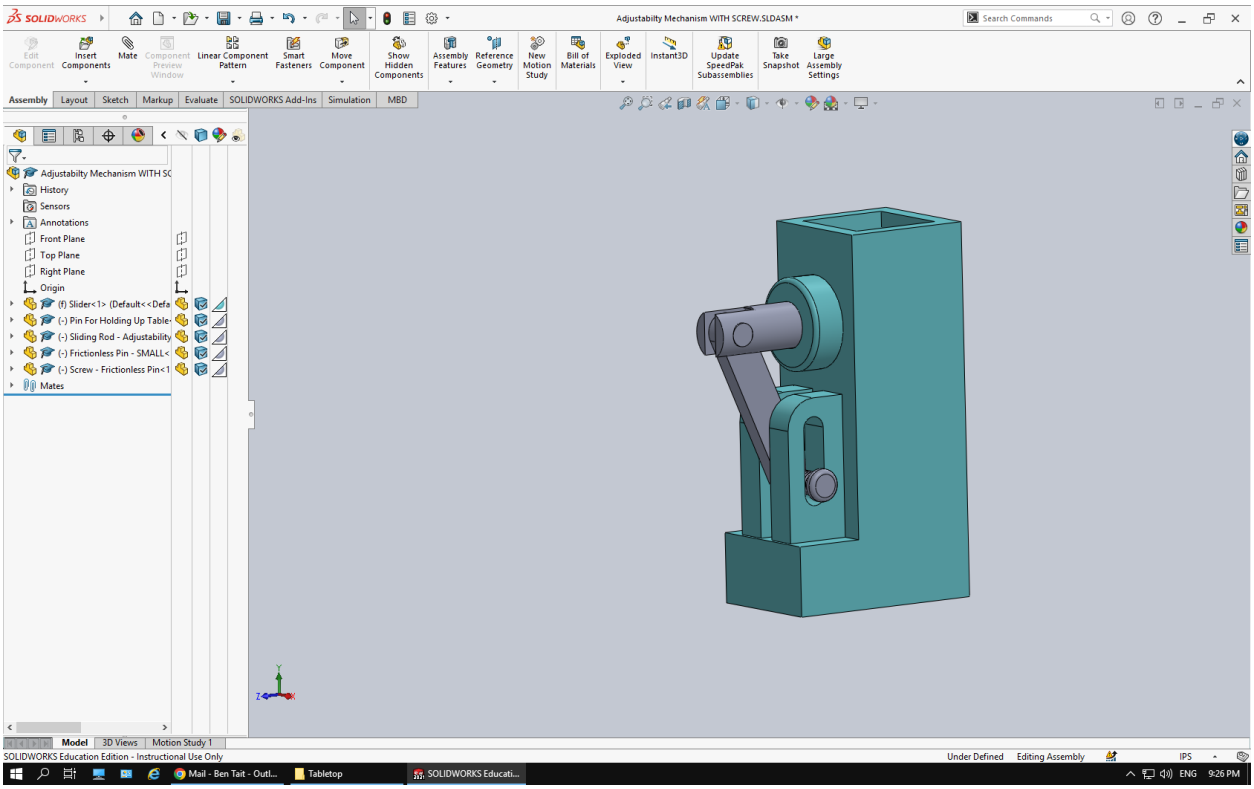
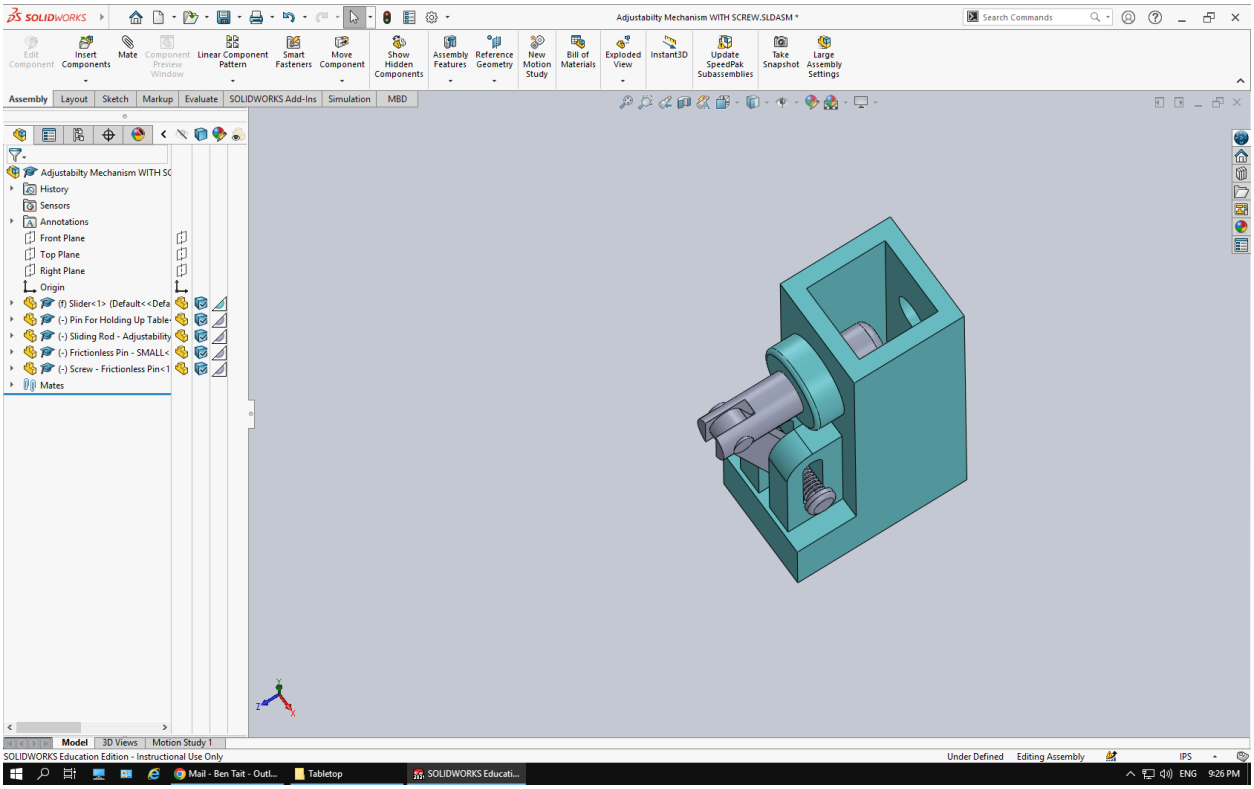




3. Skills and Resources Available:

- Team Expertise: Your project team comprises members with diverse skills and backgrounds, including engineering, & design (software & mechanical). This collective expertise allows you to tackle various aspects of design and project management effectively.
- University Resources: Being affiliated with the University of Ottawa provides access to academic resources, libraries, and faculty support for technical advice/guidance.
- Client Feedback: Regular interaction with our client provides valuable insights into The client's specific needs and preferences. The client's input is critical in guiding the design process.
- Project Management Tools: We are using project management tools such as Wrike to plan, track, and manage tasks, timelines, and team collaboration.
- Prototyping Tools and Equipment: Access to prototyping tools and equipment will facilitate the physical construction and testing of your design prototypes.
- Budget: We have a budget for the project, which allows you to procure materials and resources required for the design and prototypes.
- Material/Seller Information: We have identified potential companies for certain components, such as wheels, and have knowledge of their products and costs.
- Benchmarking Data: Information gathered from benchmarking similar products or designs allows you to compare and evaluate your design against existing solutions.
- Design Concepts: We have developed initial design concepts, including subsystem designs for table height adjustment, tabletop design, and wheel selection, which serve as a foundation for further development.
- Project Plan: Our project plan outlines the tasks, timelines, and responsible team members, helping us stay organized and on track.

Missing Skills/Resources and How to Obtain Them:

- Accessibility Testing and Certification: To ensure your design is fully accessible and compliant with relevant standards, you may need access to specialized testing equipment or consulting services. Seek partnerships with organizations or experts in accessibility testing.
- Manufacturing Expertise: If we plan to manufacture our product on a scale, consider partnering with manufacturers or experts in the field to ensure cost-effective and high-quality production.
- Marketing and Distribution: If we intend to bring your product to market, we may require skills and resources for marketing, distribution, and sales. Consider partnerships or hiring professionals with expertise in these areas.
- Funding: If additional funding is required beyond our allocated budget, explore options such as grants, crowdfunding, or investment to support our project's development and production phases.

4. Based on each member's course load, there is limited time to allocate for the design and its implementation. Since the date of having the final prototype is for the week of November 26th there is 1.5 months remaining to finalize the design and work of the prototypes until the date of submission.

As seen in the Wrike, there are various plans for developing the project deliverables. Within the plan, after the in-class presentation there will be more context on feedback and finalization of plans for the project. After the week of the 8th of October, since Deliverable D contains concrete designs for the table during the span of the following two weeks there will be a finalization of what is required.

To assess the amount of time, since our group is made of entirely engineering students, this implies that the course load is heavy. Based on various weeks there will be important labs and tutorials to attend, so we will

allocate at minimum 4 hours a week on this project as a group. When course loads get lighter there will be time for more flexible working hours to allocate on this project, as in 2-3 extra hours into prototyping and developing.

The time to implement a design can vary on various factors like the project scope, available time with project time, and finalization. Considering these constraints and to ensure that our group can maintain a sustainable pace without overwhelming its members, we anticipate that the implementation will likely take around a month to complete. This timeline allows us the flexibility to accommodate any unexpected delays or adjustments that may arise during the project.

Finally, since the group divided the task into the body and the tabletop. Since there won't be a lot of time, the estimation of time that it will take is at minimum 2 weeks or 30 hours. This estimation is based on welding, drilling, 3D printing, purchasing, cutting, building, and modifying. The entirety of this table may take a large sum of time; however, proper time management is doable within the 1.5 months.

5.

- Acceptable Height Range: An essential assumption is that the acceptable height range for the adjustable table is defined and aligned with The client's specific needs and preferences. Any deviation from this range could impact the usability and effectiveness of the design.
- Availability of Materials/Components: The assumption that necessary materials and components for the design are readily available in the market within your budget. Supply chain disruptions or material shortages could potentially affect the project timeline.
- Budget Constraints: Assuming that the allocated budget for the project is sufficient to cover the costs of materials, manufacturing, and other expenses. Any budget overruns or unforeseen expenses could impact the feasibility of the project.
- User Accessibility Requirements: It is assumed that the design will meet all accessibility requirements and standards to ensure that The client can use the table safely and comfortably. Failing to meet these requirements could result in an unusable product.
- Safety Standards Compliance: An assumption is made that the final design will comply with safety standards and regulations to prevent accidents or injuries when using the adjustable table.
- User-Friendly Controls: It is assumed that the control mechanism for adjusting the table's height will be user-friendly, as her family members must be able to operate it easily. Any complexity or difficulty in using the controls could hinder the product's usability.
- Client Satisfaction: Assuming that The client and her family will be satisfied with the final product and that it will meet their specific needs and expectations.
- Prototype Testing Success: Assuming that the prototypes developed will meet performance and safety criteria during testing phases. Any unexpected issues discovered during testing may require design modifications.

4.2 BOM

6.

BoM - Bill of Materials

Price	Part Name	Part Link	Unit of Measure	Part Usage	Quantity
$24.08 total	Caster Wheels	https://www.amazon.ca/Housables-Locking-Capacity-Threaded-Furniture/dp/B0725W3MY6?source=ps-sl-shoppingads-lpcontext&ref_=fplfs&psc=1&smid=A1T1PCXZCQWDN5	Unit	Wheels of the table, so they can move and also lock	1 Package x 4 wheels
$32.58	Ply Wood	https://www.homedepot.ca/product/3-8-inch-4-ftx8-ft-standard-spruce-plywood/1000173237	Unit	Table top	1
$4.47	Door Hinge	https://www.homedepot.ca/product/everbilt-3-inch-with-square-corners-satin-nickel-door-hinge-1-pc-/1000769448	Unit	Adjusting support of the table top	2
$0.16/each	Washers (0.5 inch Diameter)	https://www.homedepot.ca/product/paulin-1-2-inch-flat-washer-18-8-stainless-steel/1000182050	Unit	Lever mechanism	12
$0.67/each	Nuts	https://www.homedepot.ca/product/paulin-1-2-13-inch-finished-hex-nut-grade-2-oversized-hot-dipped-galvanized-unc/1000141758	Unit	Lever mechanism, table build	24
$2.82	Spring	https://www.homedepot.ca/product/paulin-1-4-od-x-1-1-8-inch-extension-utility-spring/1000127101	Unit	Lever mechanism	2
$2.98	Bolts 0.5 inch diameter	https://www.homedepot.ca/product/paulin-1-2-x-2-inch-hex-head-cap-screw-zinc-plated-grade-5-unf/1000134022	Unit	Lever mechanism	12
$32.28/per unit	Aluminium Square Tubing	https://www.homedepot.ca/product/alexandria-moulding-1-inch-x-1-inch-x-8-ft-metal-square-tube-in-satin-clear/1000675506	Unit	Legs of the table	2

$1.46/each	Metal Pins	https://www.homedepot.ca/product/paulin-3-16-inch-x-3-1-4-inch-hitch-pin-clips/1000126875	Unit	Adjustable table pin connector	1
$1.96/4pc	Brackets	https://www.homedepot.ca/product/everbilt-1-1-2-corner-brace-zinc-plated-4pc/1000773638?rrec=true	Unit	Legs of the table	4
$29.95/0.5kg	3D printed Caps	Water Soluble Filament - https://filaments.ca/products/pva-filament-natural-1-75mm	Unit	To protect the legs of each table, when the table descends	1
$26.99	Wood Sealant	https://www.canadiantire.ca/en/pdp/thompson-s-waterseal-exterior-multi-surafce-waterproofer-clear-3-78-l-1-gallon-0491467p.0491467.html?rrecName=Top%20Sellers&rrecReferrer=categorylevelN&rrecProductId=0491467P&rrecProductSlot=3&rrecSchemeId=catlevel3_rr&rrec=true	Unit UnitUnit	To protect and waterproof the table top	1
$2.73/foot	Aluminum Rods	https://millenniumalloys.ca/product/ar061-6061-t6-aluminum-rod-0-75in-diameter/	Unit	Used for the lever mechanism	3 feet
$7.84/per package (250pk)	Screws 0.25 inch diameter 1.25 inch length	https://www.lowes.com/pd/Fas-n-Tite-6-x-1-1-4-in-Bugle-Coarse-Thread-Drywall-Screws-1-lb/999996482	Unit	Table legs + support base to adjustable mechanism	2
$6.87/ per package	Screws 1.5 inch	https://www.homedepot.com/p/Everbilt-8-x-1-1-2-in-Coarse-Zinc-Plated-Phillips-Bugle-Head-Wood-Screws-50-Per-Pack-822642/317479600	Unit	Table top	12

Total: $272.78 + tax(Assuming all costs will be bought and no second hand use is in place)

For the bill of materials, it can be assumed that all the products purchased are used for the final prototype . Knowing that there is a given $50 - $100 for the development of the final prototype, the BOM goes over the cost by $172, since we are assuming that every product purchased is brand new. While the cost is the original price for each part, there is going to be factors where the final cost will be at minimum $100 less since there are products that are going to be $0 due to the availability of these products within our homes. This table is the overall assumption of how much each material costs realistically to construct a working final prototype.

4.3 Project plan update

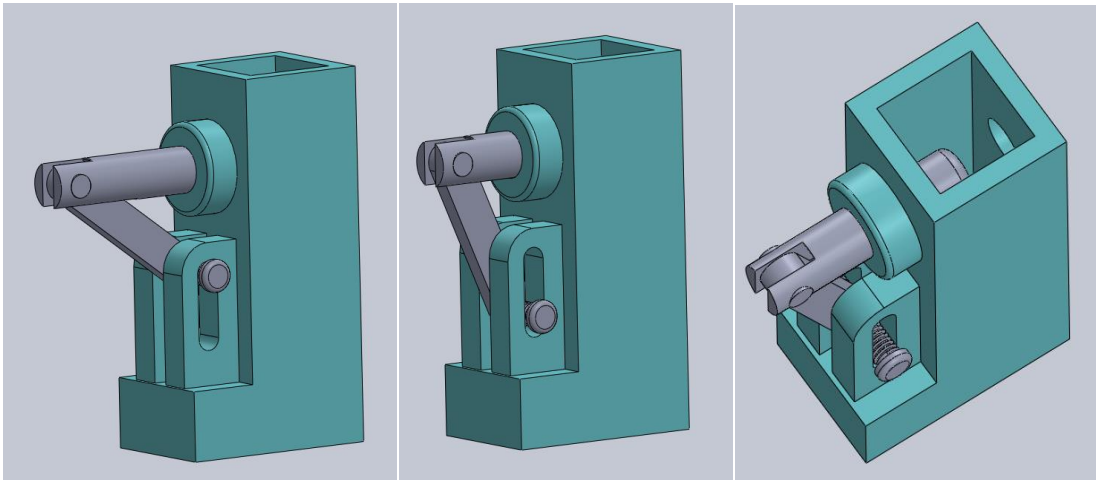
WrikeSnapshotPDD

5 Prototype 1, Project Progress Presentation, Peer Feedback and Team Dynamics

5.1 Prototype 1

1. 3D printing the table pin/slider

2.



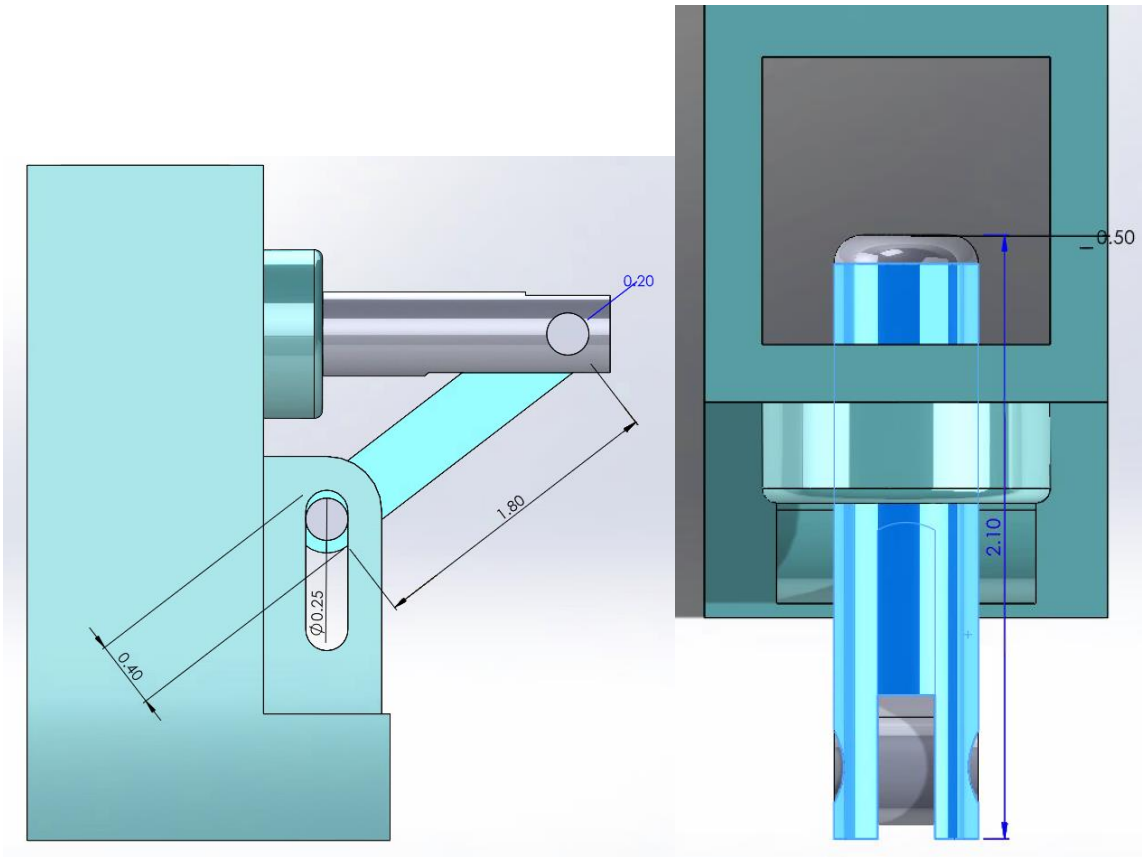
Purpose/Function of the Pin/slider: lock/unlock to the tables' legs for height adjustment.

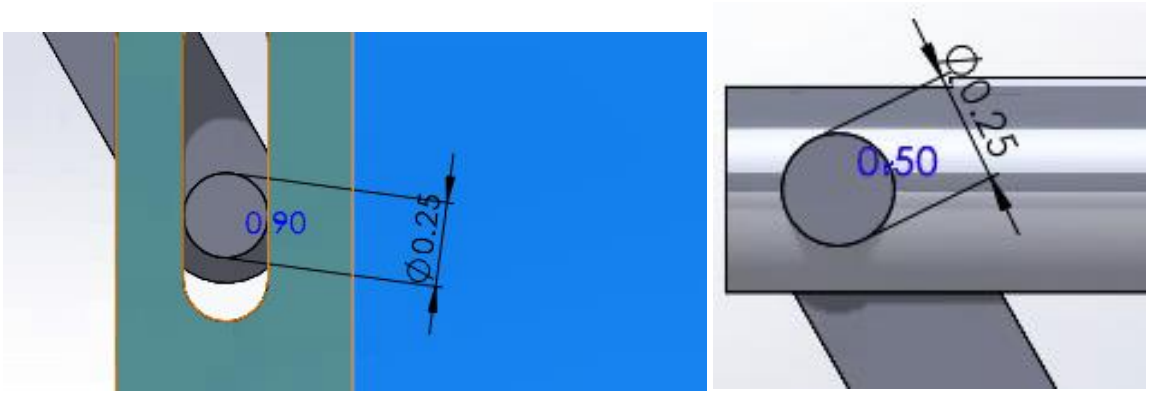
Left Image: pin is unlocked. (grey part) & blue part can no longer slide on the table legs. (locked at a height)

Middle Image: pin is locked. (grey part) & blue part can slide on the table legs. (unlocked, so height can be adjusted)

3. Dimensions are the same for expected & actuals values:

   The blue part's dimensions are 4 x 1 x 0.20 in (thickness at the top)





5.2 Project Progress Presentation

DeliverableDpres.pptx

5.3 Project plan update

Wrike Timeline Snapshot

6 Design Constraints and Prototype 2

6.1 Design constraints

Identify Two Non-Functional Design Constraints:

- **Constraint 1: Safety**

Justification: Safety is a paramount non-functional design constraint for our project. The constraint goes beyond the basic requirement of not causing harm, extending it to ensure the product contributes to the user's wellbeing. Our client, The client, has specific mobility challenges, and the table's design must ensure that she does not get injured while using it. An important safety concern raised during client feedback was the risk of The client hitting her head on the table, especially when the table is adjusted to its lowest point. To address this, we need to implement safety measures to prevent such incidents.

Design Changes to Satisfy the Constraint:

To enhance safety, we plan to add a soft cover or cap on top of the table. This cover will act as a protective cushion, reducing the risk of injuries in case of any impact. This modification aligns with the safety concerns highlighted by our client. This material should also be non-toxic, easy to clean, and durable enough to withstand regular use while providing the necessary cushioning. Beyond the selection of the material, the design will incorporate rounded edges and corners, recessed adjustments control to minimize the risk of accidental harm. We will also implement a controlled movement mechanism that ensures the table adjusts its height slowly and smoothly, thereby reducing the risk of a sudden drop. Locking mechanisms will also be in place to secure the table at various heights, ensuring it does not collapse or move unexpectedly.

Proof:

We conducted research on the most suitable materials for the protective cover and consulted relevant safety standards. Our analysis showed that adding a soft cover significantly reduces the risk of injury in case of accidental contact with the table's surface. Moreover, we considered similar safety measures in existing products and their effectiveness in preventing injuries. Through the combination of research on impact-absorbing materials and consultation of safety specific to furniture design, we established a foundation for our safety measures. Our findings indicate that materials such as silicon or heigh density foam will allow a high reduction in injury risks. We can also learn from failures and successes in existing products, integrating these lessons into our overall design.

- **Constraint 2: Portability**

Justification: Portability is another critical non-functional constraint for our design. The table needs to be as compact as possible to fit into a Prius for transportation, as indicated by the client. Portability must be achieved without sacrificing the table's strength, stability, and durability – features that the client still requires for daily use. We understand the importance of keeping the table lightweight and easy to transport while ensuring its functionality.

Design Changes to Satisfy the Constraint:

To satisfy the portability constraint, we will further explore design modifications to make the table as compact as possible. This might involve optimizing the folding or collapsing mechanism to reduce the table's size for transportation, even if it takes more time to disassemble and assemble.

Proof:

Our team will conduct simulations and calculations to determine the optimal folding or collapsing mechanism that maximizes compactness while maintaining usability. We will also seek inspiration from existing products with innovative compact design solutions to ensure the effectiveness of our design changes. By surveying products that have successfully integrated portability with functionality – we can adopt strategies that have been proven effective in real-world scenarios. Also, engaging with users through testing and usability will provide invaluable feedback on the practical aspects of the table's portability features.

6.2 Prototype 2

1. **Summarize New Client Feedback and Changes:**

New Client Feedback:

Since our last interaction with our client, The client, we have received valuable feedback regarding the proposed design changes related to safety and portability. The client was appreciative of the safety measures we are implementing, especially the soft cover on the table to prevent head injuries. However, there was an additional request from the client to include a safety latch mechanism to prevent the table's height adjustment rod from moving unexpectedly, like the safety pin on The client's current wheelchairs. The client also emphasized the importance of keeping the table lightweight and easy to adjust.

Changes to Design:

To address the client's additional feedback, we will incorporate a safety latch mechanism into our design to prevent unintentional height adjustments. We will also explore options to optimize the table's weight while maintaining structural integrity.

2. **Critical Product Assumptions:**

While our design has been progressing, there are some critical product assumptions that we have not yet tested:

- **Assumption 1: Table Stability**

We assume that the design changes, including the lever mechanism and the added safety latch, will maintain the table's stability at different height levels.

- **Assumption 2: Ease of Adjustment**

We assume that the table's height adjustment system, including the safety latch, will be user-friendly and easy for The client and her family members to operate.

3. **Development of Prototype 2:**

- Prototype 2 will primarily focus on implementing the safety latch mechanism to prevent unintended height adjustments.
- Prototype 2 will also explore design modifications to reduce the table's weight while ensuring structural integrity.
- Detailed schematics, drawings, and 3D models will be developed to represent these design changes.

4. **Documentation of Prototype 2:**
    - Prototype 2 will be documented using sketches, diagrams, and pictures.
    - We will provide an explanation of the purpose and function of the safety latch mechanism and the weight optimization modifications.

Figure 1: Subset: Caster Wheels

The caster wheels presented all have locks to prevent the movement of the table when required. They are attached to each point of the table frame – to allow easy mobility for any user. The wheels are also removeable for portability and ease for cleaning. The wheels have an average 125lbs load, so it will be able to hold up table, as well as 100lbs extra.

Figure 2: Subset: Tabletop

The tabletop is made of plywood, the corners are rounded and has a cutout to allow the client to be immersed in it. The external and internal corners are all rounded for optimal safety for the client and others. The table stands at (3ft x 3ft) dimensions and supports (100lbs) of load.

Figure 3: Subset 3: Adjustability

Adjustability mechanism is designed through 3D printing. This body of the mechanism allows for a pin to be used as a lever to adjust the table up and down. This is part one of the body, that was created out of PLA filament.

5. **Prototype Testing and Evaluation:**

- Prototype 2 will be subjected to rigorous testing to validate our critical product assumptions.
- Testing will focus on the safety latch's effectiveness in preventing unintentional height adjustments and the impact of design changes on the table's weight.

- Testing results will be documented in an organized, tabular format to compare actual performance with updated target specifications.

6. **Client Meeting and Information Gathering:**

    - In our next client meeting, we intend to present the design changes based on the client's additional feedback.
    - We aim to gather feedback on the safety latch mechanism and any other concerns or preferences the client may have.
    - We will also discuss the progress made in reducing the table's weight without compromising its integrity.

6.3 Project plan update

WrikeSnapshot

7 Other Considerations

7.1 Economics report

1. **Adjustable Play Table Business: Cost Overview**

Variable Costs:

1. **Materials Cost:**
    - Wood for table frame
    - Plywood for tabletop
    - 3D printing materials for adjustable mechanisms
2. **Labor Costs:**
    - Direct labor involved in manufacturing, assembling, and finishing the play tables.
3. **Packaging Materials:**
    - Boxes, wrapping, labels, and any other materials used for packaging.
4. **Shipping Costs:**
    - Variable shipping costs based on the destination and shipping method.

Fixed Costs:

1. **Rent for Manufacturing Facility:**
    - Monthly cost for the space where the tables are manufactured.
2. **Salaries:**
    - Fixed salaries for management and administrative staff
3. **Utilities:**
    - Monthly costs for electricity, water, and other utilities
4. **Insurance:**
    - Insurance costs for the manufacturing facility and products

Direct Costs:

1. **Direct Labor:**
    - Wages for workers directly involved in the manufacturing process.
2. **Direct Materials:**
    - Cost of materials directly used in the production of each table.

Indirect Costs:

1. **Indirect Labor:**

- Salaries for staff indirectly involved in production, such as supervisors and quality control.

2. **Indirect Materials:**
    - Materials that contribute to the manufacturing process but are not directly incorporated into the product.
3. **Depreciation:**
    - Depreciation of machinery and equipment used in production.

Material Costs:

1. **Wood and Plywood:**
    - Costs associated with purchasing wood and plywood in bulk.
2. **3D Printing Materials:**
    - Costs of filaments and other materials used in 3D printing parts.

Labor Costs:

1. **Direct Labor:**
    - Wages for workers directly involved in manufacturing processes.
2. **Indirect Labor:**
    - Salaries for supervisory and administrative staff

Overhead Costs:

1. **Rent and Utilities:**
    - Overhead costs associated with the manufacturing facility.
2. **Insurance and Depreciation:**
    - Overhead costs related to insurance and depreciation of equipment.

2. **Income Statement: Adjustable Play Table Business**

Year 1:

Category	**Amount ($)**
Sales Revenue	500,000
Cost of Goods Sold (COGS)	250,000
Gross Profit	250,000
Operating Expenses	150,000
Operating Income	100,000

Year 2:

Category	Amount ($)
Sales Revenue	800,000
Cost of Goods Sold (COGS)	380,000
Gross Profit	420,000
Operating Expenses	200,000
Operating Income	220,000

Year 3:

Category	Amount ($)
Sales Revenue	1,200,000
Cost of Goods Sold (COGS)	550,000
Gross Profit	650,000
Operating Expenses	300,000
Operating Income	350,000

3. **NPV Calculation:**

1. **Identify Cash Flows:**
    - Initial Investment (Year 0): $800,000
    - Operating Income Year 1: $100,000
    - Operating Income Year 2: $220,000
    - Operating Income Year 3: $350,000
    - Operating Expenses Year 1: $150,000
    - Operating Expenses Year 2: $200,000
    - Operating Expenses Year 3: $300,000
2. **Calculate NPV for Each Year (Discount Rate = 8%):**
    - Use the formula: $PV = \sum (FV/(1+i)^n)$
    - NPV Year 1: $(100,000/(1+0.08)^1) - (150,000/(1+0.08)^1) = -\$46,296.30$
    - NPV Year 2: $(220,000/(1+0.08)^2) - (200,000/(1+0.08)^2) = \$17,146.78$

- NPV Year 3: $(350,000/(1+0.08)^3) – (300,000/(1+0.08)^3) = \$39,691.61$

3. **Cumulative NPV:**
    - Cumulative NPV Year 1: -$46,296.30
    - Cumulative NPV Year 2: -$29,149.52
    - Cumulative NPV Year 3: $10,542.09
4. **Break-Even Point:**
    - The break-even point is reached when the cumulative NPV becomes positive.

4. **Unit Price Based on Pricing Strategy:**

- Assumption: The unit price is set at $100 for the adjustable play table, considering production costs, competitors' pricing, and perceived customer value.
- Justification: This assumption aligns with a pricing strategy that balances affordability for the target market while ensuring profitability.

References: Value-Based Pricing & How Do You Know When the Price is Right?

7.2 Intellectual property report

1.

1. US3094948A - Adjustable table supporting construction (Slanting Mechanism for Tabletop)
2. US8256359B1 - Height adjustable table (Height Adjustability for Table)

2.

Patent (US8256359B1):

The patent in question, US8256359B1, describes a height adjustable table with a unique telescoping leg arrangement. The key aspects of the invention involve eliminating horizontal supports between the legs to increase storage and knee space under the table, as well as providing telescoping legs that allow for manual and/or motorized adjustment of the table height.

Importance of the Invention:

1. **Space Efficiency:** The elimination of horizontal supports between the legs contributes to increased storage space beneath the table. This is particularly valuable for users who need to store large items, such as computers, under the table.
2. **Improved Knee Space:** Traditional height adjustable tables often have obstructive supports that limit the space available for a user's knees. The disclosed invention addresses this issue by removing such supports, enhancing user comfort.
3. **Telescoping Leg Arrangement:** The telescoping leg arrangement allows users to manually or motorize the adjustment of the table height. This flexibility is crucial for accommodating users of different heights and catering to various activities conducted at the table.

Legal Constraints and Implications:

1. **Patent Protection:** The patent, US8256359B1, provides legal protection for the disclosed invention. This means that others cannot make, use, sell, or distribute the patented height adjustable table without permission from the patent owner (Baker Manufacturing Co Inc).
2. **Exclusivity Period:** The patent is set to expire on January 31, 2027. Until then, Baker Manufacturing Co Inc has exclusive rights to the patented invention. After expiration, others can freely use the technology.
3. **Potential Licensing and Litigation:** Companies interested in manufacturing a similar height adjustable table would need to negotiate licensing agreements with Baker Manufacturing Co Inc. Failure to do so could lead to legal action for patent infringement.
4. **Prior Art Consideration:** The patent cites related patents in the field of height adjustable tables. This indicates that the inventors and the patent office considered existing technologies while determining the novelty of the invention.

In summary, the patented height adjustable table addresses common issues with traditional designs, offering improved space efficiency and user comfort. The legal protection granted by the patent ensures that the inventors or assignees have the exclusive right to the technology for a specific period, encouraging innovation by providing a limited-time monopoly on the invention.

Patent(US3094948A):
The patent with number US3094948A, titled "Adjustable Table Supporting Construction," is an intellectual property that grants exclusive rights to its inventor, George F. Clow. The importance of this intellectual property lies in its ability to protect the unique features and functionalities of the adjustable table supporting construction described in the patent. Here are some key points regarding the importance of this intellectual property and the legal constraints it places on developing similar products or businesses:

1. **Exclusive Rights:**
    - The patent provides George F. Clow with exclusive rights to make, use, sell, and distribute the adjustable table supporting construction as described in the patent.
2. **Market Advantage:**
    - Having exclusive rights gives the inventor a competitive advantage in the market. Competitors cannot legally replicate or sell the patented invention without permission, protecting the inventor's market share.
3. **Innovation Protection:**
    - The patent system encourages innovation by protecting inventors from unauthorized use of their inventions. This protection fosters a climate where inventors are willing to invest time and resources into developing new and useful technologies.
4. **Monetary Value:**
    - The patent represents an asset. It can be licensed, sold, or used as collateral for securing funding. Investors are often more willing to invest in a business that holds valuable intellectual property.
5. **Legal Constraints on Competitors:**

- Competitors are legally constrained from producing, selling, or using a substantially similar adjustable table supporting construction without obtaining proper authorization from the patent holder.

6. **Duration of Protection:**

    - The patent provides protection for a limited duration, typically 20 years from the filing date. Once the patent expires, the technology enters the public domain, allowing others to freely use and build upon it.

7. **Freedom to Operate:**

    - For businesses and individuals considering the development of similar products, the existence of this patent imposes legal constraints. They must ensure that their products do not infringe on the patented claims to avoid legal consequences.

8. **Incentive for Further Innovation:**

    - The patent system incentivizes inventors and businesses to continue innovating by offering protection for their inventions. This, in turn, contributes to technological progress and the advancement of industries.

9. **Enforceable Rights:**

    - The patent holder has the legal right to enforce the patent by taking legal action against entities that infringe on the protected invention. This may involve seeking damages or injunctions to prevent further infringement.

In summary, the intellectual property represented by the patent US3094948A is crucial for protecting the inventor's rights, fostering innovation, providing a competitive advantage, and contributing to the overall progress of technology and industry. Businesses operating in the same domain need to be aware of and respect these legal constraints to avoid infringement issues.

7.3 Project plan update

Wrike Timeline Snapshot.

8 Design Day Pitch and Final Prototype Evaluation

Answers to the questions we can be asked:

1. Importance of the Problem: The significance of addressing the client's unique needs through an adjustable table lies in its direct impact on autonomy and daily life. The core problem solved is the creation of a device that seamlessly accommodates a wheelchair. The focus on adjustability is critical, as it directly correlates with the client's ability to engage with the device effectively, making it an essential aspect of the project.

2. Basic User Requirements and Importance: The user requirements for the adjustable table are rooted in diverse needs. The adjustability within height parameters is fundamental for promoting autonomy, safety, and long-term value. Portability ensures the table's versatility in various locations, both indoors and outdoors, supporting participation in diverse activities. Safety and durability are prioritized for daily use, while versatility of surfaces ensures comfort in different environments.

3. Differentiation in Design: Our design distinguishes itself by offering tailored adjustability within specific height parameters, addressing the unique needs of mobility devices. Enhanced portability allows flexibility in usage, both inside and outside the house, accommodating diverse activities. Safety and stability are prioritized through a sturdy design that remains stable even when pushed, ensuring safety during daily use.