GNG2101

**Design Project Progress Update**

**Bathroom Assist (g\_2)**

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**Table 1. Acronyms**

| **Acronym** | **Definition** |
| --- | --- |
| BOM | A list of all the materials used in the making of the product |
| DFX | Used to describe the metrics that were prioritized during the design process |

**Table 2. Glossary**

| **Term** | **Acronym** | **Definition** |
| --- | --- | --- |
| Acrylic |  | A durable glass-like plastic material |
| Granularity |  | The level of detail |
| Marginal Spec |  | The compromised specification which is likely achievable |
| Neoprene |  | A foam-like plastic material |
| Target Spec |  | The ideal specification that is likely unachievable |

# Introduction

This deliverable aims to outline our development process from DFX to the creation of our first detailed design. The deliverable will; explain what we're designing for and why, describe our given problem and initial solution designs, and show a detailed blueprint and Bill of Materials of our expected final product.

# Sustainability Report and DFX

## Sustainability report

**Table 3. Triple Bottom Line**

|  | Social | Economic | Environmental |
| --- | --- | --- | --- |
| Positive | 1. Give clients personal freedoms.  2. Allow clients greater integration into society.  3. Boost a client's self confidence. | 1. Low cost of production.  2. Low barrier for product redesign.  3. Low complexity materials, highly scalable. | 1. Reduce plastic waste from testing failed solutions  2. Reduce CO2 emissions of shipping failed solutions  3. Reduce fabric waste from modifying clothing |
| Negative | 1. Requiring a product for the bathroom is embarrassing  2. Owning a product like this makes it clear to others that you have a disability  3. This product could reinforce the false idea that all disabled people need help to function | 1. Paying for the materials  2. Paying for labour  3. Product is very specific and will have a potentially small market | 1. Increase plastic waste from disposal  2. Increase CO2 emissions of components  3. Increase electricity consumption during production |
| Profit | - Improve client quality of life  - Slightly worsen client privacy | - Low cost  - Low profitability | - Less plastic waste  - More electricity consumption |

LCA:

**Define objectives/scope:**

Inputs:

* Electrical Power

Output:

* Kinetic Energy

**Inventory Analysis:**

### Materials & Manufacturing

* Raw Material Extraction:
  + Metals: Mining of iron ore for steel production, copper for wiring, and aluminum for casing or frames.
  + Plastics: Derived from petroleum or natural gas, refined into polyethylene, polypropylene, and other polymers used in insulation, casings, and wiring.
  + Glass and Ceramics: Mining of silica sand and bauxite for glass or ceramic components, including protective coatings and substrates.
  + Other components: Rare earth metals (e.g., lithium, cobalt, and nickel for batteries), and silicon (for semiconductors and circuitry).
* Processing:
  + Metals: Smelting and alloying processes to create sheet metal, wiring, and connectors.
  + Plastics: Polymerization and molding processes to form plastic housings, circuit boards, and insulation materials.
  + Electronics: Printed circuit boards (PCBs) created using etching, soldering, and mounting of electronic components (transistors, capacitors, etc.).
  + Fabrication: Cutting, stamping, and machining of metal and plastic parts for components and enclosures.
* Sub-Assembly: Assembly of intermediate components such as wiring harnesses, power supplies, and modules before final assembly.
* Energy Use: Consumption of electrical power and fuel in factories for machinery, heating, and cooling systems.

### 2. Packaging

* Raw Material Extraction:
  + Cardboard: Harvesting of wood pulp to create cardboard packaging, including forestry impacts.
  + Plastics: Derived from oil or natural gas to form bubble wrap, plastic packaging inserts, shrink wrap, and protective coverings.
  + Ink and Paper for Labels: Printing materials for branding, barcodes, and information.
* Processing:
  + Manufacturing: Cardboard boxes die-cutting and gluing, plastic molding for inserts, and inkjet or offset printing for advertising/labels.
  + Additional Materials: Styrofoam or foam inserts for product protection, adhesives used in packaging.
* Energy Use: Power required for printing, die-cutting, and molding of packaging components.

### 3. Transport

* Raw Materials Transport:
  + Shipping of raw materials (metals, plastics, chemicals) from mines, refineries, or chemical plants to manufacturing facilities.
* Finished Goods Transport:
  + Shipping: Use of container ships, trucks, and rail for long-haul transportation of assembled products from manufacturing centers to warehouses or distribution hubs.
  + Energy Use: Diesel, gasoline, or electric energy consumption by transportation vehicles, plus packaging waste generated during shipping.
* Warehousing:
  + Energy used for storing and managing products, including heating/cooling, lighting, and material handling equipment.

### 4. Usage

* Electrical Components:
  + Energy Consumption: Power drawn by the final product during its operational lifetime (such as electronics consuming electricity).
* Water Use: Cooling systems, air conditioning in manufacturing plants, or use of water in cleaning, surface treatment, or cooling of products in use.
* Resources for Maintenance/Repairs:
  + Replacement of components (batteries, chips) or consumables (e.g., toner, lubricants) throughout the product's life cycle.

### 5. End of Life

* Recycling:
  + Metals: Steel, aluminum, and copper components are typically sorted and recycled. Processes include shredding, melting, and reforming into raw materials.
  + E-waste: Collection of electronics for dismantling and recycling valuable materials like gold, silver, and palladium from PCBs and connectors.
* Landfill:
  + Non-recyclable components like plastic insulation, mixed plastics, rubber, and non-valuable electronic components are typically discarded in landfills.
  + Environmental Impact: Leaching of chemicals from plastics and electronic components into soil and groundwater.
* Energy Use: Energy required for collection, transportation, and recycling or disposal processes.

**Impact Assessment:**

**Materials & Manufacturing: 70%**

* High Resource Consumption: This stage involves the extraction of raw materials like metals, plastics, and rare earth elements, which are energy-intensive processes. Mining and refining metals (e.g., copper, aluminum, lithium) have significant environmental impacts due to deforestation, water usage, and energy consumption.
* Energy-Intensive Processe**s**: Manufacturing involves complex steps like smelting metals, molding plastics, and fabricating electronic components, all of which require significant amounts of electricity and fuel.
* Waste Generation: Industrial waste is generated during metal extraction, plastic production, and electronics manufacturing. Chemical byproducts, tailings from mines, and emissions from smelting and refining processes contribute heavily to environmental damage.
* Carbon Footprint: Manufacturing plants and processing factories emit large amounts of greenhouse gases due to the burning of fossil fuels for power, contributing to climate change.

**Packaging: 10%**

* Lower Material Intensity: Packaging typically requires less material compared to the actual product, though it still has an environmental impact, primarily from plastics and cardboard derived from petroleum and wood.
* Recyclability: A significant portion of packaging (like cardboard) is recyclable, which mitigates its long-term environmental damage.
* Energy Use: Packaging production (e.g., plastic molding, cardboard creation, and printing) requires energy but is generally much less intensive than the manufacturing of the products themselves.

**Transportation: 20%**

* Fossil Fuel Dependency: Transporting raw materials and finished goods involves a significant amount of fuel consumption, particularly for long-distance shipping via trucks, trains, and ships. Transportation is largely dependent on fossil fuels (diesel, gasoline), which contributes to greenhouse gas emissions.
* Emissions: The carbon footprint from transportation is substantial, particularly for international shipping and air freight, which are responsible for a large percentage of global CO₂ emissions.
* Logistics and Warehousing: Storage facilities and warehousing also consume energy for lighting, heating, and refrigeration, adding to the overall environmental impact.

**Usage: 40%**

* Energy Consumption: The product consumes electricity during its operational life, and ongoing energy use contributes to the carbon footprint of the product.
* Maintenance and Replacement: batteries (which are how the pistons are powered) that require constant changing and disposal contribute additional environmental impacts due to the energy and materials required for production and disposal.

**End of life: 50%**

* Electronic Waste (E-waste): Disposal of electronic products can have a severe environmental impact, as e-waste contains hazardous materials like lead, mercury, and cadmium, which can leach into the soil and water if not properly recycled.
* Low Recycling Rates: While metals are often recycled, many other components, especially plastics and mixed materials, are not. Inadequate recycling facilities and practices in many parts of the world exacerbate the problem.
* Landfill Impact: Non-biodegradable plastics and toxic chemicals from electronic components persist in the environment for decades or longer. The impact on ecosystems from landfill disposal is significant, contributing to soil contamination and greenhouse gas emissions from decomposing organic material.

**Interpretation:**

**Materials & Manufacturing:**

Incorporating recycled materials into the production process can drastically lower the product's current environmental effect. For instance, employing recycled polymers or metals could lessen the need to extract raw materials, reducing energy use and the damage that mining activities cause to the environment. The product's carbon footprint could be further reduced by investigating energy-efficient manufacturing techniques, such as employing renewable energy sources in production facilities.

**Packaging:**

Even though packing has a negligible overall influence on the environment, it can still be improved. Long-term waste could be decreased by switching to biodegradable packaging materials like recycled cardboard or plant-based polymers. This change would guarantee that any packaging that the user threw away would decompose in the environment more quickly, reducing the amount of waste that ends up in landfills and the emissions that go along with it.

**Usage:**

During its use, the product has a negligible effect on the environment. Promoting the installation of complementary systems, such as toilets with minimal water usage, might, however, further lessen the overall environmental impact of the product. Through the product's alignment with other eco-friendly activities, consumers can attain enhanced resource conservation, including gradually reducing water consumption.

**End of life:**

. The impact of the product's end of life can be lessened by promoting appropriate recycling procedures. Giving consumers access to a recycling program or service would help guarantee that priceless parts are retrieved and dangerous materials are not disposed of inappropriately. It would also include instructions on how to safely disassemble or return the device. With this strategy, the negative environmental effects of e-waste and landfill accumulation might be greatly mitigated.

## Design for X

1. **Redesign**
   1. Allow for the product parts to be modular and replaceable, to allow for users of all sizes to have more compatibility and comfort when using the design.
   2. This would be achieved by ensuring that the product can be easily disassembled and that additional modified parts can be attached to the main belt contraption affecting the main circuitry of the device.
   3. The product ideally allows for the left and right parts of the main belt contraption to be detached and replaced by a part with similar required specs.
   4. More replaceable and modular parts are beneficial to the system.
2. **Flexibility**
   1. The product can be adjusted to a number of differing waist sizes to allow for the user to continually use the product as they grow up, alongside allowing the user to position their hands on the device in a way that is comfortable for them.
   2. This would be measured by both the required range of motion to use the device(degrees) and its maximum length (meters).
   3. Ideally, the product can be used with only 90 degrees of horizontal range of motion and can extend to cover the front half of the average waist size of a human adult (15 inches).
   4. A smaller range of motion usage is better.
3. **Portability**
   1. This product's use case is that it allows people with certain debilitating conditions to become far more independent. As a result, the product must be made with specific weight and dimensional considerations in mind.
   2. This would be measured by checking to see that the product is sufficiently foldable/collapsible such that it can fit into an average-sized backpack/briefcase.
   3. To achieve this design specification, the product ought to weigh less than 3 Kgs and be less than 18(h)/12(w)/6(d) in volume.
   4. A product that has less weight and a smaller dimensional volume is better.
4. **Simplicity**
   1. The product has no intended age group for usage and therefore must be sufficiently simple enough such that low intuition and low information users can use the product without a great deal of friction.
   2. This would be measured through the product's time to usage (seconds) by different groups of people, segregated by age.
   3. Ideally, product usage time for a first-time user of any age group is 30 seconds max.
   4. A quicker usage time is better.
5. **Reliability**
   1. The product is intended to be used for the user's entire life, as the intended market is those who have incurable, debilitating issues. As a result, the product must be sufficient over both a long time horizon and a variety of use situations.
   2. This would be measured by analyzing the product components' individual expected usable lifespans (months/years), alongside their general resilience, measured through their Ingress protection rating.
   3. This would be achieved if the product can be used 5,000 times over 2 years minimum and if each individual component has a rating of IP66.
   4. More usage before a required repair is better, alongside a higher IPXX rating.

# Problem Definition, Concept Development, and Project Plan

## Problem definition

Client Needs:

* A device that pulls down an object utilizing little frontloaded hand movements
* A device that is extendable/retractable and fits a variety of people.
* A device that is lightweight
* A portable device that requires little hand-assisted setup.
* A device that requires no usage of the knees to operate fully.
* A device that either does not utilize any electronics or is waterproof.
* A device that a small child can independently set up.

Problem Statement:

Develop a durable, portable, extendable, and attachable belt that can push up and pull down pants of all waist sizes.

needs-inspired metrics:

* Portability (cm^3 size)
* Extendability (m length)
* Flexibility (θ degrees bendability)
* Usability (seconds time-till-usage)
* Durability (months/years useful lifespan)
* Weight (g)
* Cost (CAD)

Similar solution benchmarking:

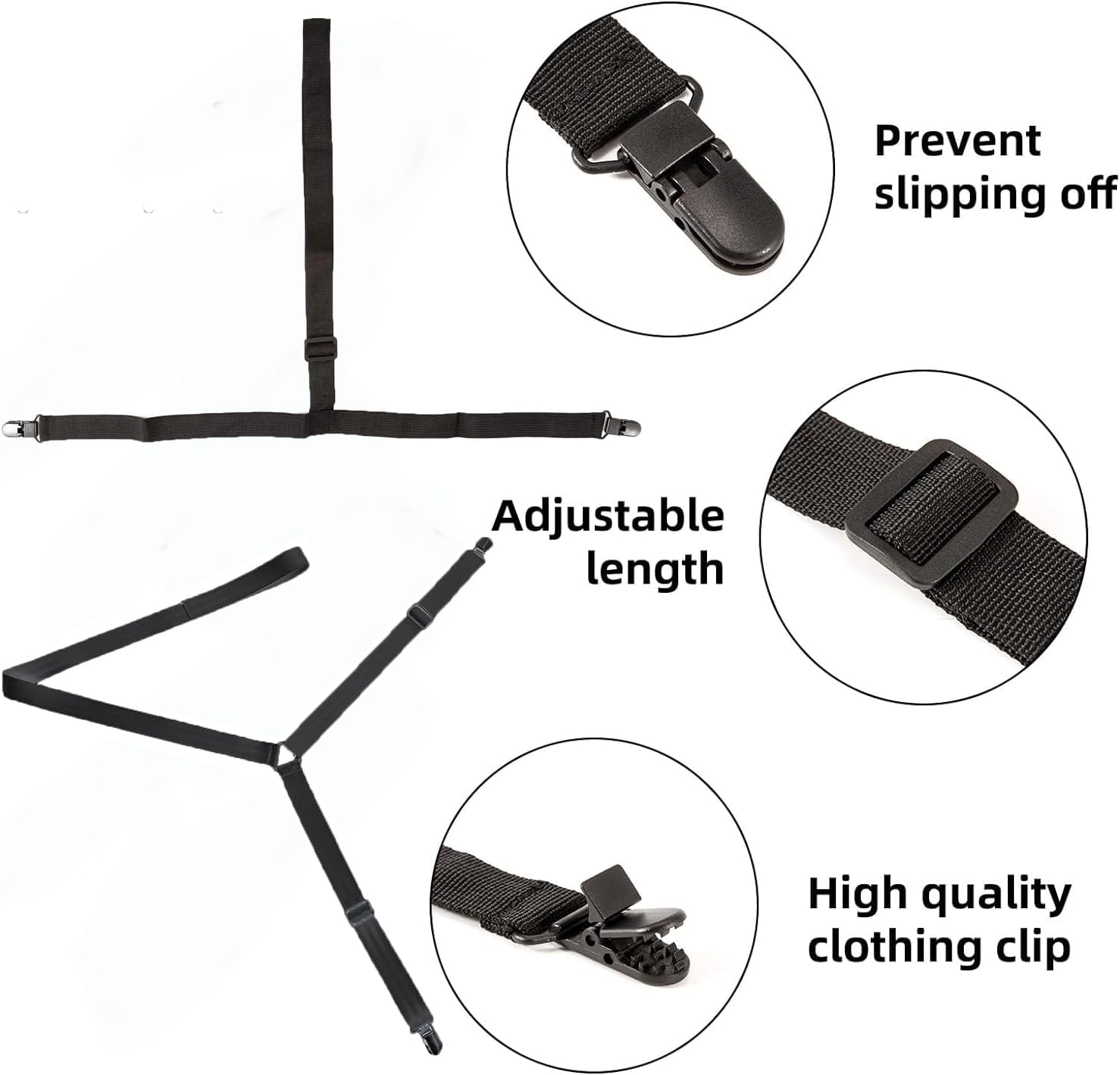
Dressing Stick (example: <https://www.performancehealth.ca/dressing-stick-deluxe> )

**Figure 1. Dressing Stick**



Dressing Clip (example: <https://www.amazon.ca/Assistive-Disabled-Dressing-Disability-Pregnant/dp/B0CST2YNC2> )

**Figure 2. Dressing Clip**



Sliplift aid (example: <https://www.activeliving.ie/product/sliplift-pants-aid/> )

**Figure 3. Sliplift Aid**



**Table 4. Benchmarking**

|  | Importance | Units | Dressing stick | Dressing Clip | Sliplift Aid |
| --- | --- | --- | --- | --- | --- |
| Portability | 5 | cm^3 | 130.7 | 10 | 15.75 |
| Extendability | 3 | m | 0 | 0 | 0 |
| Flexibility | 2 | θ degrees bendability | 0 | 360 | 10 |
| Usability | 5 | Seconds to use | 5 | 20 | 10 |
| Durability | 4 | Years | 5 | 3 | 3 |
| Weight | 5 | g | 131.5 | 20 | 40 |
| Cost | 1 | CAD | 12.69 | 48.45 | 104.16 |

**Table 5. Target/Marginal Specs**

|  | Units | Maringal Spec | Target Spec |
| --- | --- | --- | --- |
| Portability | cm^3 | 100 | 80 |
| Extendability | m | 0.5 | 1 |
| Flexibility | θ degrees bendability | 90 | 270 |
| Usability | Seconds to use | 10 | 5 |
| Durability | Years | 5 | 10 |
| Weight | g | 250 | 130 |
| Cost | CAD | 100 | 75 |

* The client is expected to use the product daily at school and so portability is necessary for this product. 80cm^3 was chosen as the target spec since it allows the client to easily pack the product into their backpack. 100 cm^3 is the marginal spec since the size is more realistic based on the functionality of the product, however it is still easy to pack into a separate bag to bring to school.
* We intend for this product to continue being useful as the client grows up. 1m of extendability was chosen as a target spec since it allows the client ample room for growth. 0.5m is marginal since it allows for growth while not compromising durability as extending the product to 1m would likely lead to frailty.
* The product should not break when the client bends it and as such a degree if flexibility is required. 270° was chosen as the target spec since it allows the product to bend significantly before breaking. 90° was chosen as the marginal spec since it allows for bending without compromising the usability of the product by using flimsy materials.
* For an accessibility product a short use time is expected. 5 seconds is the target spec since it will greatly reduce the time required to dress/undress. 10 seconds is the marginal spec since it still reduces time to dress/undress however it is more realistic given the clients struggles with flexibility.
* Since the product is intended to continue assisting the client as they grow, it must also be durable enough to not break after several years of use. A life span of 10 years was chosen as the target spec since it provides the client through most of highschool at which point the hope is that the client will have outgrown the need for our product. A life span of 5 years is marginal since it is more realistic when considering the lifespan of the expected material used in our product.
* The clients grip strength issues require for the product to be relatively light in for use. 130g was chosen as the target spec to mirror the weight of the benchmarked dressing stick. This weight is believably light for our product. 250g is the decided acceptable weight range for our product given the weight of our expected materials.
* 75$ is the target cost since it allows us room to make mistakes while building the final prototype. 100$ is the marginal cost since it is the total allotted budget.

## Concept development

Concept Ideas:

* Full loop belt with clamps to hold pants
* Piston with one clamp on end and stick
* Flexible semi-circle with piston powered clamps
* Rod with 2 clamps on it
* Belt buckle forced expander

**Table 6. Concept Comparison**

|  | Units | Mari-ngal Spec | Target Spec | Full loop belt with clamps to hold pants | Piston with one clamp on end and stick | Flexible semi-circle with piston powered clamps | Rod with 2 clamps on it | Belt buckle forced expander |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Portability | cm^3 | 100 | 80 | 100 | 80 | 85 | 110 | 100 |
| Extendability | m | 0.5 | 1 | 0.3 | 1 | 0.5 | 0 | 0 |
| Flexibility | θ degrees range of motion | 120 | 90 | 180 | 45 | 90 | 45 | 180 |
| Usability | Seconds to use | 10 | 2 | 10 | 3 | 9 | 3 | 10 |
| Durability | Years | 5 | 10 | 4 | 5 | 5 | 10 | 2 |
| Weight | g | 250 | 130 | 200 | 140 | 150 | 130 | 230 |
| Cost | CAD | 100 | 75 | 100 | 80 | 75 | 75 | 100 |

**Choose one or a few promising solutions you wish to develop further based on your**

**evaluation**

Of all the products examined, the two most promising solutions are the Flexible semi-circle with piston-powered clamps and the Full loop belt with clamps to hold pants.

**Develop a global design concept which is either an integration or modification of the promising concepts chosen in the previous step, or a brand-new concept created from these ideas. Justify your approach.**

Out of the promising ideas tested and chosen, a combination of the “Flexible semi-circle with piston-powered clamps” and the “stick piston with one clamp on the end” would fulfill most constraints.

By utilizing pistons attached to the belt alongside clamps attached to the belt, the product will be able to pull down pants without the user having to exercise any vertical range of motions, causing less strain than the other products tested.

The product will fulfill this by utilizing buttons attached to the belt, which will allow the user to clamp their pants and extend the pistons, pulling the pants down. The user will hold onto the remotes, and pull the pants back up when they need to put them back on.

**Visually represent (sketch, diagram, CAD model, etc.) your global concept**

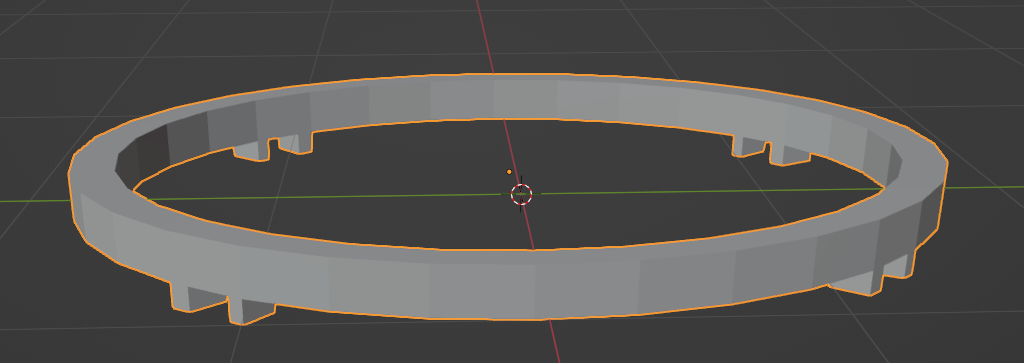


Figure 4: Full loop belt with clamps to hold pants

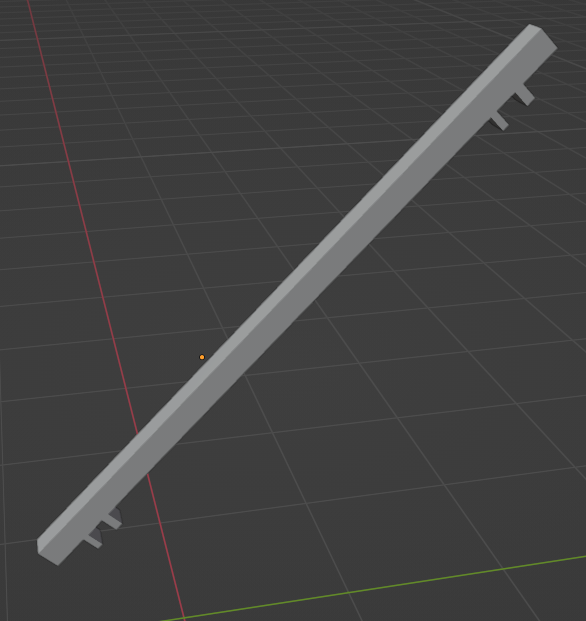
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Figure 5: Piston with one clamp on end and stick Figure 6: Rod with 2 clamps on it

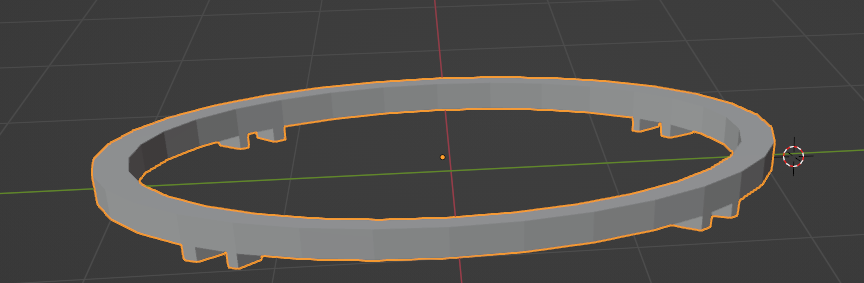
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Figure 7: Belt Buckle forced expander

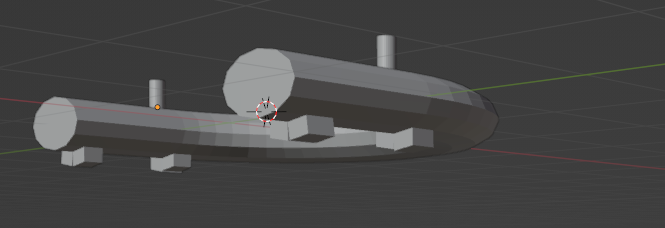


Figure 8: Flexible semi-circle with piston powered clamps (Global Concept)

**Provide a few lines explaining your concept’s relationship to the target specifications, as well as its benefits and drawbacks.**

By examining the previous concepts and how they fare against the metrics, a concept like the Flexible semi-circle belt with piston-powered clamps seems to be the most viable solution for the problem presented.

This product stands out, as it gives full functionality while only requiring 90 degrees of horizontal range of motion, and 0 degrees of vertical range of motion, both of which are very important for the client to effectively use the product.

The product also beats the others in terms of portability, as it takes half as much space as the full loop belt solutions and is far easier to fold and pack than the stick.

Finally, its design allows for extendability, as the piston length can be manually configured by the user to not extend past the length required to pull down their garment.

**Provide a few lines explaining your concept’s relationship to the DFX factors you identified in Project Deliverable B.**

**Design for Redesign:**

The product's main benefit as it relates to redesign is the fact that to make it accessible for larger people the only components that must change are the length of the belt, the length that the pistons must be able to extend, and the spacing between the clamps. The benefit here is the modularity of the system, as each component can be tweaked without causing trouble to the components.

**Design for Flexibility:**

As described above, the product is extremely flexible, as it allows for full use with a relatively small range of motion.

**Design for Portability:**

Also as described above, the product is far more foldable than the other concepts/ideas and can be packed far more easily than the ideas which weigh less.

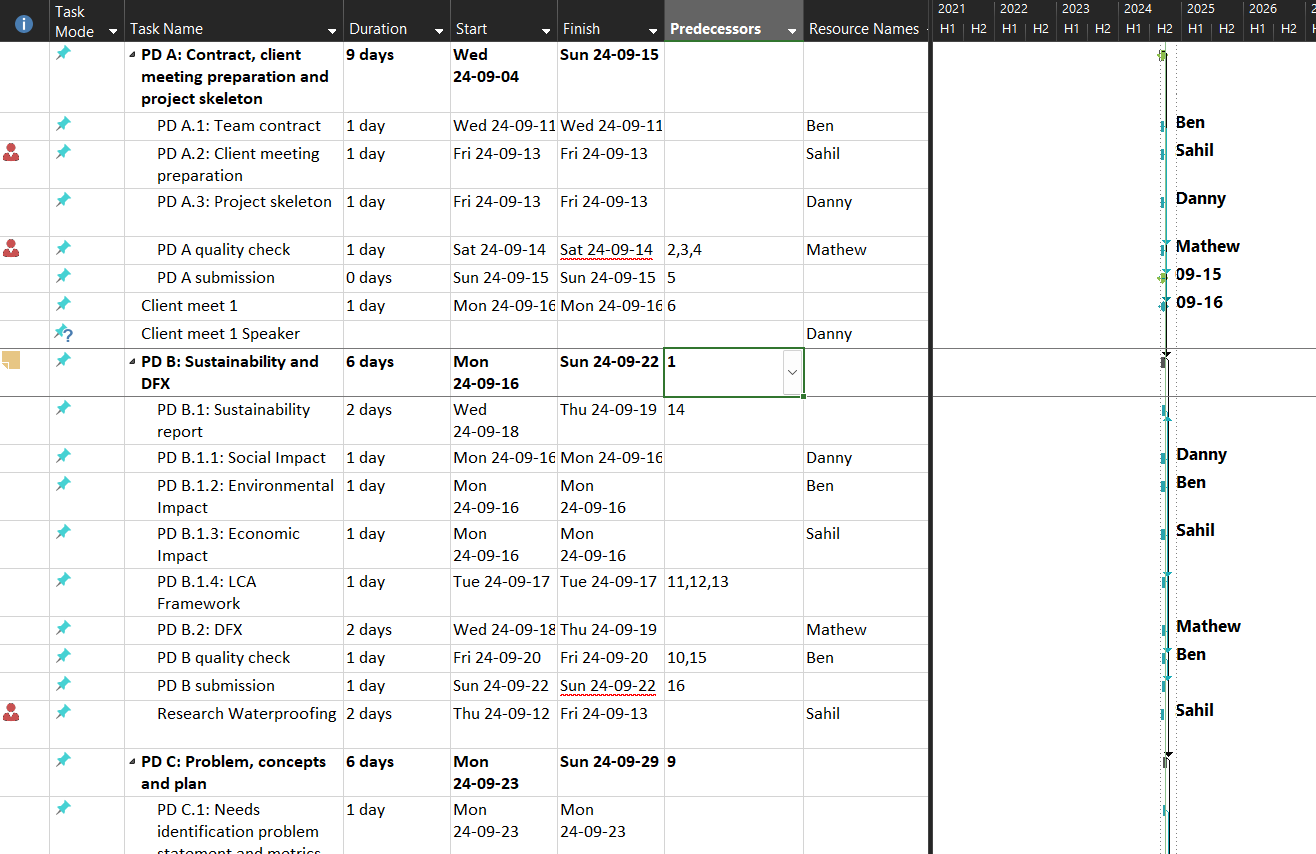
**Design for Simplicity:**

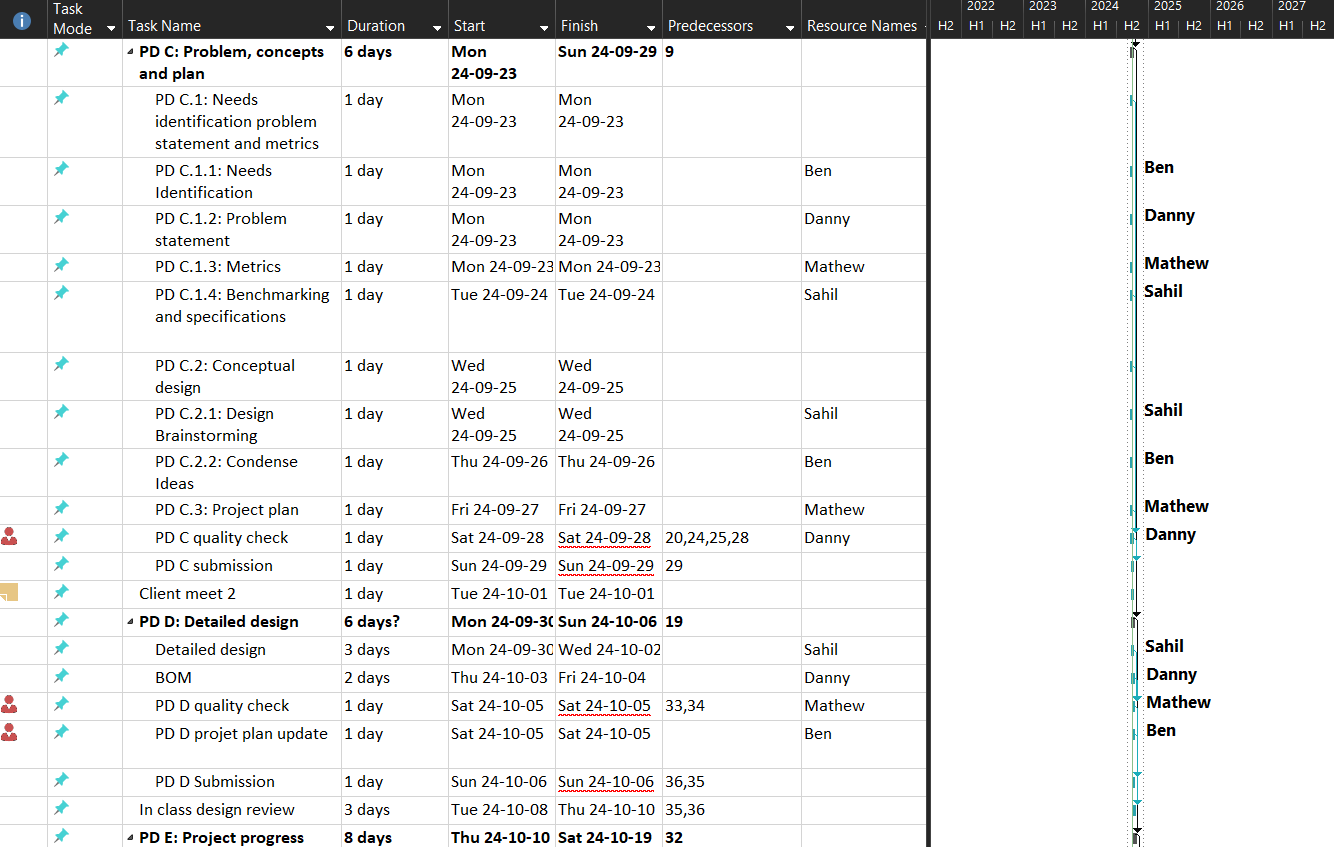
The product's usage is handled solely by ~4 buttons, and therefore the time to usage past the first time is relatively low.

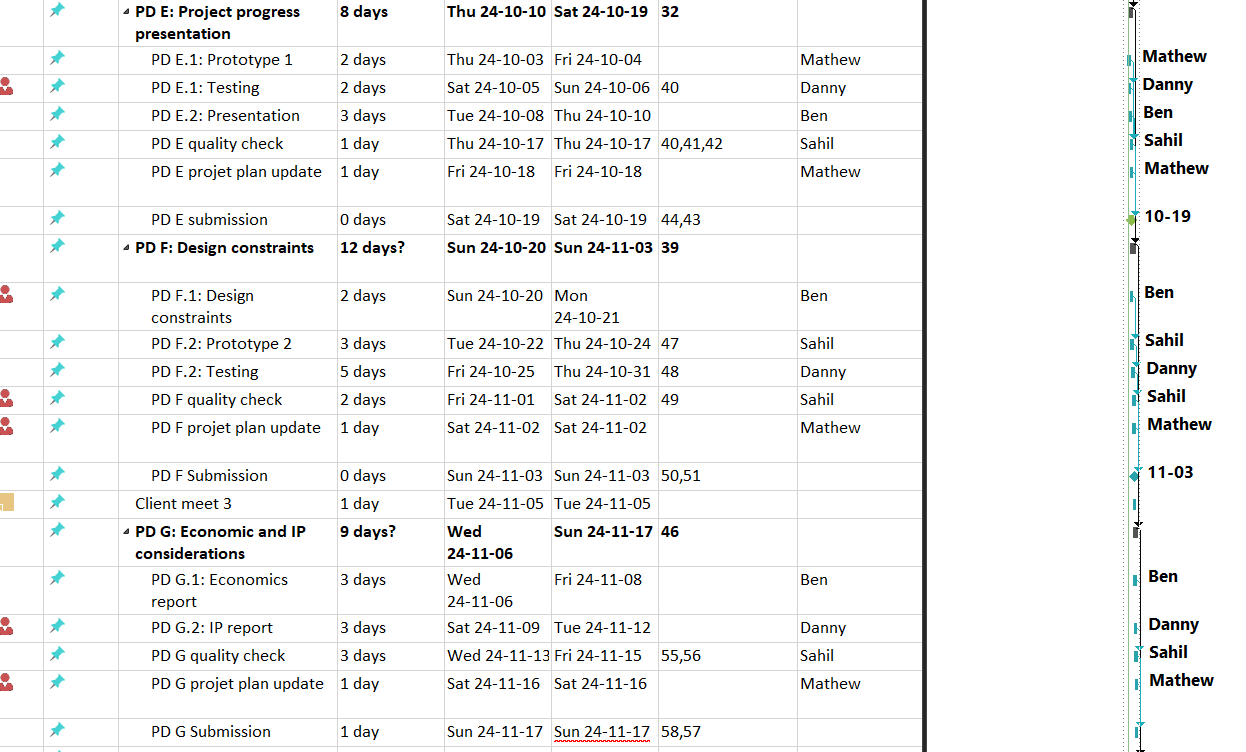
**Design for Reliability:**

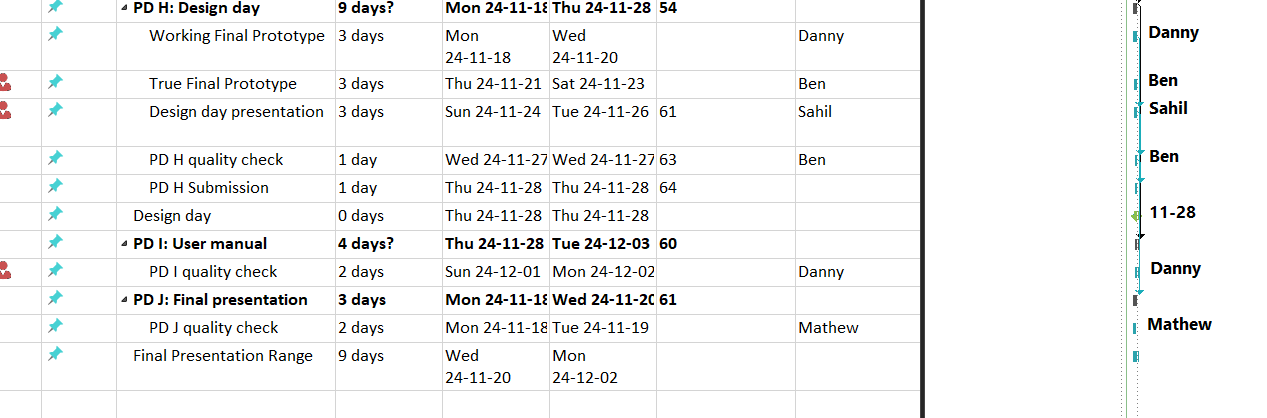
Small pistons last for a relatively long time (>3 years), and small circuit boards (like the ones which are driven by the buttons) last for decades when used at most 3 times a day. The other parts (clamps, belt fabric, buttons, etc.) are merely driven by those components, and have a natural lifespan far longer than the expected use of this product.

## Project plan

**Figure 9. Project Plan**

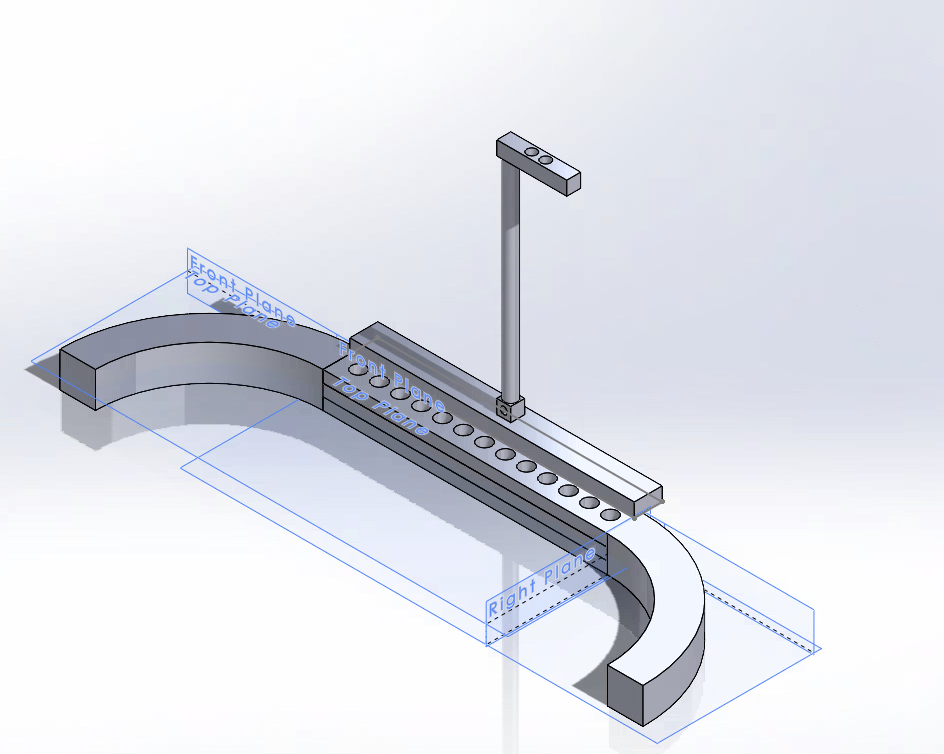






# Detailed Design and BOM

**Figure 10. Detailed Design**



## Detailed design

**Summarize the client feedback that you received during your second client meeting and clearly state what needs to be changed or improved in your design.**

The greatest feedback we received from the client meeting is that we need to pay further attention to the materials that we utilize, as going into the meeting, we had a fully designed idea, but we needed to figure out what the physical manifestation would look like. As a result, we improved the design by increasing the granularity, by creating specific dimensions for our product alongside specific materials used for each part of the product.

**Provide a detailed list of skills and resources you have at your disposal that will enable you to create your design. If there are skills or resources missing to complete your design, describe how you will obtain them.**

* Solidworks/CAD/Blender skills.
* Mill/3D Printer/Laser Cutter.
* We will purchase any missing resources needed to complete the project online, or through Makerstore.
* Any necessary skills will be learned though research

**Explain what considerations you must take to design or manufacture your concept, based on your updated detailed design, to meet your DFX factors. Are some factors more important than others? Why?**

The most important design factors are **design for redesign** and **design for portability**. Design for redesign is important as the product is meant to be utilized for a significant period and as a result requires a design that can be modified quickly to be used by a growing/changing person. Design for portability is also important because the product is intended to be brought alongside wherever the user goes.

* We take into consideration the design for extendability by making the middle piece of the half-belt have holes in them alongside a sprung pin that locates in the holes and can be depressed to slide the internal piece can be moved to be shorter or longer
* We consider design for flexibility by having the clamps and the vertical motion of the device be controlled by buttons and switches. This design is also simplistic, which is another design factor.
* We design for portability by ensuring that the product is lightweight (under 3kg) and small enough to fit inside the average backpack.
* We design for simplicity by assigning any functionality to buttons and switches making it easy to learn how to use the product. The clamps and pistons extend in seconds allowing for quick use times.
* We design for reliability by building the base piece out of durable (½”)thick acrylic which will extend the lifespan of the product significantly.

**Provide a realistic assessment of the time required to implement your design and the actual time your group and its individual members have at their disposal**

The time required to implement the design as it exists now given all the base materials and parts is 3 ½ weeks if the group puts 5-7 hours per week (approximately 25 hours to build).

Each individual member can reasonably allocate 5 hours a week towards completing the design as of right now, trailing downwards as the semester progresses.

**Define any other critical product assumptions that could affect your ability to implement your design. For example: the acceptable values for a specification, availability of material/component, or a critical functionality.**

1. Piston length, availability, and time of arrival could cause problems and delays as it pertains to the delivery of the product, because our design heavily utilizes pistons and is non-functional without them. If pistons are unavailable or arrive late, we will be unable to build the necessary prototypes.
2. Acrylic sheets rarely come in the desired thickness, and when they do, they are not of the correct size and are expensive. Sourcing acrylic for use in milling and laser cutting could prove to be a bottleneck.

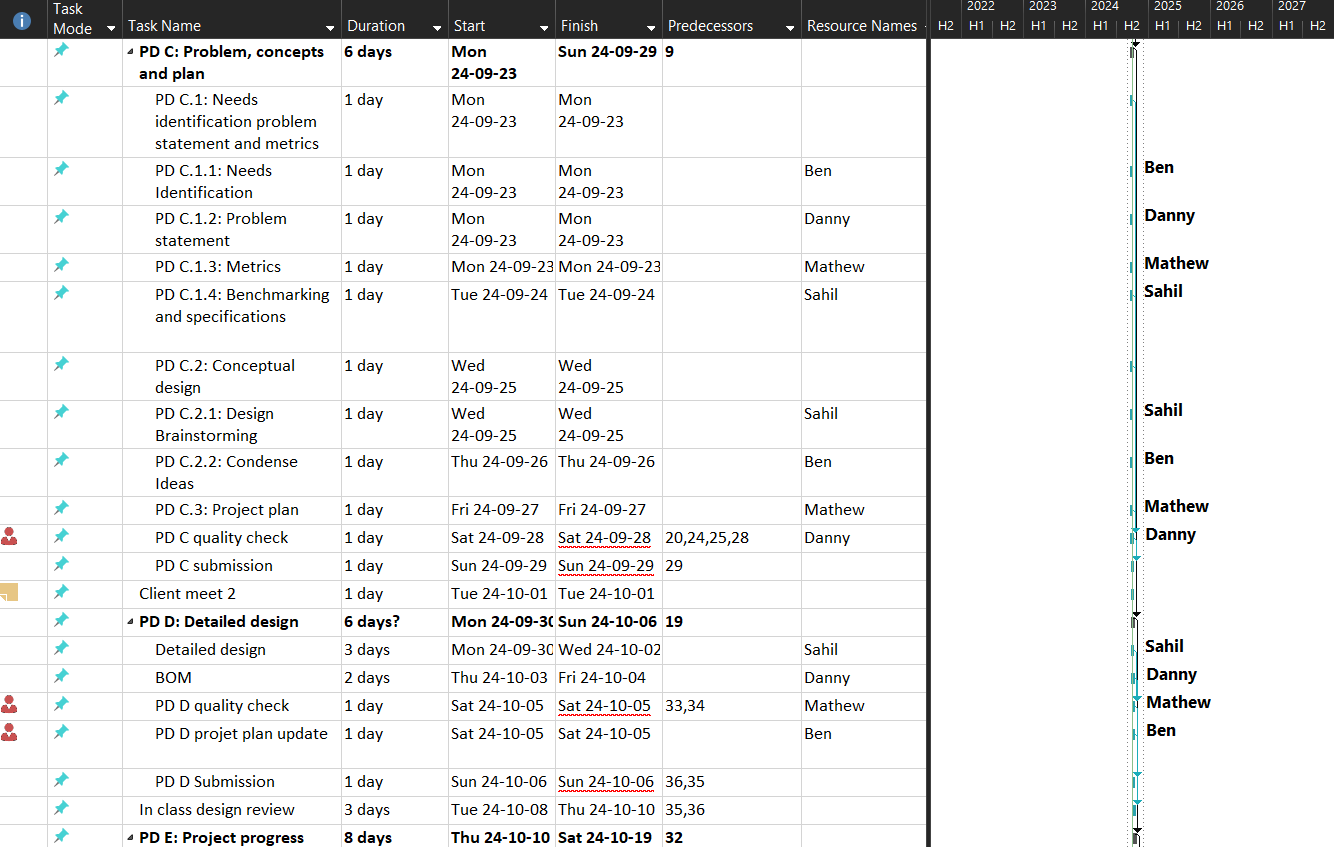
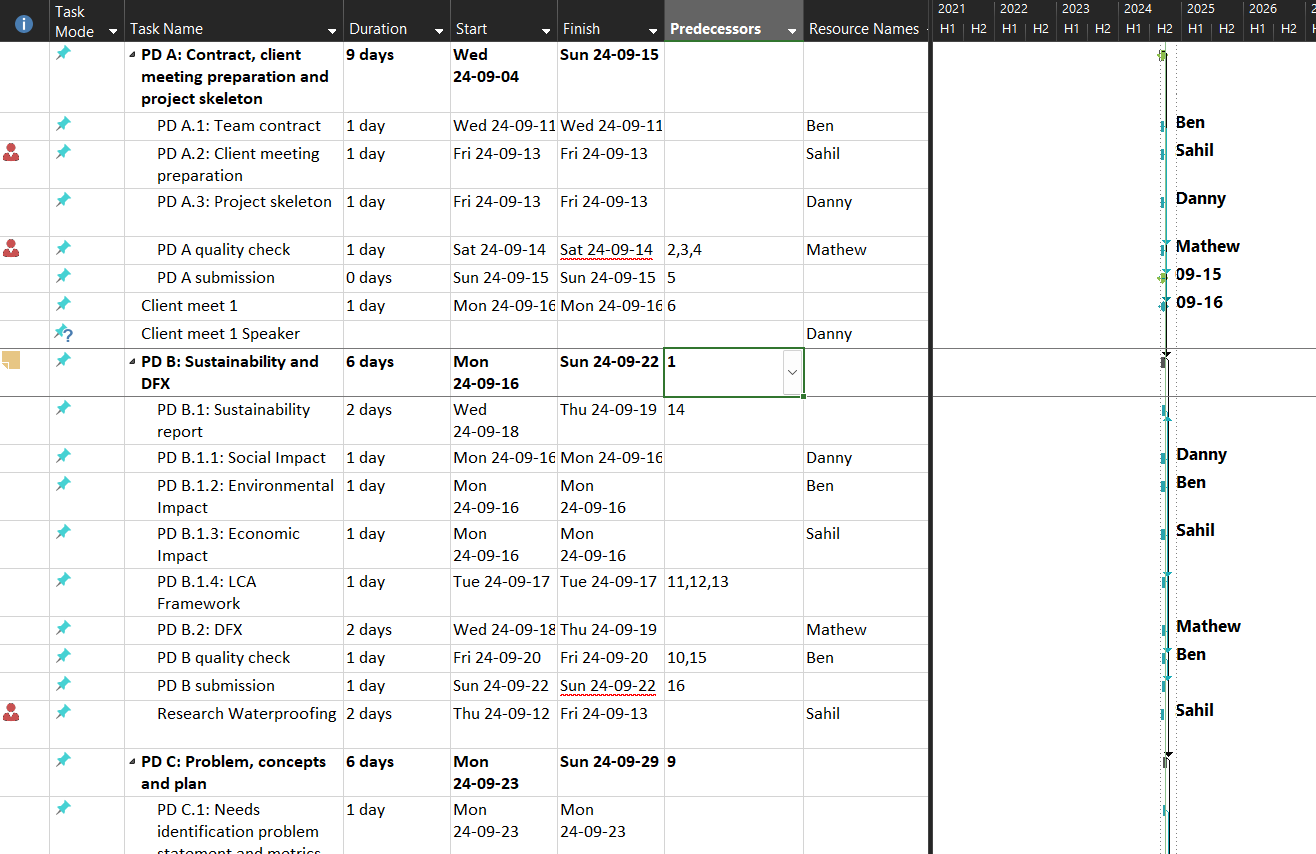
## BOM

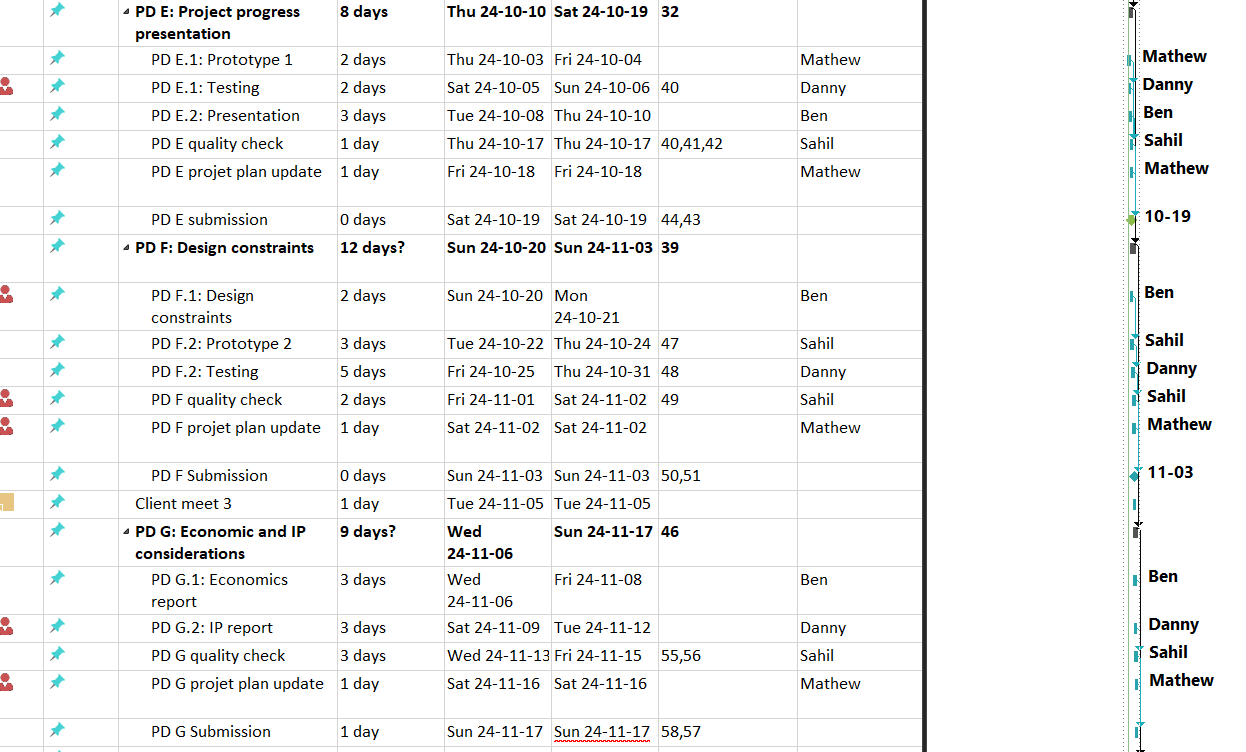
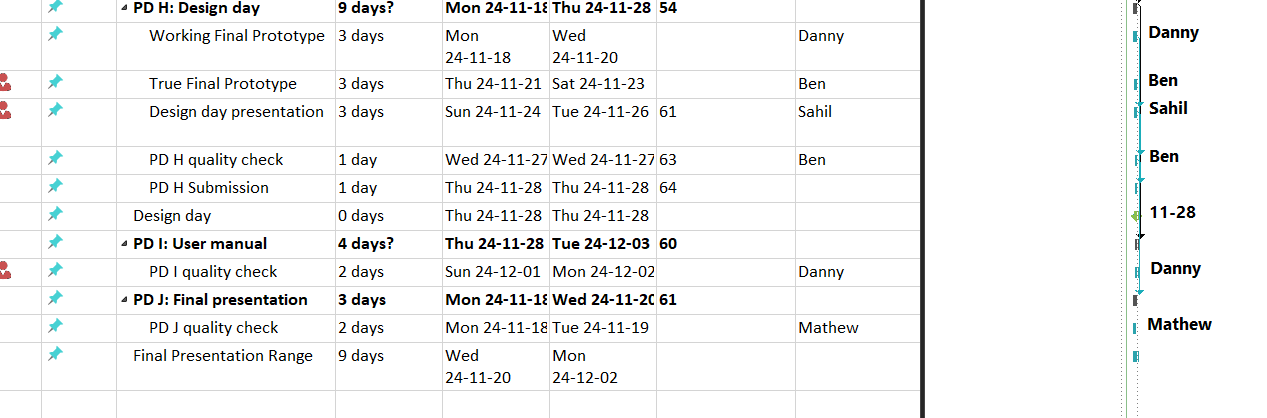
**Table 7. BOM**

| ITEM | Description | Material | Size (mm) | Qty | Seller/  Process | Price |
| --- | --- | --- | --- | --- | --- | --- |
| 1 | Left Belt Piece | Acrylic | R(in) 81.28  R(out) 106.68  Height 25.4 | 1 | Laser Cut | ~$6.42 |
| 2 | Right Belt Piece | Acrylic | R(in) 81.28  R(out) 106.68  Height 25.4 | 1 | Laser Cut | ~$6.42 |
| 3 | Middle Belt Piece Top | Acrylic | 203.2 x 25.4 x 8.46 | 1 | Laser Cut and Milled | ~$5.30 |
| 3 | Middle Belt Piece  Middle | Acrylic | 203.2 x 25.4 x 8.46 | 1 | Laser Cut and Milled | ~$5.30 |
| 3 | Middle Belt Piece  Bottom | Acrylic | 203.2 x 25.4 x 8.46 | 1 | Laser Cut and Milled | ~$$8.30 |
| 4 | Piston | Various (Purchased) | 150 x 60 | 1 | [link](https://www.amazon.ca/MAOPINER-Actuator-Mounting-Recliner-Electric/dp/B091C8YSH2/ref=sr_1_7?crid=2X7V7XTRBICWJ&dib=eyJ2IjoiMSJ9._YyJvluWbLqBJjgZ81whb2wAuH_mVBZr3NfSrZb3sqPQ_PjCKXlXNlr71Ve2KCY6osohdkhAnMnC3lv7Myp1OBl7bKUyQeO6qOnBDS-AOzkxeVqWNOGRea6-A5qS1Z5ziK5xcTJwYH3JAmH36DHg0L38B5_5oWHjXtn3agtRtUNDZXIXuHm8Vhed6hwNNmX1dcgEszcFRtd8C6Zt8iWacnHAmZa6JOJHuEjHIocyqNvShK_k0rzliH-NBOt-j0sunnQ9EmzKmOKDRx7J6JwR7pJHO4V2_awGgFYdGJMKByY.5BN7Wf1-8P7HVJTg_iQNx6ZMkVv_Wsd2lOfElP4pIeQ&dib_tag=se&keywords=linear%2Bactuator&qid=1728101128&sprefix=linear%2Caps%2C80&sr=8-7&th=1) | $37.95 |
| 5 | Belt Cover | Neoprene |  | 1 | [link](https://www.amazon.ca/DUPDMKIN-Neoprene-Adhesive-Projects-Soundproofing/dp/B0D3TPW6RK/ref=sr_1_2?dib=eyJ2IjoiMSJ9.ntSR0iifh7qrXtDrxtb16dieiQFGglcrA3btmvLA0dPRwdWkicUXOhuLV4R0uRx6dvVxViEX570v9doBq1QxUM700BduPI8XVHeiz0lvo6d0aFLYLo7hrW3acLzM9e-xnjQlJaTxWDR5t38q9pB5M7pIwkppH86Fmhqam753hAhmUvN3KXSFomXMpzFxwonVKeKafiUHONM0zdV4CC3TTQqv6GrdjUG5fQMJe_EvJzv0WHidHiNddF0cUQoObElfUBPcSX7JEsOKGy_gts6Gs1dpFm_1XCnIN66tn0B-Ck0.KtoMKRK_Dswr3GaTcSH5Amsqw42PhTZHaoAbb8jCa10&dib_tag=se&keywords=neoprene+foam&qid=1728100021&sr=8-2) | $11.19 |
| 6 | Switch | Various (Purchased) |  | 1 | [link](https://makerstore.ca/shop/ols/products/12mm-latching-on-off-button) | $1.50 |
| 7 | Button | Various (Purchased) |  | 2 | [link](https://makerstore.ca/shop/ols/products/micro-tactile-button-6mm) | $3.00 |
| 8 | Button/Piston Cover | PLA |  | 1 | 3D Print | ~$4 |
| 9 | Clamps | Various (Purchased) | 12.7mm x 12.7 mm | 4 | [link (B)](https://www.mcmaster.com/products/spring-clamps/miniature-spring-clamps-8/) | $7.16 |

Total = $96.54

## Project plan update





# Conclusions

The significance of material selection in product design has been brought to light by our project, as our second client meeting made clear. At first, we had a solid conceptual design but we weren’t sure what physical materials would be required to make it happen. We improved our design by defining measurements and choosing appropriate materials for every component. With skills in Solidworks, CAD, and Blender, we are great with 3d modeling and design simulation, but we still lack knowledge of manufacturing processes like CNC milling and laser cutting, which we plan to gain through collaboration and additional training.

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