Faculty of Engineering and Applied Science

ENGR 1025U – Engineering Design

Winter 2025

Design Project 2: Design of a Portable Vertical Lift

Course Instructors: Dr. Sharman Perera, P.Eng and Professor Hidayat Shahid, P.Eng

SUNRISE INDUSTRIES

Uniform Team Identification Page:

Student Name	**Student ID**	**Percent Contribution**	**Signature**
Christopher Pavao	100969921	100%	CP
Prince Masensa	100977541	95%	PM
Benjamin Quan	100988228	95%	BQ
Sageevan Chandrakanth	100918791	95%	SC
Adiyat Jubair	100968335	95%	AJ
Davyd Studnytskyy	100977119	95%	DS
Matthew Taylor	100973819	95%	MT
Tooba Malik	100978433	95%	TM

Executive Summary:

This design project seeks to create a portable, safe, and effective means of performing vertical travel using a scissor lift to clean and maintain the interior surfaces of a large glass enclosure. The workspace for this project is a room measuring 20 feet wide, 40 feet long, and 12 feet high. The primary purpose of the lift is to elevate a worker up to accessible heights, clean the glass walls and ceilings, or maintain lighting. The system will support a maximum nominal load of 200 kg (440 lbs), including workers and tools.

The proposed solution is a scissor lift mechanism that can reach a maximum vertical extension of 12 feet. The lift will include guardrails on the platform, anchor points for a harness, and a stable base with four wheels and locks to ensure safe use and mobility. The design will be consistent with a portable, straightforward height access device and lend itself to electronic travel control. The design concept can be utilized for many applications, such as glass maintenance, construction facility maintenance, or warehouse applications.

To generate the final idea, the team evaluated and analyzed several design concepts considering different arguments (safety, load capacity, mobility, ease of use and material durability). The final design, determined using a concept selection matrix, was developed in a virtual prototype using SolidWorks. The resulting CAD model includes multiple exploded views (full assembly drawings) and animations of the assembly to demonstrate the product's functionality.

The following report outlines the team's engineering design process to understand the problems and customer needs, develop technical specifications, generate initial concepts, propose a final design based on rationale and considered engineering principles and design judgement, and include a bill of materials for manufacturing. Additional support materials are enclosed for review, including a project Gantt chart, marketing brochure, and CAD drawing package.

As part of the project, the team has sought to provide a cost-effective, flexible, user-centred lifting solution that satisfies the industry's questions. All of the considerations of

sound principles of engineering judgement and design principles in the process are also reflected in the work.

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Mission statements of the project:

The mission of our project is to design a portable, user-friendly vertical scissor lift that enables workers to safely access elevated interior surfaces, primarily concerning a glass-structured room measuring 20 feet wide, 40 feet long, and 12 feet high. This device will assist users in cleaning tall windows and installing lighting fixtures, with the capability to support a load of approximately 200 kg (440 lbs), including the worker and their equipment.

Our goal is to deliver a solution that is:

- Safe: A structurally sound mechanism with safety railings and the potential for anchor points for a harness to create a safe working environment at height.
- Simple: The scissor lift is designed for ease of use and assembly while keeping the overall mechanism mechanically simple and intuitive for the user.
- Portable: The body is portable with wheels or treads to facilitate movement across flat surfaces and limit worker downtime while moving between locations.
- Compact: It is appropriately sized to create a stable working environment without being bulky or inconvenient.
- Multi-functional: Although designed primarily for cleaning glass surfaces, this lift is envisioned for many broad-use applications in maintenance, construction, or retail environments where workers need access to work at heights safely.

Contracting with this group of engineering students is a benefit, so the lift will be designed to be mechanically simple but effective while paying careful attention to the user's dimensions, weight distribution and comfort. Our showing of the final design will include a complete CAD model or animated virtual prototype of the lift and possibly/workings of a marketing brochure that consists of the system's capabilities in application to real-life settings with actual instances. Finally, this project exemplifies the tenets of pragmatic engineering, meeting a real-world need and providing a safe and effective solution while balancing functionality to cost and manufacturability/user experience.

Customer Needs Assessment:

The primary user of the vertical travel scissor lift is a maintenance or cleaning worker responsible for working in the interior of a large glass enclosure. However, the lift should also be used in myriad industries, such as construction, retail, and facility management, where elevated access is a regular part of the job. With the purpose of application and the operational environment in mind, the following customer needs were identified:

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1. Safety.
The system should have strong guardrails and harness anchoring points to prevent falling.
The platform should remain stable while lifting and working.
There should be emergency stop or manual override capabilities.

2. Load capacity.
The lift must have a capacity of at least 200 kg (about 440 lbs), allowing a worker and tools to work on the interior.

3. Height reach.
The platform needs to reach at least 12 feet on vertical travel, which would allow a worker to clean or just work on installing lights near the ceiling.

4. Mobility
The apparatus should be easily transported using caster wheels or treads in the glass room. The apparatus should allow for tight turns and/or be easily moved in tight quarters.

5. Platform Area
The platform should have enough area to support workers on their feet (with tools) to move about without slipping or losing balance.

6. Ease of Use
The lift should be easy to use with simple controls to allow for independent operation with

minimal training. Workers should raise and lower themselves independently.

7. Compactness and Storage

The item should be compact when not in use to reduce storage space.

The components should be quick and easy to assemble, disassemble, or fold as needed.

8. Durability and Reliability

Materials must be corrosion-resistant and able to withstand repeated use in indoor environments.

The product must maintain performance over time with little to no ongoing maintenance.

9. Versatility

While it should be primarily intended for cleaning glass surfaces, the lift should also be acceptable for

- Installing or maintaining items mounted to ceilings
- Stacking or moving items in retail spaces
- General maintenance inside facilities

10. Cost Effectiveness

The finished product should be low enough in price so that companies can purchase it in small to medium quantities. Design should avoid unnecessary complexity while also utilizing materials that are both effective and relatively inexpensive.

List of major design specifications:

- Maximum Lift Height: 12' (3.66m, 116.75")
- Minimum Platform Height: Approximately 2' (1.5 ft) fully retracted
- Platform Size: Minimum of 2.5 ft x 2.5 ft (0.76m x 0.76m, 30")
- Maximum Weight Capacity: 200kg (440 lbs), which includes workers and tools
- Base Width: Less than 36 inches to fit standard doorways

- Safety Features:
    - Guardrails (minimum 42 inches in height)
    - Toe boards (minimum of 4 inches in height)
    - Anchor point for fall restraint harnesses,
    - Locking wheels or outriggers,
    - Manual lowering system for emergency stop.

- Mobility System:
    - Features lockable caster wheels or similar treads;
    - Designed for easy movement to distinct locations while being repositioned in close indoor areas.

- Materials:
    - Lightweight metal framing (aluminum or steel alloy);
    - Materials resist corrosion and excessive wear.

- Lifting Mechanism:
    - Manual scissor lift or assisted scissor lift;
    - Smooth vertical movement capability based on maximum mechanical simplicity and fewer parts.

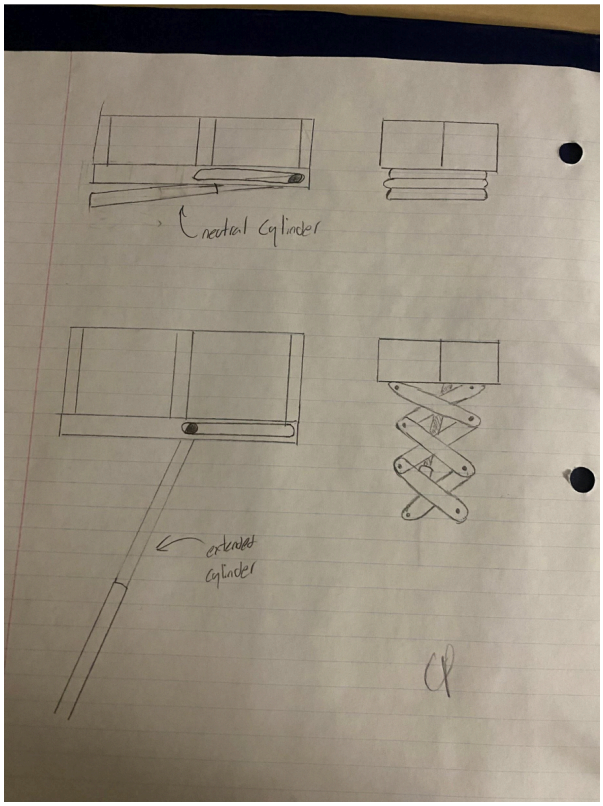
- Ease of Use:
    - Easy controls;

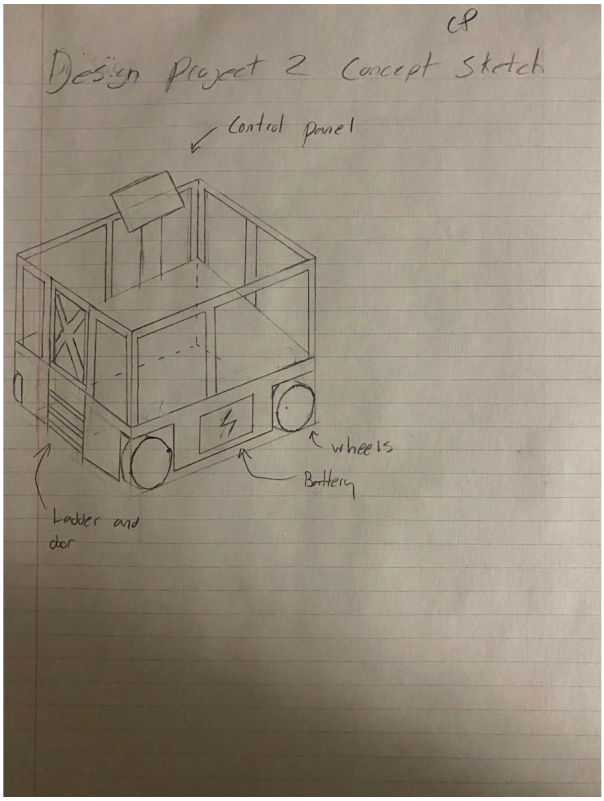
    - Minimal required training for safe operation.

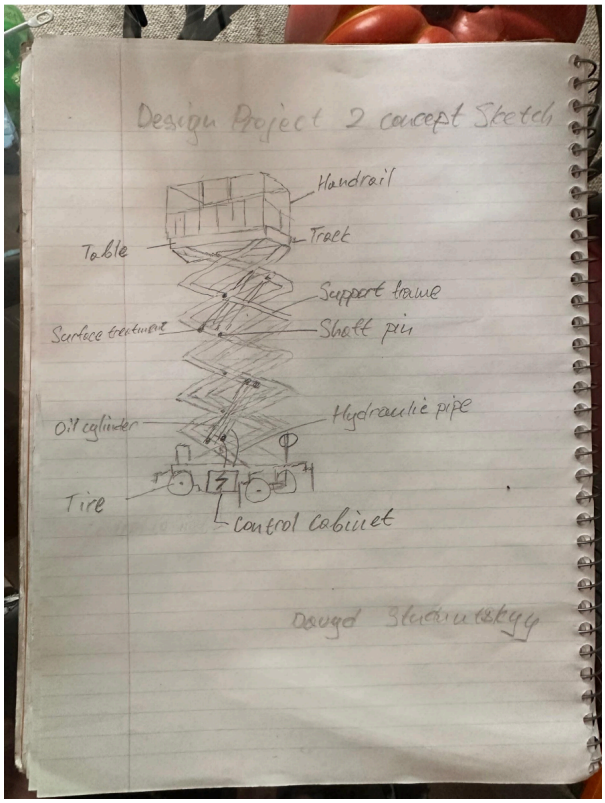
- Environmental Suitability:
    - Intended for indoor use,
    - Designed to minimize or prevent contact with fragile glass objects.

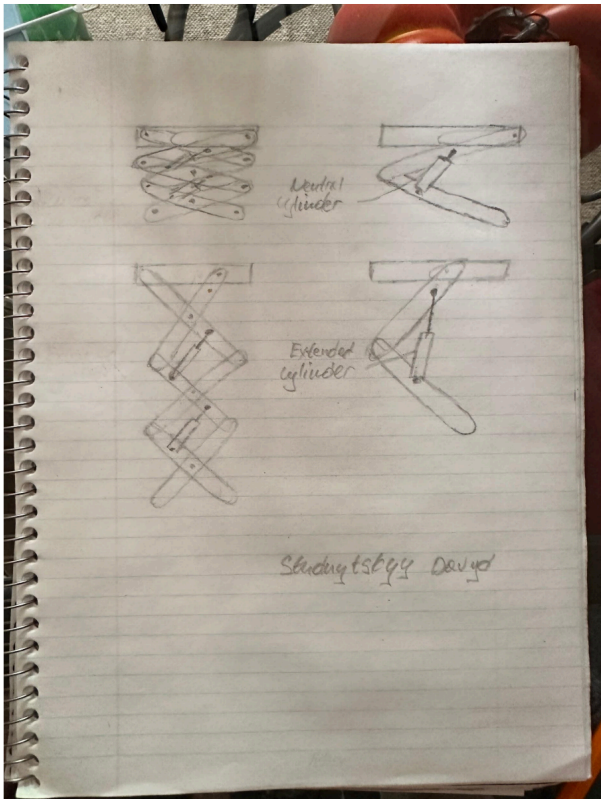
- Compliance:
    - Design meets ANSI safety and engineering drawing standards;
    - Fully documented with SolidWorks; multi-view drawings and BOM included.

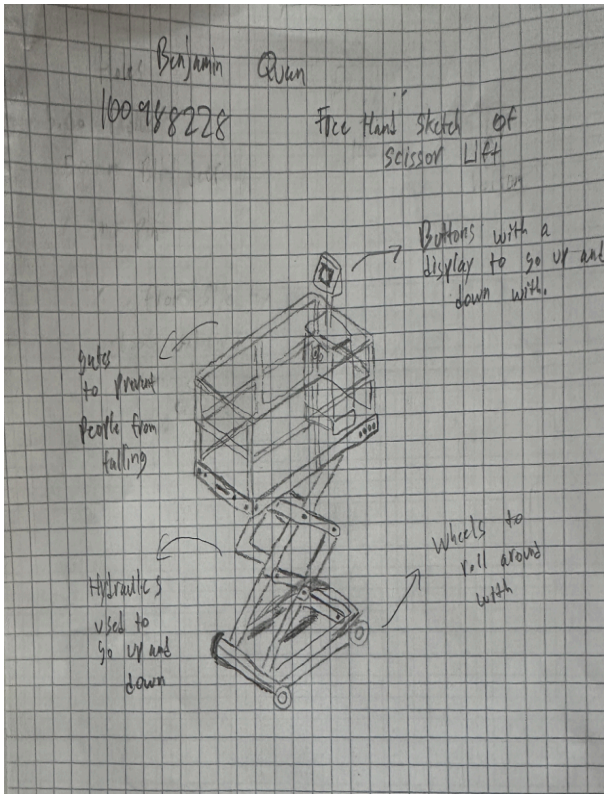
Design sketches of different candidate design concepts

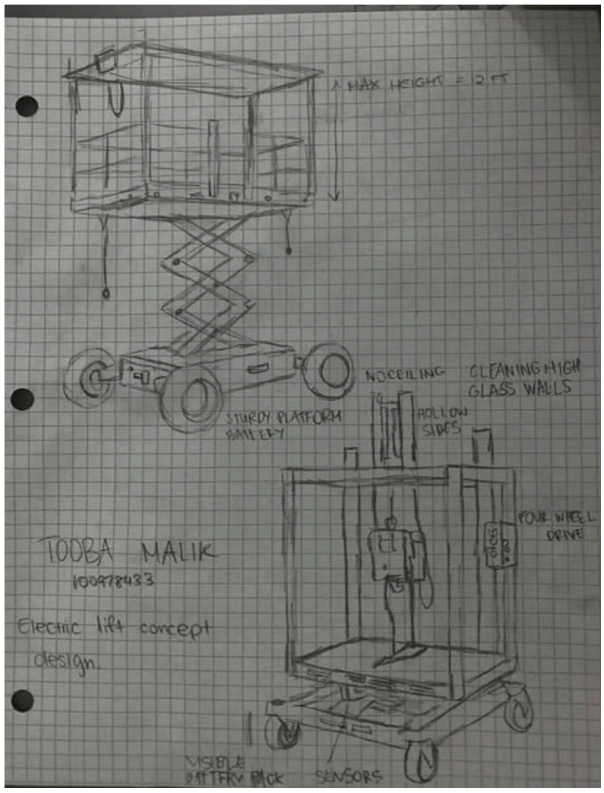


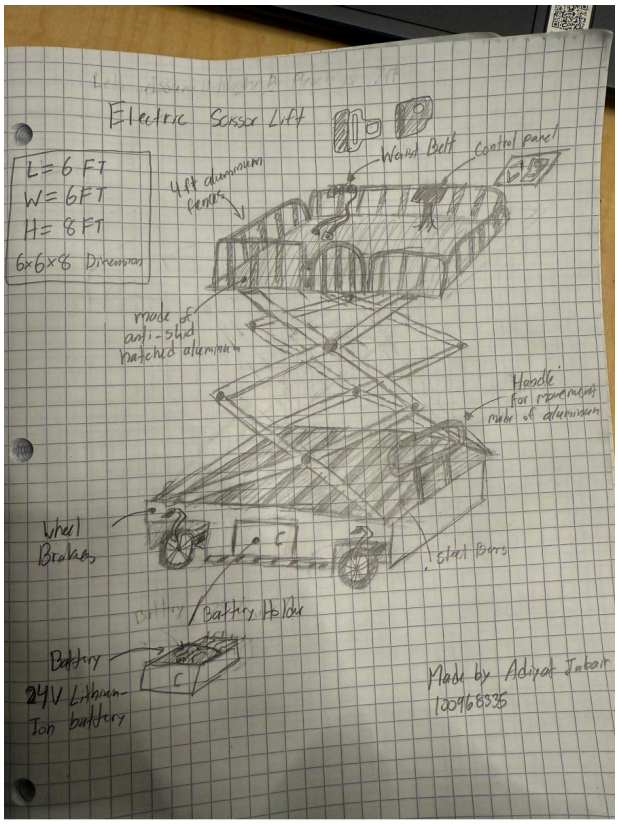


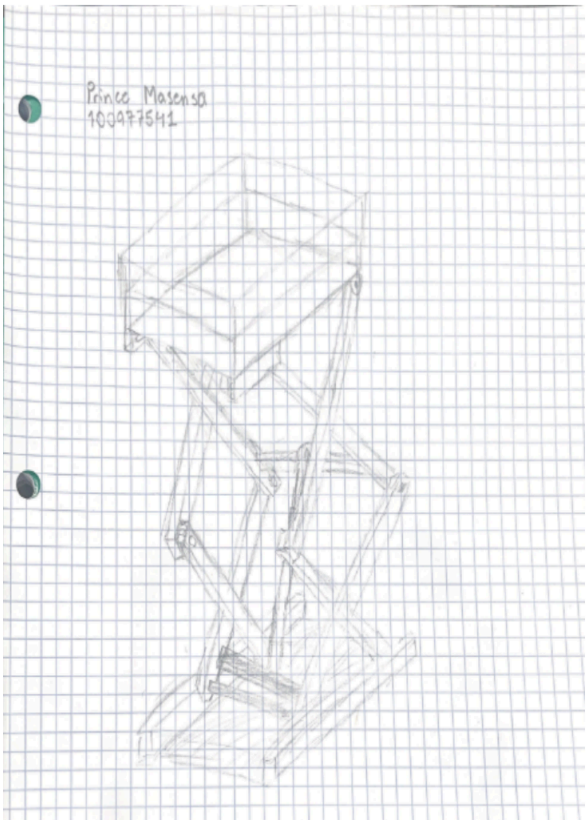





Benjamin Quan
100488228
Free Hand sketch of Scissor Lift
Buttons with a display to go up and down with.
gates to prevent people from falling
Hydraulics used to go up and down
Wheels to roll around with

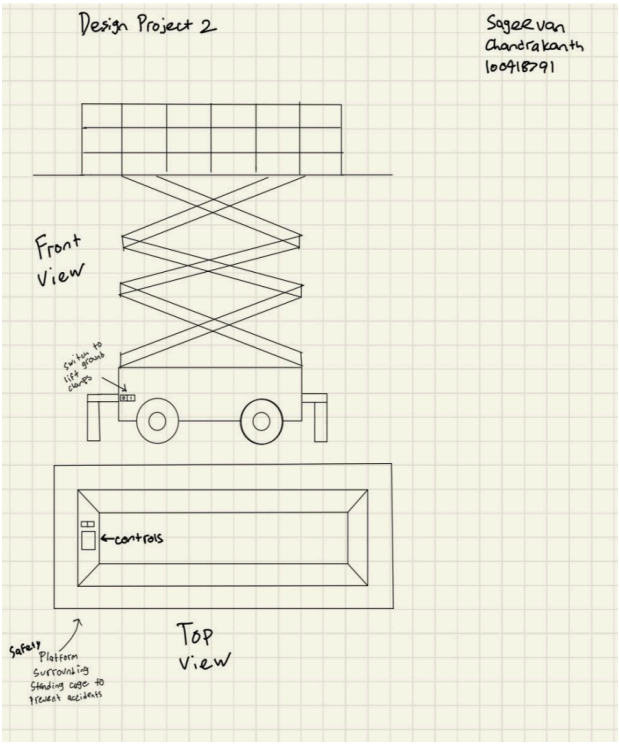

MAX HEIGHT = 12 FT
NO CEILING
CLEANING HIGH GLASS WALLS
STURDY PLATFORM
HOLLOW SIDES
FOUR WHEEL DRIVE
TOOBA MALIK
100478433
Electric lift concept design.
VISIBLE BATTERY PACK
SENSORS


Electric Scissor Lift
L=6 FT
W=6FT
H= 8FT
6x6x8 Dimension
Waist Belt
Control panel
4ft aluminum planks
made of anti-skid hatched aluminum
Handle for maneuvering made of aluminum
Wheel Brakes
Steel Bars
Battery Holder
Battery
24V Lithium-Ion battery
Made by Adizat Jakan
100968535


Prince Masenga
100977541

Design Project 2

Sagar van Chandrakanth
100418791



Concept selection process:

As part of the preliminary design process, each team member developed an individual concept sketch exploring potential solutions for a vertical lifting system. While the core idea of using a scissor lift mechanism was consistent across most sketches, each concept introduced unique features or design approaches to address challenges related to stability, safety, mobility, and ease of use, as shown above.

A ranking scheme was developed based on everyone's contributions and opinions, as well as the scissor lift's major design specifications and requirements.

Name Of Group Members	**Safety**	**Functionality**	**Accessibility**	**Feasibility**	**Simplicity**	**Total /50**	**Notes**
Christopher Pavao	9	8	8	9	9	43	Solid compact base,
Adiyat Jubair	8	10	8	8	8	42	Reliable lifting structure
Prince Masensa	8	9	7	7	6	37	Detailed mechanical design
Tooba Malik	7	8	9	7	6	37	User focused design

Davyd Studnutskyy	7	8	7	7	7	36	Fully explained layout
Benjamin Quan	5	6	6	7	7	31	Additional features
Sageevan Chandrakanth	5	6	6	7	7	31	Simplicity and attractive

The concept selection process was quite lucrative, effective and efficient.
We noticed that most of our concept sketches involved electric scissor lifts. After thoroughly analyzing each concept sketch, complexity, cost, and safety, we decided to use a mixture of 2 central concept sketches. Christopher Pavao's and Adiyat Jubairs.

Christopher Pavao's base was selected as his concept was simple yet very professional while meeting all the requirements. To pair with this, we selected Adiyat Jubair's platform. It contained safety mechanisms, fences, waist belts, control panels, and more. With this combination, this was the best model of a scissor lift for the given functions out of all the concept sketches.

It met all of the major design requirements and was cost-effective. It was also the best option for further development! In short, selecting the concept was collaborative and productive, allowing us to draw the most substantial parts of several ideas into our final, cohesive, practical design concept.

Detailed Descriptions:

The final design selected for this project is a battery-powered, portable vertical scissor lift combining a compact, stable base with a safety-enhanced platform. The design supports a total load of up to 200 kg (440 lbs) and can lift the user to a maximum height of 12 feet, suitable for cleaning glass surfaces or installing ceiling fixtures in a 20 ft × 40 ft × 12 ft glass enclosure.

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1. Assumptions Made

- The lift will be used indoors on level, hard flooring.
- Only one worker is on the platform at a time.
- The worker will be using light-duty tools and cleaning equipment.
- The environment is low-humidity and climate-controlled, so weatherproofing is not essential.
- The worker has basic training in using lift controls and safety equipment.

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2. System Components & Functionality

- Base Frame:
  Constructed from aluminum or lightweight steel alloy for durability and reduced weight. The frame features a rectangular footprint compact enough to fit through standard doorways and includes caster wheels with locking brakes for secure positioning.
- Scissor Lift Mechanism:
  A series of cross-linked metal arms form the scissor structure. Powered by an electric linear actuator, the arms expand and contract to raise and lower the platform. The

movement is guided to remain vertically stable and balanced.

- Control System:
  The lift uses a control panel mounted on the platform with simple up/down push buttons. Power is supplied by a 24V lithium-ion battery housed within a secure control box at the base.

- Platform Design:
  The platform is large enough to support workers and tools (approximately 2.5 ft × 2.5 ft). It includes:
    - Guardrails on all sides (42 inches high)
    - Toe boards (4 inches) to prevent slipping
    - Anchor points for safety harnesses
    - Anti-slip surface coating for traction

- Power Source:
  The device is powered by a rechargeable lithium-ion battery system designed for moderate-duty cycles, sufficient for several up-down operations before recharge is needed.

- Mobility System:
  Lockable caster wheels push the lift effortlessly and securely parked during operation. Wheel positioning and weight distribution were designed to prevent tipping during elevation.

3. Cost Analysis (Estimate)

- Frame materials: Moderate-cost aluminum or mild steel
- Scissor arms: Steel for strength
- Actuator system: Mid-range linear actuator (~$150–$250)
- Battery and wiring: ~$100–$150
- Miscellaneous (wheels, hardware, controls): ~$100
- Estimated total cost (prototype build): $8000–$10000 CAD

The estimated cost for the entire scissor lift prototype is approximately $8000 - 10000 CAD, based on a complete and exhaustive bill of materials, which accounted for all structural, mechanical, and safety components. This estimate comes from a detailed part-by-part breakdown (documented in the Appendix). It reflects a realistic cost for a one-off prototype using industrial-grade, heavy-duty materials. This price for a one-off, electric scissor lift prototype focused on safety is reasonable. Comparable products currently being commercially sold are in a similar price range, with prices for mid-size, light-duty lifts starting and ranging from $9,000 CAD to $15,000 CAD. Considering the features included and safety features incorporated, the price is realistic and corroborates with commercial lifts offered on the market.

Ability To Meet Design Specifications:

- Height Reach: Platform reaches full 12 ft height
- Load Capacity: Supports 200 kg (worker plus tools)
- Safety: Guard rails, harness anchor points, and stable scissors structure
- Mobility: Lockable casters make for easy repositioning
- Ease of Use: Control panel that is straightforward and intuitive
- Compliance: Designed for easier compliance with ANSI standards

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Human Factors

- Platform dimensions provide a space for standing, moving, and/or tool storage.
- Ergonomics help ensure railings do not obstruct platform edges
- Controls are at waist height to make them easier to use
- Materials are designed with smooth edges to prevent cuts or injury
- Movement is smooth and damped to minimize vibrations

Safety Considerations

- High handrails (≥ 42")
- Guarded platform edges have toe boards (≥ 4")
- Emergency stop button on platform-slip surface on platform
- Redundancy on the scissor locking mechanism when raised for stability

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Manufacturing Process

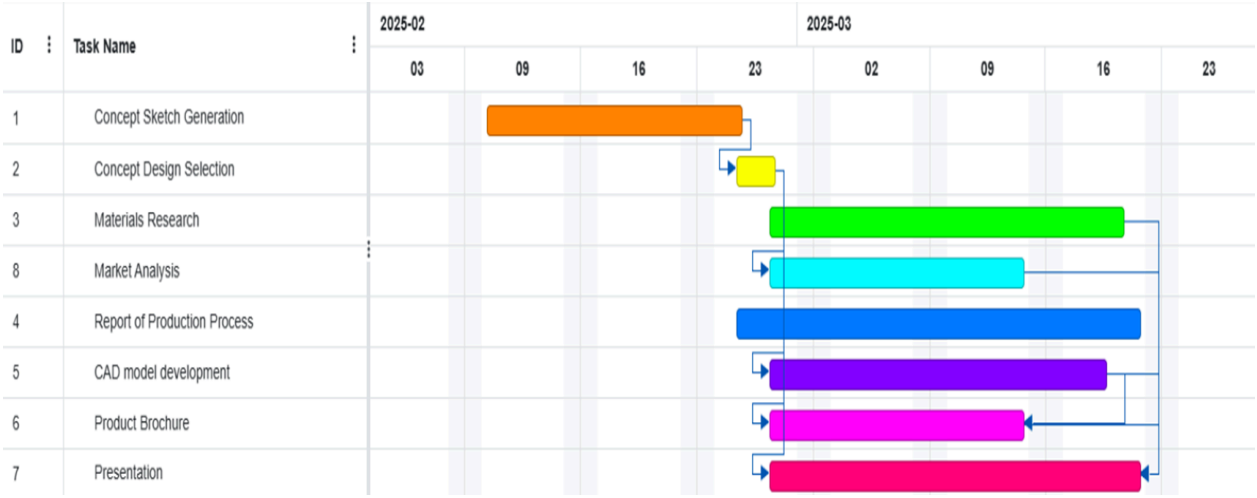
- Frame/platform uses cut and welded aluminum tubing
- Scissors are laser cut or water-jetted with assembly
- Done using bolts or rivets
- Off-the-shelf wheels/bearings/motor components

- Electrical wiring is essential, with controls for the motor, some lights, and an emergency stop.
- Final assembly is done with several pieces bolted together, and some safety items/controls are secured.

Environmental Impact

- Made with materials that are recyclable (e.g., aluminum, some steel)
- Battery powered with rechargeable batteries, reducing reliance on fossil fuels while providing for indoor use
- Long-term durability reduces waste from frequent replacements
- Compact form reduces transport emissions

Gantt Chart: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2025-03
03
09
16
23
02
09
16
23
1
Concept Sketch Generation
2
Concept Design Selection
3
Materials Research
8
Market Analysis
4
Report of Production Process
5
CAD model development
6
Product Brochure
7
Presentation

Conclusions:

The development of our vertical travel scissor lift was motivated by a straightforward objective: to develop a safe, reliable, and portable lifting system that can support a worker. At the same time, they conduct interior maintenance and cleaning activities within a large glass enclosure. Our team worked in partnership throughout the design process to address and focus on some critical engineering considerations: load-bearing capacity, stability, mobility, usability, and safety.

Starting with a detailed assessment of customer conditions and many different ideation sketches, we considered and documented several design possibilities, each incorporating unique features and mechanical solutions. From there, following a structured method of concept selection, we began to highlight the positive attributes of each of the top designs and condense those attributes into an overall hybrid final concept, which would utilize the solid base structure from Christopher Pavao's design and the platform details oriented around safety from Adiyat Jubair's design.

The final design addresses and meets all of our key requirements:

- Lifting height of 12 feet, weight capacity of 200 kg (440 lbs)
- Compact footprint for maneuverability in indoor environments
- Safety features, which include railings and harness points
- Powered by battery for practicality and usability.

In addition to concept development, we produced a detailed CAD model and an animated virtual prototype using SolidWorks to simulate real-world performance. Supporting documents, including engineering drawings, a Gantt chart, a bill of materials, and a marketing brochure, were created to complete the design package.

Overall, the project provided valuable experience in team-based engineering design, decision-making, and technical communication. We are confident that our final solution offers a practical, cost-effective, and user-centred approach to vertical elevation for maintenance tasks and can serve various applications in industries such as construction, retail, and facility management.

Acknowledgement:

We sincerely thank Professor Perera for their guidance, feedback, and support throughout this project. His insights were instrumental in helping us navigate the design process and remain focused on safety, practicality, and engineering fundamentals.

We also thank the Teaching Assistants and course staff for their assistance with lab sessions, technical support, and clarification of project requirements.

Finally, we acknowledge the dedicated efforts of each team member for their contributions to concept development, CAD modelling, report writing, and presentation preparation. This project would not have been possible without consistent teamwork, collaboration, and communication.

References:

[1] *RoomOutside*, "Contemporary Frameless Conservatory Glass Box Extension." [Online]. Available: https://www.roomoutside.com/products/contemporary-frameless-conservatory-glass-box-extension/

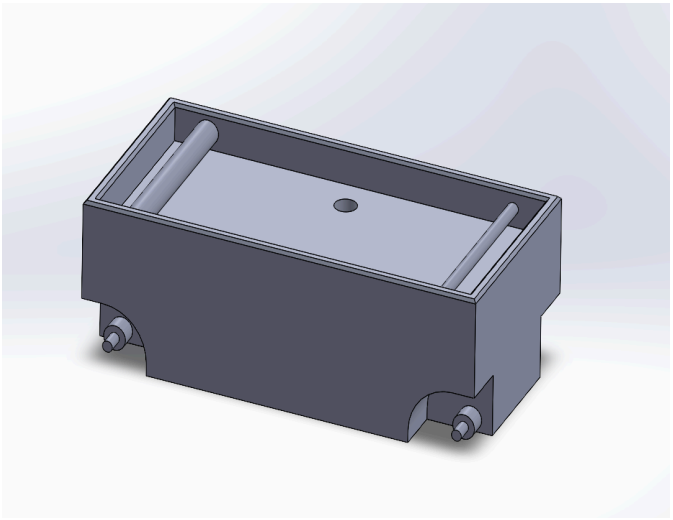
[2] American National Standards Institute, *ANSI A92.6 - Self-Propelled Elevating Work Platforms*, ANSI, 2012.

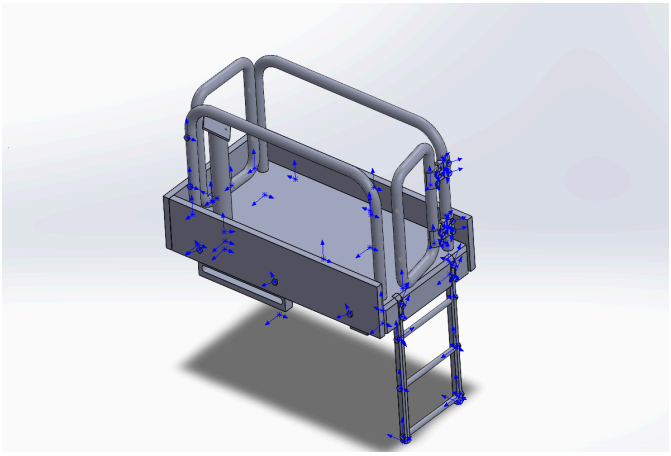
[3] *McMaster-Carr*, "Aluminum 6061 Sheet." [Online]. Available: https://www.mcmaster.com

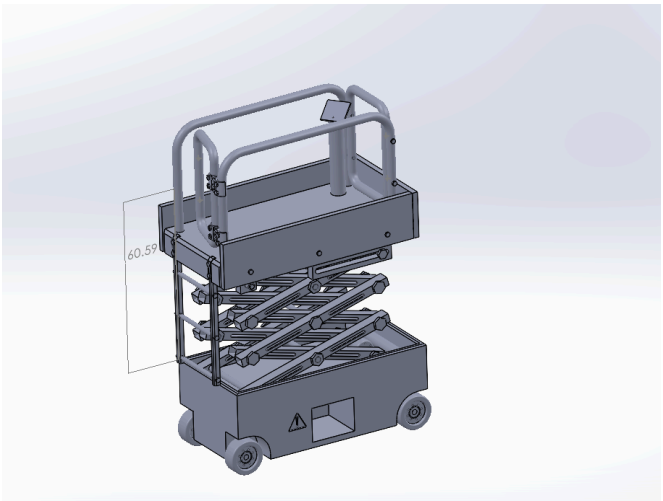
[4] *Engineering Toolbox*, "Properties of Metals and Materials." [Online]. Available: https://www.engineeringtoolbox.com

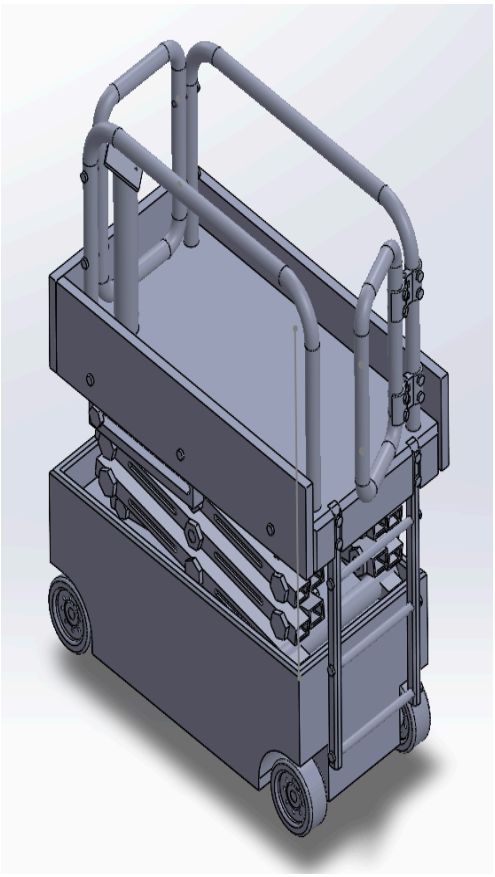
Appendix:

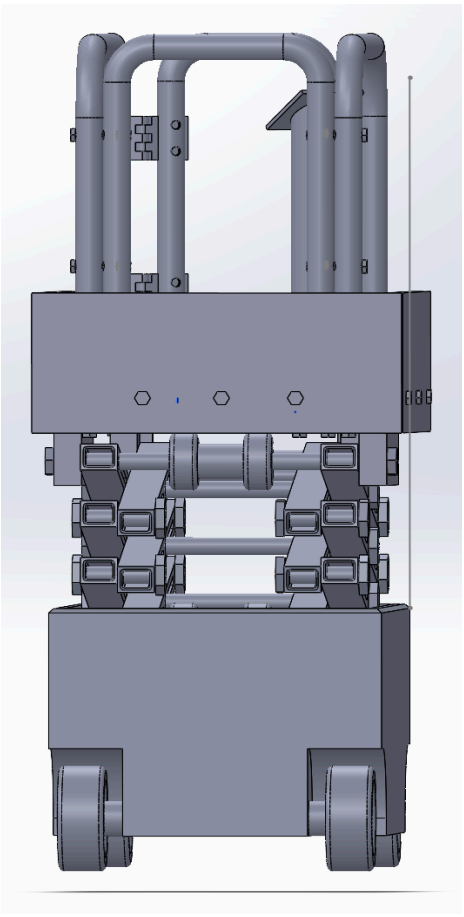
Solidworks Scissor Lift Model:

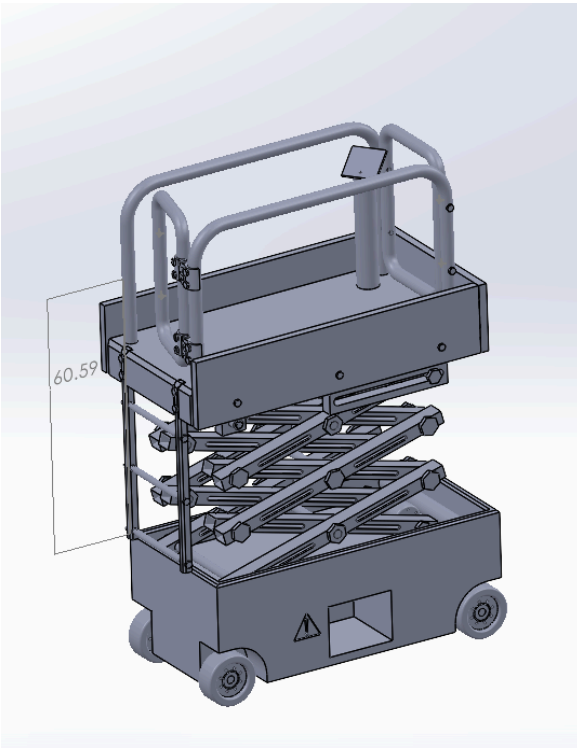








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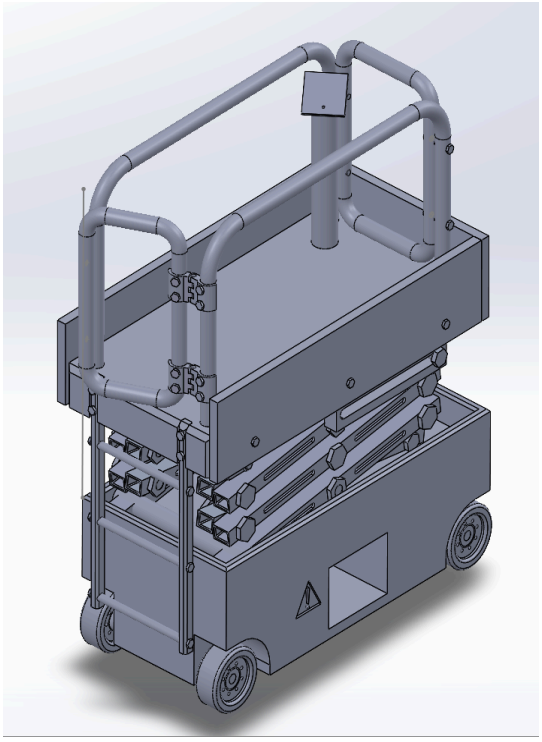

Bill Of Materials:

Item No.	Components	Component Composition	Description	Quantity	Cost For 1 (CAD)
1	Axel	Steel Alloy	Axle that connects and allows the wheels to rotate	1	$300
2	Nut	Stainless Steel	Secures bolts and fasteners in place	11	$2
3	Bar	High-Strength Steel	Structural bar that holds the platform and provides support to the scissor mechanism	12	$50
4	Short Bolt	Stainless Steel	Short bolt used for securing the bars together	8	$5
5	Body	Steel Frame	Main body frame of the scissor lift	1	$2,500
6	Tire	Rubber With Steel Hub	Wheel component for mobility	4	$150
7	Long Bolt	Stainless Steel	Long bolt used for structural connections of the bars	3	$8
8	Platform	Steel	The upper surface of the scissor lift that supports loads and provides a stable working area	1	$1,000
9	Side Wall Short	Steel	Shorter side wall for frame stability.	1	$400
10	Side Walls Long	Steel	Longer side wall for structural support and safety purposes	2	$500
11	Side Rails Long (For Hitch)	Steel	Same function as Item 12 but has Hitch 1 connected so it can be attached to the Rails	1	$500
12	Side Rails Long	Steel	Longer version of Item 13	1	$500
13	Rails	Steel	Safety features added to make the mechanism more safe	1	$700
14	Hitch 1	Steel	Attached to Item 11 and connects to Hitch 2 of Item 13	2	$300
15	Right Side Ladder Pole	Steel	Used to support Item 17 on the right while being connected to the platform	1	$400
16	Left Side Ladder Pole	Steel	Used to support Item 17 on the left while being connected to the platform	1	$400
17	Ladder Catch Pole	Steel	Used as steps to get onto the platform	3	$150
18	Hitch 2	Steel	Used to connect the Rail to Hitch 1 of Item 11	2	$300
19	Small Gate For Hitch	Steel	Same function as Item 13 but serves as a gate to close/open after climbing the ladder	1	$400
20	Screen Pole	Steel	A vertical support that holds and secures the control screen or display for the operator	1	$400
21	GC-12V 12V Deep Cycle Battery	Lead-Acid Battery	Two GC-12V batteries supply power to the scissor lift	2	$840
22	310185 Control Box (Aerial Equipment Parts)	Steel	Control box allows user to control the scissor lift	1	$390
Total Cost:					**$9,266**