Section 39 - Group 23

ENGR 1025U: DESIGN PROJECT TECHNICAL REPORT

Design Project 2: Design of a Portable Vertical Scissor Lift

Due Date: April 1, 2024

Group Name: SkyLift

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Executive Summary:

The global rise in modular construction projects has led to a notable increase in demand for scissor-lifts that are both cost-effective and safe. Consequently, producing, designing, and developing scissor lifts has become essential. Our goal with this project is to create a scissor lift that has great functioning and satisfies safety standards while also cutting down on costs and the environmental impact that it may have.

The constraints of the projects were to ensure that the scissor lift would reach ceiling heights of 8-14 ft. The scissor lift is easily disassembled and assembled for transportation and portability. A two-person crew should be able to move and set it up on the 2nd floor of a two-story building with no elevators or ramps. The platform accommodates at least one worker, with stability and safety for workers considered.

Throughout the project, various concepts had been analyzed. These concepts spanned from using pneumatic actuators to a hydraulic-based power source to generate the up/down motion of the scissors. We also discussed using batteries to power the scissor lift. Based on the selection matrix, the finalized concept was to utilize modular batteries powered hydraulics and electrical motors for the lifting mechanism.

Following Weeks of discussion, our team built a virtual prototype using SolidWorks and created an exploded view of the assembly to understand the product's workings better. Our final design, SL-LxxL_Pro, uses an electric hydraulic lifting system. The lift can be directly plugged into a socket if the construction site has a power supply, or it can run on electricity from the four strong rechargeable batteries in the base. For safety purposes, the new sylift_200 has a top and bottom control panel, emergency stop, rubber grip on the top rails, hazard lights, and rubber bumpers on the base of the lift.

In conclusion, our final design for the SL-LxxL_Pro utilizes battery-powered hydraulics powered by an electric motor for its actual lifting mechanism. This design improves efficiency and ensures minimal negative environmental impact. The design is per OSHA regulations, requiring the lift to have railings for fall protection and a safety system in case of collapse.

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Mission Statement:

At skyLIft Co. our mission is to supply simple, safe, and reliable lifting solutions by maintaining a dedication to excellence, innovation, and quality engineering. Our team comprises hard-working individuals who work day and night to produce the highest-quality scissor lifts in the industry. Our customers are the key that drives our company forward.

Our team comprises experienced engineering, design, and manufacturing experts who bring decades of experience to develop our products. We also work closely with our customers to understand their specific needs. We use cutting-edge technology and manufacturing facilities to design and manufacture scissor lifts that meet stringent quality standards and exceed the customer's expectations.

Furthermore, we are a company that upholds our environmental and societal obligations and is determined to conduct our business environmentally and socially responsible. We work hard to reduce our carbon footprint and waste, encourage ethical and sustainable business practices, and promote the health and happiness of our employees, partners, and communities. Committed to sustainability, we strive to develop solutions that enhance productivity and minimize environmental impact.

Skylift Co. is at the forefront of the industry in providing the best scissor lifts through our dedicated commitment to serving our customers with innovative, safe, and reliable products. We will continue to expand while remaining dedicated to serving our customers.

Customer Needs Assessment:

The scissor lift market has grown in the past few years and will continue to grow. The general predicted growth for scissor lifts is 6.5% annually, with the fastest growth rate for engine-powered lifts at 9.1% annually. The development of scissor lifts has been reduced due to the COVID-19 pandemic. However, it is well on its way to recovery with the rise in modular construction projects around the world [1]. The increase in infrastructure projects outlined in Canada's Long-Term Infrastructure Plan also attests to this rise in demand and the reasons behind it [3]. Therefore, it is reasonable to assume that the current lift market is efficient and safe, allowing the work to be done in as little time as possible.

Table 1 Shows Customer Needs and the conditions that were met.

Customer Needs	Description	Conditions Met
Height Requirements	Can reach ceilings of 14 ft	✅
Lift Capacity	Can lift to 450 lb	✅
Ease of Assembly/Disassembly	4 modular batteries.	✅
Platform to Hold One Person	Platform hotels 3 people with ease	✅
Lightweight for two people to carry	The total weight of lift is 1200 lb. 2 people can easily carry it.	✅
Safety Features	Safety rial, control panel, emergency brake, hazard lights	✅
Price	Reasonable Price of $2500	✅
Durability	Made of high-quality aluminum and stainless steel.	✅
Maintenance Requirements	Little Maintenance, just replacing modular batteries when needed.	✅
Environmentally Friendly	Electric Motors and batteries	✅
Lifting Speed	20 seconds	✅

Major Design Specifications:

These are the main design requirements from the CSA regulations that were followed when designing the scissor lift, in addition to the customer requirements mentioned above.

Table 2: BASIC CSA Requirements for the scissor lift

Requirement	Description	Source
Platform Width and Surface	Width shall be not less than 0.46 m. The platform floor shall have a slip-resistant surface.	CAN/CSA-B354.2-01 (R2013) - Section 4.13.1
Top Rail	The top rail should surround the platform. The height of the rail shall be 1.07 ± 0.08 m	CAN/CSA-B354.2-01 (R2013) - Section 4.13.2.1
Mid Rail	Mid-rail shall be approximately midway between the top rail and the platform surface	CAN/CSA-B354.2-01 (R2013) - Section 4.13.2.2
Flexible Materials	Flexible materials such as cables, chains, and ropes shall not be used in the guardrail system, except they may be used as a midrail at access openings, MAXIMUM 0.76 m wide	CAN/CSA-B354.2-01 (R2013) - Section 4.13.2.3
Structural Integrity	Each top rail, mid-rail, or equivalent vertical barrier shall withstand a concentrated test load of 1340 N (300 lbs)	CAN/CSA-B354.2-01 (R2013) - Section 4.13.2.4
Toeboards	The platform of the lift must have toeboards on all sides.	CAN/CSA-B354.2-01 (R2013) - Section 4.13.3
Access	Aerial Platform shall include means for personnel to use in entering or exiting the platform, when in lowered position.	CAN/CSA-B354.2-01 (R2013) - Section 4.13.4
Anchorages for Fall Protection System	Each anchorage shall be capable of withstanding a static force of 16 000 N	CAN/CSA-B354.2-01 (R2013) - Section 4.13.5

	(3650 lbs) without reaching ultimate strength	
Battery Location	Batteries shall be secured, guarded, and ventilated to prevent damage and buildup of hydrogen gas.	CAN/CSA-B354.2-01 (R2013) - Section 4.14.2
Upper Controls	Upper controls for aerial platforms must be easy to access, intuitive, fail-safe, and secure against unintended use. They should automatically return to a neutral state and be clearly marked.	CAN/CSA-B354.2-01 (R2013) - Section 4.8.1
Lower Controls	Lower controls for machinery must be accessible from the ground, override upper controls, automatically return to neutral, be safeguarded against unintended use, and be marked.	CAN/CSA-B354.2-01 (R2013) - Section 4.8.2
Emergency Stop Device	Aerial platforms must have emergency stop devices at both the upper control and lower control stations, which, when activated, halt all powered movement of the platform.	CAN/CSA-B354.2-01 (R2013) - Section 4.8.4

The Consumer requirements and the basic requirement of the project were to design a scissor lift that is lightweight, portable, and can be used in indoor and outdoor settings. It should be able to reach a height between 8 -14 ft high, have a lift capacity of 400 lbs, and must be able to assemble/disassemble easily. The scissor lift should also be able to be set up by a 2 person crew and moved between floors of buildings with no elevators and ramps. The scissor lift should also be able to accommodate at least one worker on the platform and have some safety features while also taking into account the environmental considerations of the end product.

Sketches:

All team members designed eight sketches. Then, each sketch was ranked using a concept selection process that we had come up with, and the best sketch was chosen for the final design.

Design #1:

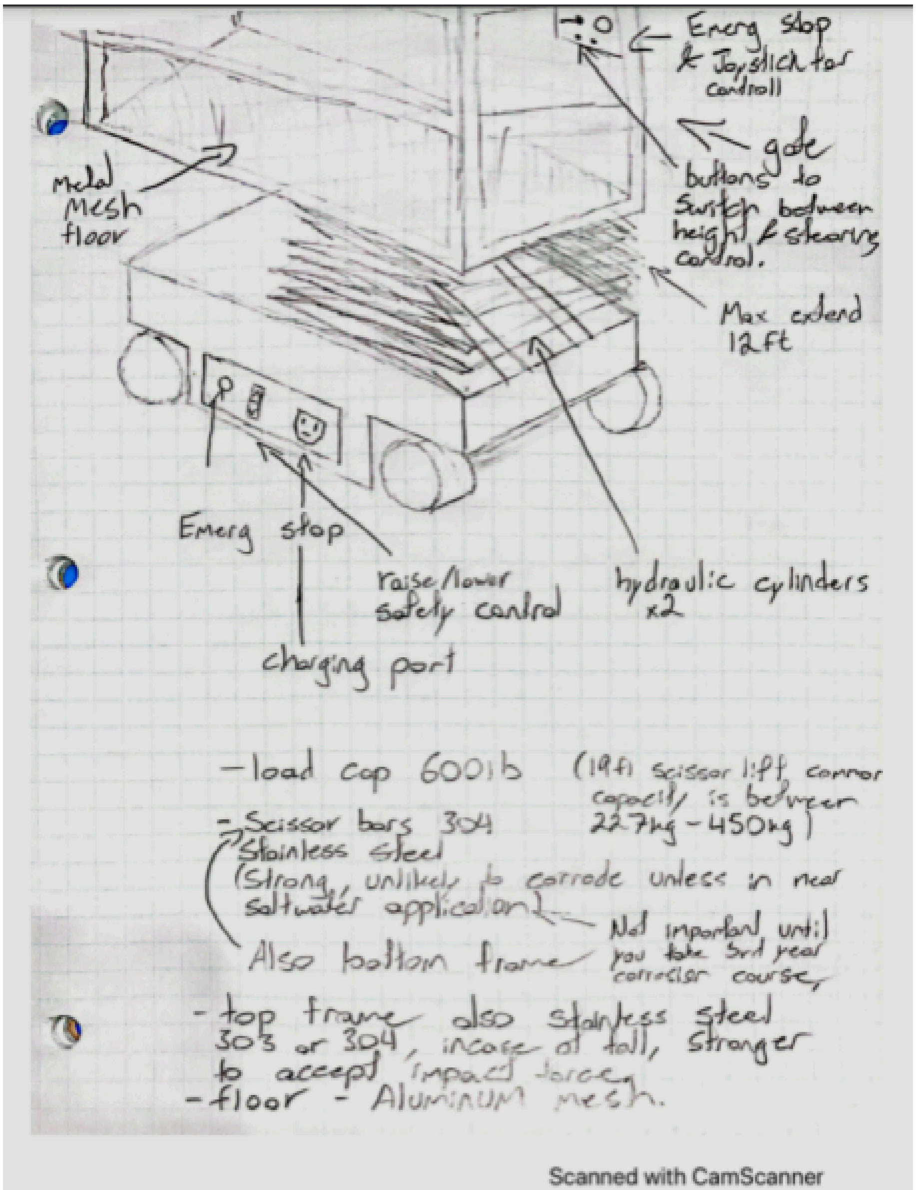


Figure 1: Alex Sabatini Design

Design #2:

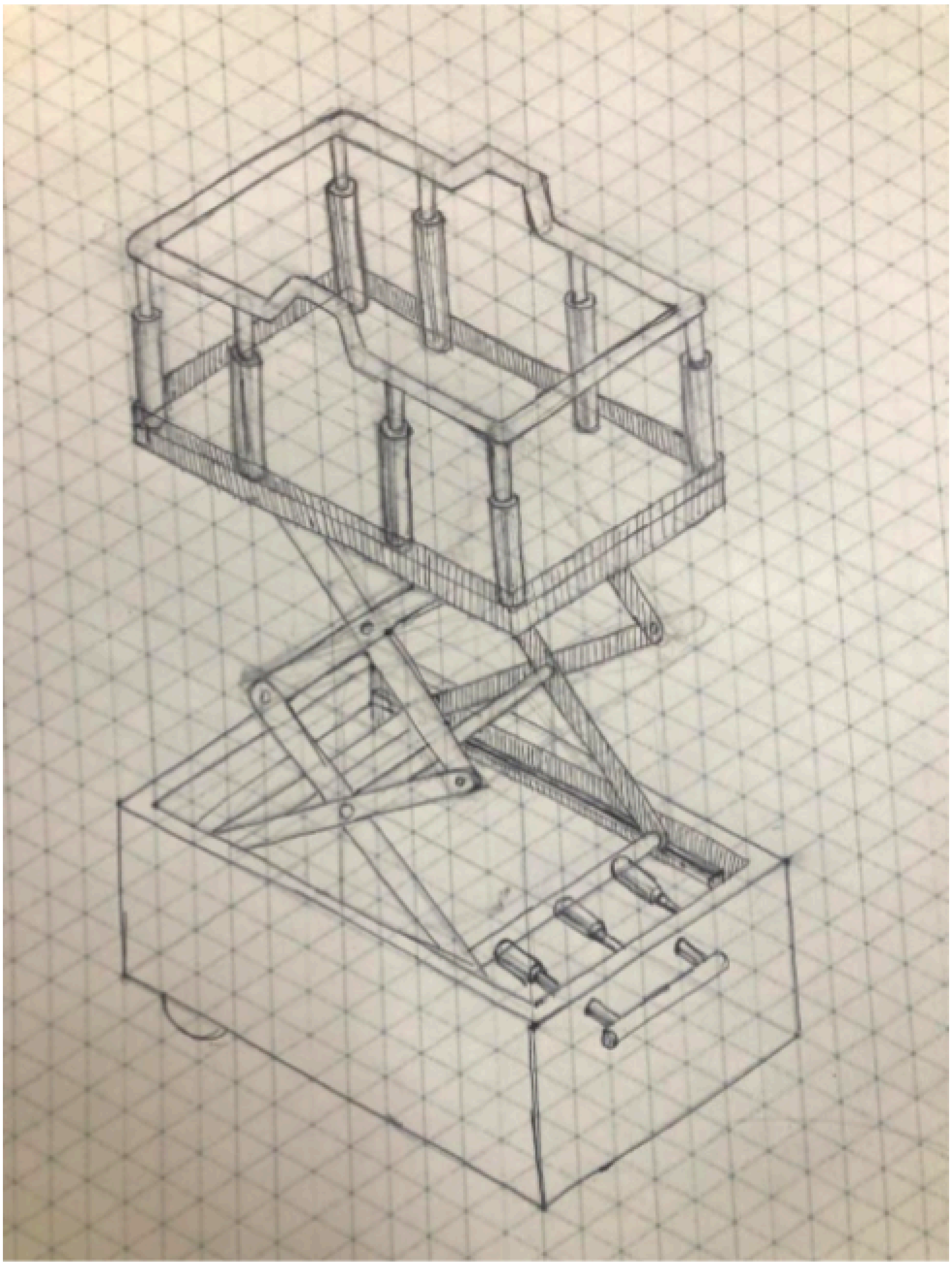


Figure 2: Umer Bashir Design

Design #3:

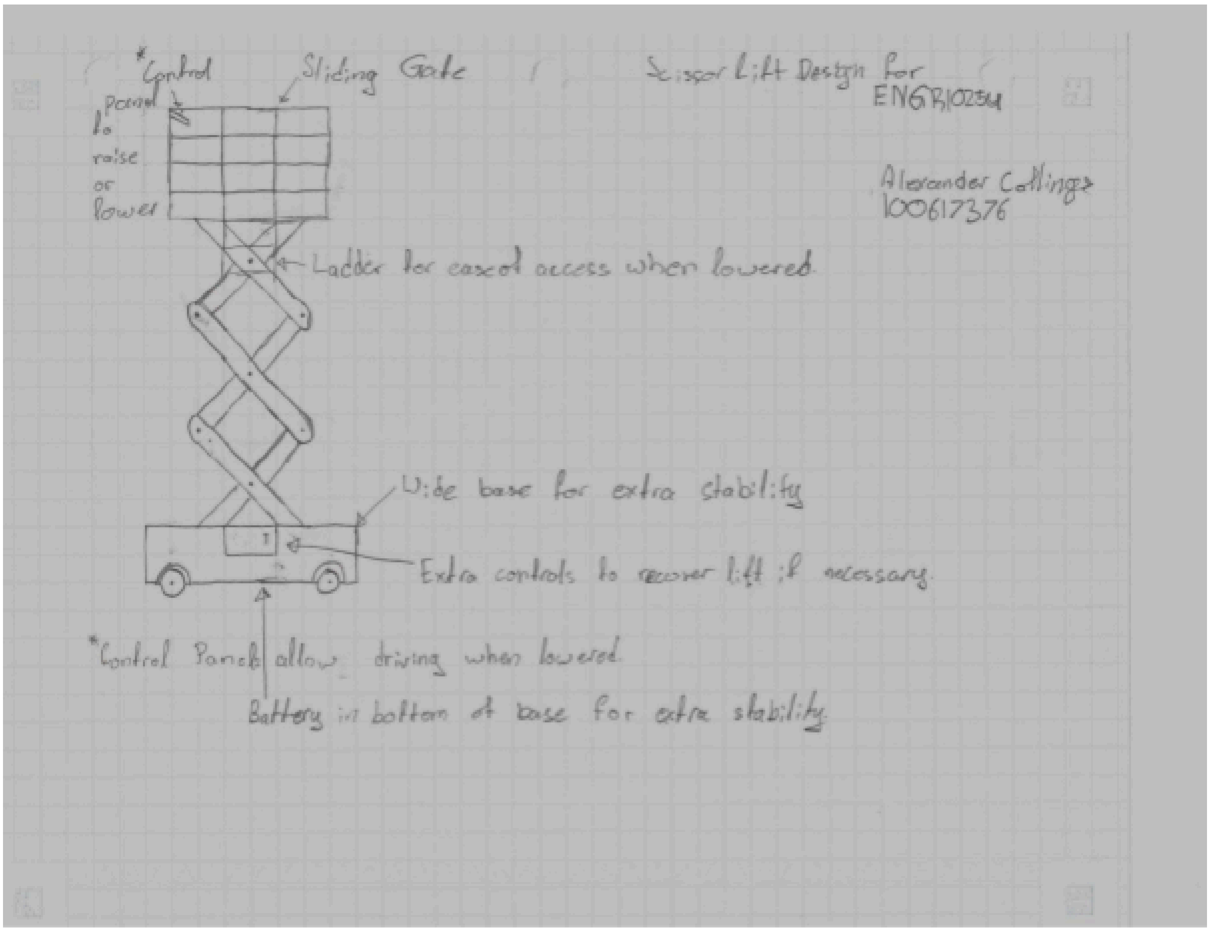


Figure 3: Alexander Collings' Design

Design #4 :

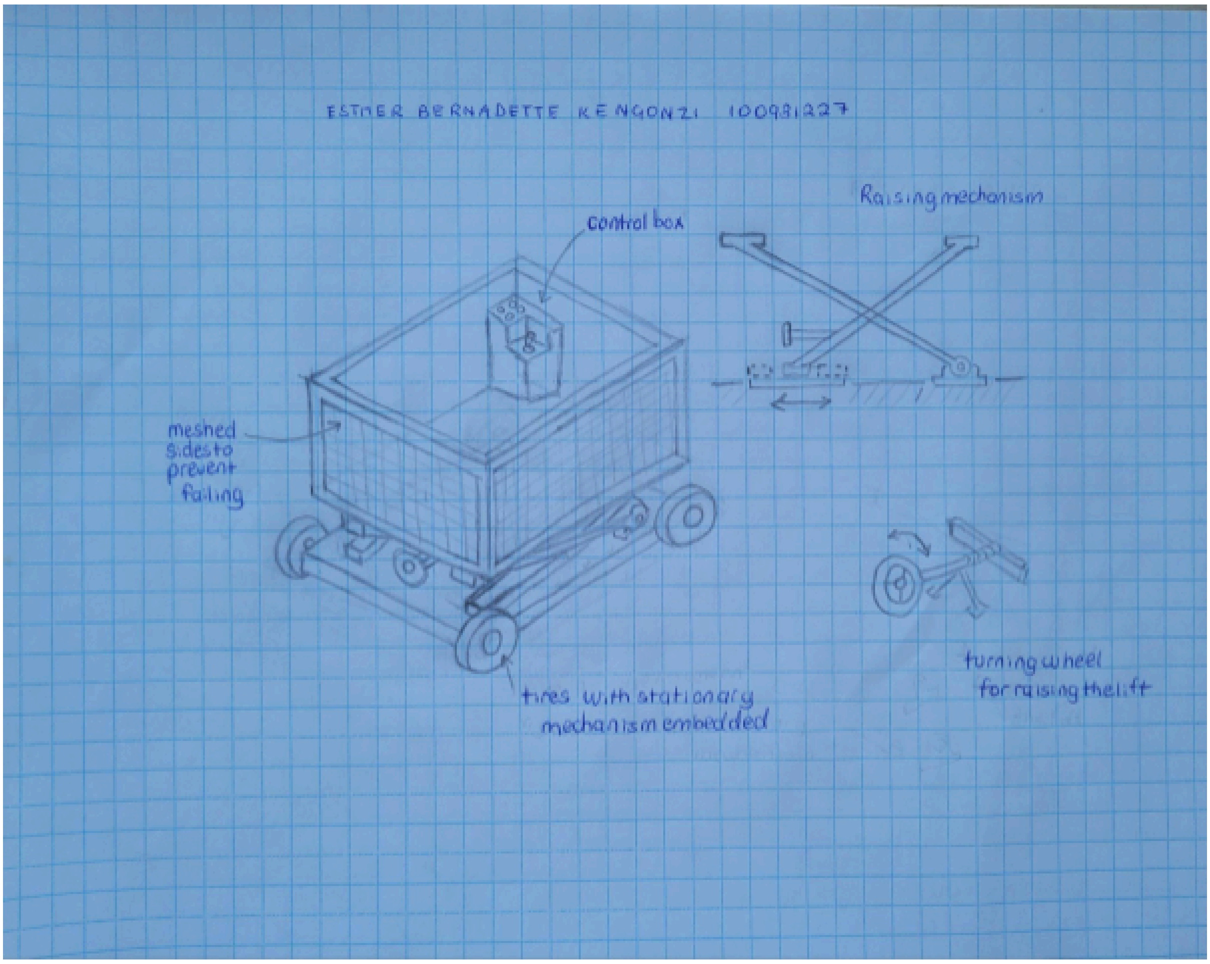


Figure 4: Esther Bernadette Kengonzi Design

Design #5:

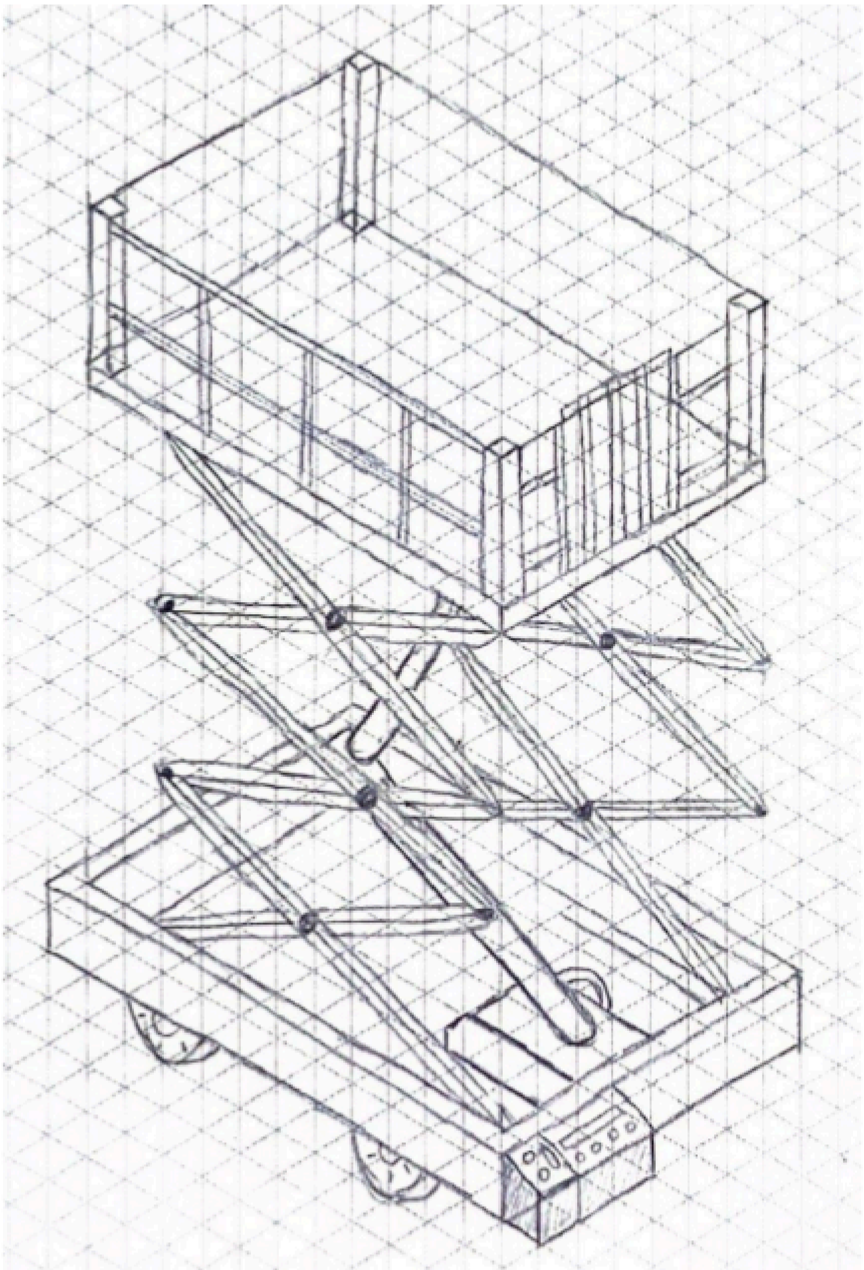


Figure 5: Nabhil Irtisham Design

Design #6:

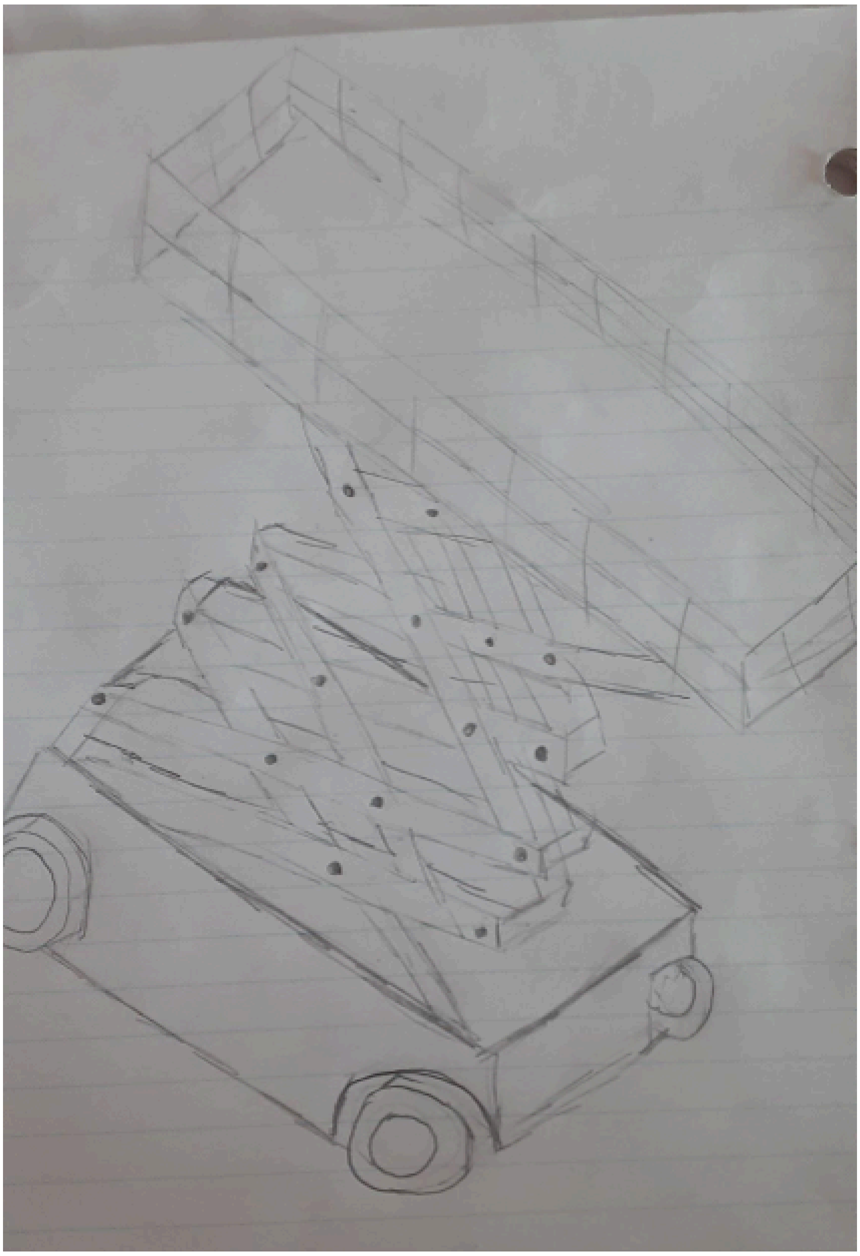


Figure 6: Quinn Lundy's Design

Design #7 :

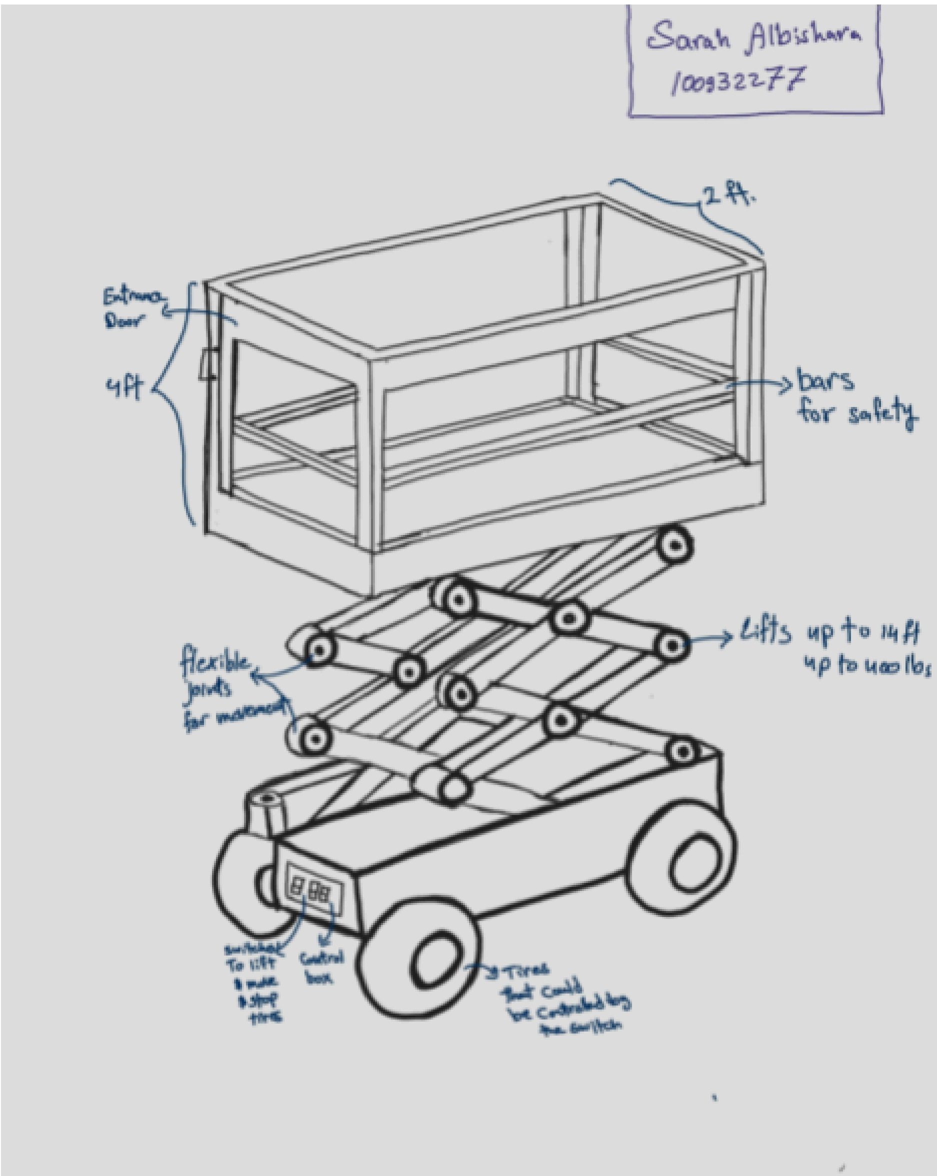


Figure 7: Sarah Albishara Design

Design #8:

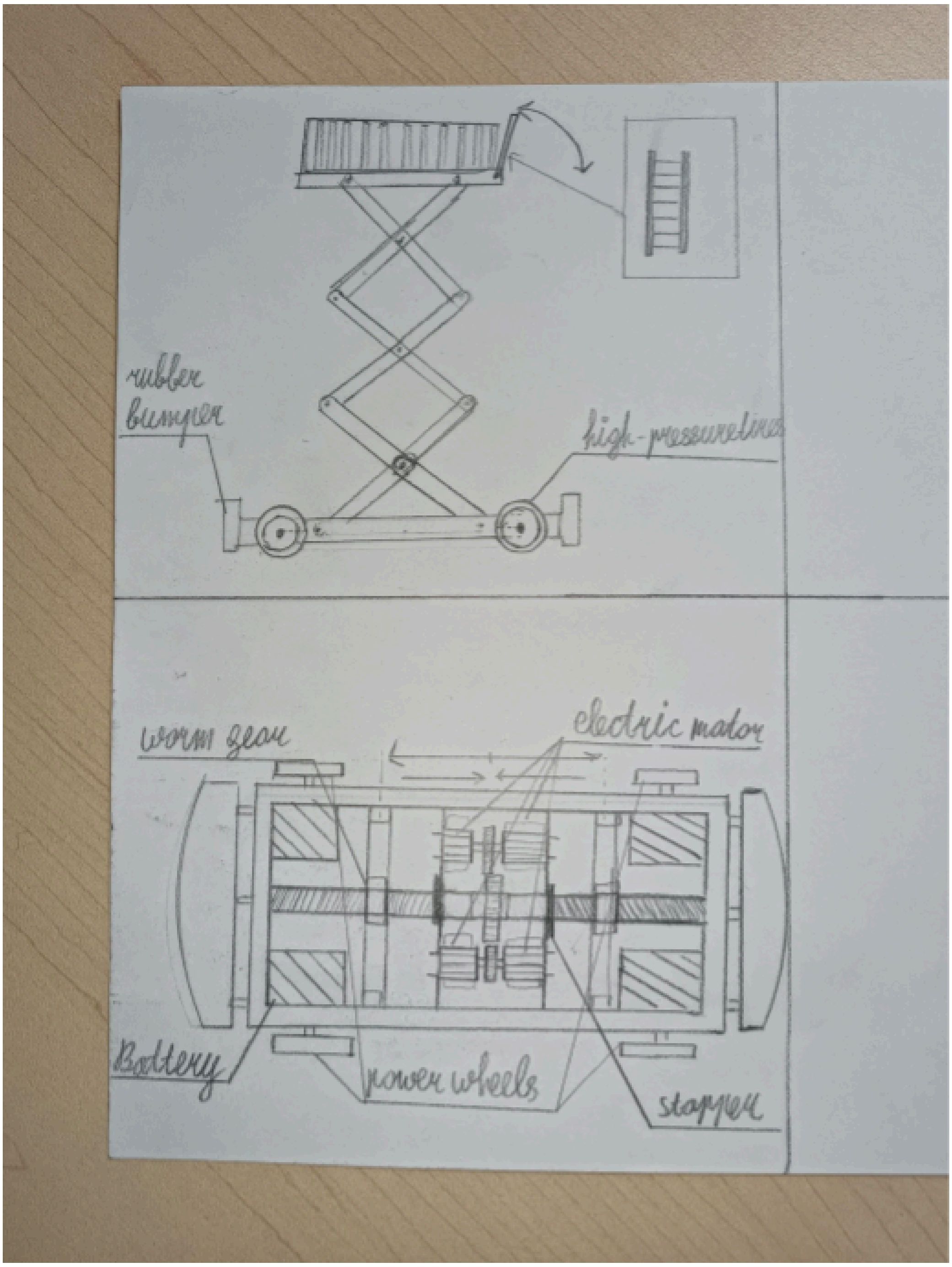


Figure 8: Ivan Voloshin

Concept Selection Process:

We organized an online meeting where we first decided on the metrics that were to be used to rate the concepts. Then, each member presented and explained their ideas' functionalities and unique features, which the rest of the group scored. The comparison criteria we followed included cost, durability, weight, safety features, low maintenance, ease of use, power efficiency, ease of assembly, aesthetics, capacity, environmental friendliness, and lifting speed. The most important criteria were safety, low maintenance, ease of assembly, and the lift's capacity.

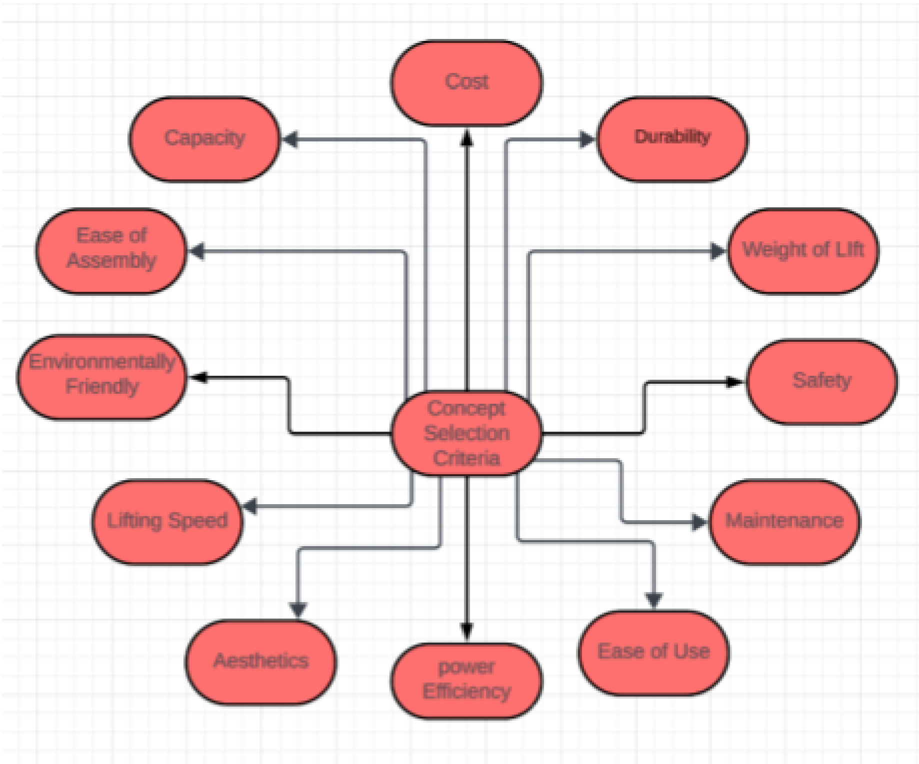


Figure 9: Concept Selection Criteria

The scores were given on a one-to-ten scale where a concept would score ten points if its design outstandingly met a specific criterion. The total number of points for each idea was added, and the one with the highest score was chosen as the best design. The best design was then critically evaluated, and improvements from other designs were added.

		Umer		Alexander		Esther		Nabhil		Quinn		Sarah		Ivan		Alex	
Criteria	Score Weight	Score	W score	Score	W score	Score	W score	Score	W score	Score	W score	Score	W score	Score	W score	Score	W score
Cost	8	7	56	3	24	7	56	5.5	44	4	32	6	48	6	48	5.5	44
Durability	6.5	6	39	7	45.5	6	39	7	45.5	7.5	48.75	5	32.5	7	45.5	7	45.5
Weight (of lift)	4	5	20	3	12	8	32	4	16	3	12	7	28	5	20	6	24
Safety	10	4	40	8	80	7.5	75	5.5	55	5	50	5	50	7	70	7	70
Low Maintenance	7	8	56	5	35	6	42	6	42	6	42	6	42	7	49	6	42
Easy to use	6.5	7.5	48.75	6.5	42.25	7.5	48.75	6	39	6.5	42.25	6.5	42.25	7	45.5	8	52
Power efficiency	5	4	20	3	15	6.5	32.5	6.5	32.5	5.5	27.5	7.5	37.5	6	30	7	35
Ease of assembly	7	4	28	2	14	8	56	5	35	4	28	7.5	52.5	8.5	59.5	4	28
Aesthetic	2	5	10	6	12	8.5	17	8	16	7	14	7	14	8	16	7	14
Capacity	6.5	4	26	8	52	5	32.5	7.5	48.75	8	52	4	26	7.5	48.75	6	39
Environment friendly	4	7	28	4	16	8	32	6	24	2	8	7.5	30	8	32	7	28
Lifting Speed	1	3.5	3.5	5	5	4.5	4.5	6	6	6.5	6.5	4	4	7	7	6	6
Total			375.25		352.75		467.25		403.75		363		406.75		471.25		427.5

Figure 10: Concept Selection Matrix

Design #9:

The best concept and the elements that stood out from the other concepts were identified and combined to produce the final ideal concept. The final concept was chosen, so its cost would be within the desired range, and the materials were selected based on the price to make the lift more durable. The final weight of the lift, the safety features to be added, the ease of maintenance, the ease of use, power efficiency, ease of assembly, aesthetics, lifting capacity, and environmental friendliness were also considered. Figure 11 below shows the components selected from each design concept based on the criteria we intended to meet.

	Reason For Choice	Design	Any improvements
Cost	Material -cradle: painted steel	Al Esther	cover for the charging part
Durability	stainless steel hydraulic & Electrical battery		
Weight (of lift)	Material: Size:		cradle dimentions 1x1.5 m
Safety	Controls top and bottom: emergency stop: bumpers:	Alex Sarah Esther	change the ladder to single step Horizontal thick bars
Low Maintenance	Parts are easily accessible for maintaining		modularity not too many parts
Easy to use	Location of Control Panel(s): Maneuverability:		Switches: up/down , forward/backward/tu
Power efficiency	system:		electric hydrolic
Ease of assembly	based on parts:		battery Use standard sizes
Aesthetic	Cool Factor:		(hint of white)
Capacity	up to 400 lbs.		
Environment friendly	System: Power:		
Lifting Speed	based on system		-- sec (full loaded) depends on the load

Figure 11: Components Selected from each design

Detailed Description of Final Design:

The sketch below was a mixture of the best components selected from each sketch. This is the final sketch that we decided to work with and proceed with building our CAD model.

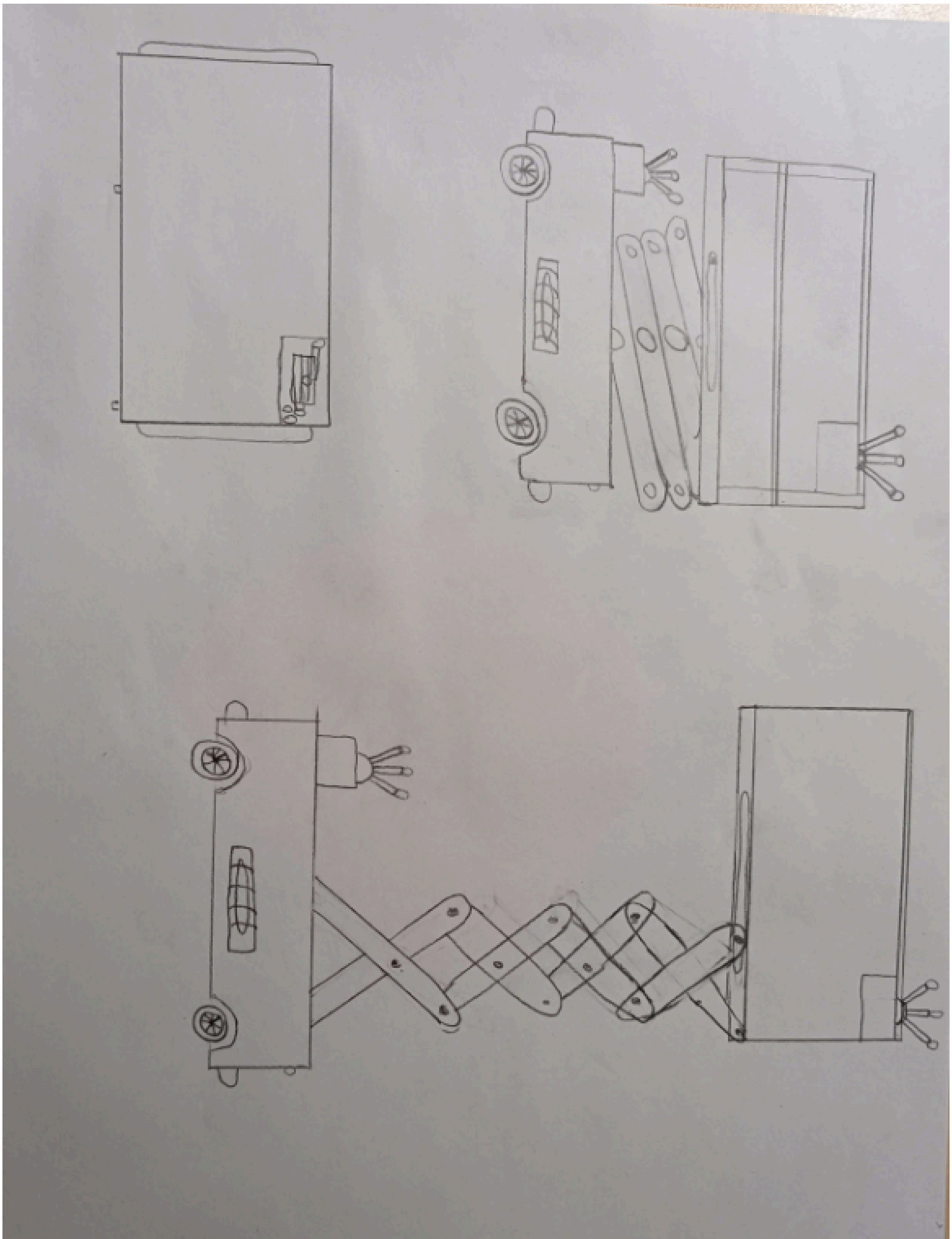


Figure 12: Final Hand Sketch of Design

Purpose and features:

The new SL-LxxL_Pro is a lightweight vertical travel scissor designed to outcompete its predecessors. It has been designed as the best solution for electrical and mechanical tasks at construction sites with 8-14 feet-high ceilings. It has a lift capacity of 450 Ib and can be easily disassembled/assembled for transportation. A two-person crew can set it up on the second floor of buildings with no elevators or ramps. The top platform of the lift can accommodate two people with sufficient space for their tools and materials.

The new SL-LxxL_Pro has been embedded with new features to enhance its users' safety. These new features include top and bottom controls, an emergency stop, rubber grip on the top rails of the cradle, hazard lights, and rubber bumpers at the front and back of the lift's base. The top and bottom controls ensure that the person on the ground can modulate the lift's operation if the person above in the scissor lift fails. The emergency stop is for terminating the lifting and lowering process of the lift when pressed in case of an emergency. Rubber bumpers reduce the effects of collisions in case the lift bumps into something as it is moving. The parking brake keeps the scissor lift in place when it is enabled. The battery level indicator can show the batteries' charge level so that the users are alerted if the lift needs to be recharged. The hazard lights can be turned on so that the driver in the lift can see the obstacles around the bottom of the lift.

Functionality of System:

The new SL-LxxL_Pro uses an electric hydraulic lifting system. The lift can be directly plugged into a socket if the construction site has a power supply, or it can run on electricity from the four strong rechargeable batteries in the base. The batteries are modularly fit into the base of the lift so that they can be easily removed and replaced. The lift has been designed with controls to facilitate steering, forward, and back motions as long as it is not ascending or descending.

Manufacturing Process:

Prototyping

After creating the final concept, computer-aided design software developed an analytical-focused prototype. It was used to show all the team members what the lift would physically look like and also to find out if it would work the way it was intended to. If non-intended behavior was noticed, adjustments were made to the lift components' dimensions and structure. The prototype also enabled us to check how well the customer needs had been met to ensure our goals were reached, and we proceeded to design our manufacturing process.

Material Section, Fabrication, and Assembly:

The new SL-LxxL_Pro comprises a cradle, where the user stands to be lifted, scissors legs and hydraulic cylinders that make the lifting motion, and a base with tires for the forward and back ground motion. The base also has modular spaces where a motor and batteries can be fitted. The batteries are the primary power source for the lift, and there is also an option to connect the lift directly to a power supply. The cradle has a platform guarded with rails. The base of the lift, the platform, and the guard rails on the cradle are made of Aluminum 3003, with the top part of the top guard rail coated with Vulcanized silicone to provide the user with a place to grip; the scissors legs are made of Stainless steel Sae 304. The batteries are high-weight ones purchased off the shelf.

Quality Control and Testing:

At different stages of the production line, a random sample of each manufactured part is checked using dimensional inspection and mechanical testing to see if the required specifications are still being achieved. The parts that do not meet the requirements are returned to the recycling station to be remolded, and parts that are within the specifications proceed to the assembly point.

Packaging and Distribution

After manufacturing, the parts needed to put one scissor lift together, excluding the batteries, are packaged in a single container along with the assembly instructions, safety features, and proper operation guidelines and sent to the SkyLIft Co. distribution centers across Canada. The scissor lifts are sold in these containers without being assembled or on request; they can be assembled at the distribution center and delivered as one unit. In both cases, the batteries are packaged and sold separately. The lifts can also be exported out of Canada on request.

Environmental Impact:

Environmentally friendly designs:

We deem caring for our environment an essential task at SkyLift Co. Thus, designing our manufacturing processes entails studying the environmental impact our productions would have on the environment. In the long run, We choose the most efficient ways to make our new products with the most negligible negative environmental impact. One way to do so is by creating designs that rely on accessible materials. Secondly, the designs are built around standard and non-standard parts. The standard parts are purchased from other companies, while our company manufactures the non-standard parts. Our manufacturing processes use eco-friendly materials and methods to reduce costs and negative environmental impact. For example, the aluminum and steel used are processed from the recycled machineware collected as scrap at our factory. The Vulcanized silicone is also purchased from our partner companies that deal mainly with recycling rubber.

Recycling old machines:

SkyLift Co. also takes back old construction machinery, which are fixed, if they are still in good shape, and sold for a lower price, or if in bad shape, are recycled to provide materials to make new machinery. This reduces the need to dig the ground to extract new materials and thus reduces negative impacts on the environment.

Cost Analysis:

The total Production Cost to produce one Siccos airlift was calculated to be $2000.00. The Retail price of one scissor lift is $2500.00. This means the scissor lift was marked by 25%, and the company has a profit margin of 20% per unit. These prices and profit margin are in line with our competitors.

Table 3: Retail and Production of Scissor Lift (Per Unit)

Price of Parts Individually	Cost in Canadian Dollars
Base	$300.00
Scissors	$250.00
Platform	$200.00
Control Panels	$150.00
Batteries	$100.00
Hazard Lights	$50.00
4 Wheels	$100.00
Bumpers	$50.00
Hydraulics	$300.00
Other Miscellaneous Parts	$100.00
Labor Cost Per Unit	$200.00
Manufacturing Cost Per Unit	$150.00
Quality Control Costs per Unit	$50.00
Total Production Cost Per Unit:	$2000.00
Retail Price:	$2500.00

Return On Investment:

Finally, an NPV table was made to calculate the investment worth of producing scissor lifts throughout the first four years. The total project NPV over 4 years was calculated to be $12512.59.

	Year 1				Year 2				Year 3				Year 4			
($ in thousands)	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**
Development Cost	-1250	-1250	-1250	-1250												
Ramp-Up Cost				-1000	-1000											
Marketing and Support Cos					-250	-250	-250	-250	-250	-250	-250	-250	-250	-250	-250	-250
Production Cost						-10000	-10000	-10000	-10000	-10000	-10000	-10000	-10000	-10000	-10000	-10000
Production Volume						5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000
Unit Production Cost						-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Sales Revenue						12500	12500	12500	12500	12500	12500	12500	12500	12500	12500	12500
Sales Volume						5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000
Unit Price						2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Period Cash Flow	-1250	-1250	-1250	-2250	-1250	2250	2250	2250	2250	2250	2250	2250	2250	2250	2250	2250
PV Year 1, r = 10%	-1250	-1219.51	-1189.76	-2089.34	-1132.43	1988.672	1940.167	1892.846	1846.679	1801.638	1757.696	1714.825	1673.000	1632.195	1592.386	1553.547
Project NPV	**12512.59**															

Figure 13: NPV Table of Scissor Lift

General Safety Guidelines:

The new SL-LxxL_Pro has been designed for vertical up-and-down movements and slow horizontal movements on reasonably flat surfaces. Therefore, to ensure the safe use of the lift, all operators need to be aware of the following safety procedures.

Inspection of the lift before each use.

The lift must be thoroughly checked before each use for any damages or faults. Things to look out for include worn-out pieces, batteries, and oil spills from the hydraulics. In case of any faults, the scissor should be returned to Skylift_Co, where it will be safely serviced.

Inspection of the worksite before operation.

Workers must check the worksite before working in a new place to establish if the conditions are safe, especially if they intend to use the rotation, forward, and back motions. Workers should look out and plan for inconveniences such as debris, overhead, and floor obstructions.

The platform should not be overloaded.

Users should ensure they put only a few items on the platform because they may fall out and hurt those below.

No people under the lift.

During operations with the lift, people must not stand redundant near the lift to

Wear protective gear.

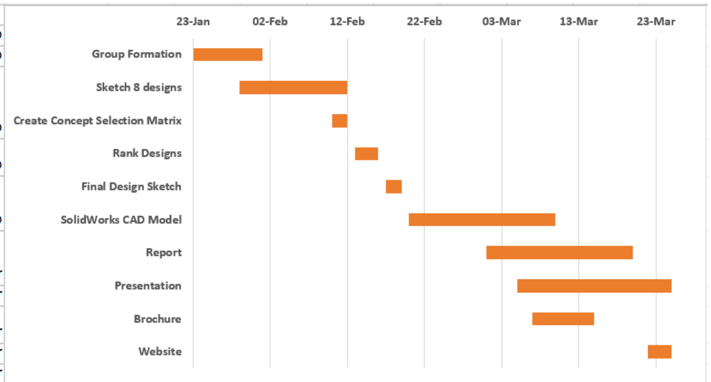
Workers should always wear protective gear such as construction gloves, helmets, and harnesses to reduce the risk of fatal injuries in case of accidents.

Proper storage of the lift.

When operations are finished, ensure the lift is stored in a place with proper ventilation and that all the controls are in neutral positions.

Gantt Chart:

Taks	Start Date	End Date
Group Formation	23-Jan	01-Feb
Sketch 8 designs	29-Jan	12-Feb
Create Concept Selection Matrix	10-Feb	12-Feb
Rank Designs	13-Feb	16-Feb
Final Design Sketch	17-Feb	19-Feb
SolidWorks CAD Model	20-Feb	10-Mar
Report	01-Mar	20-Mar
Presentation	05-Mar	25-Mar
Brochure	07-Mar	15-Mar
Website	22-Mar	25-Mar



Conclusion:

SkyLift Co. is proud to be at the forefront of modular successor lift technology. With the new SL-LxxL_Pro, we aim to revolutionize the successor lift industry. The design of the SL-LxxL_Pro is suitable for any work that requires it. Its aluminum and stainless steel give it strength and stability, allowing three people to stand on the platform and perform their work. The scissor lift uses an electric hydraulic lifting system to move it. The lift also had four rechargeable electric batteries in the base in case a socket was unavailable. The modular build allows it to have greater portability in transport so that it can be moved with relative ease between floors. The lift's electrical lifting system, modular rechargeable batteries, and environmentally friendly materials help it remain beneficial to the environment and society.

Acknowledgements:

We would like to express our sincere gratitude to Professor Shemran Pareera for assigning us the group design project as a part of our Engineering Design coursework. The professor's guidance, support, and knowledge have been invaluable throughout the project. We are grateful for the opportunity to apply our skills and knowledge to real-world scenarios, which has helped us develop critical skills useful in our future careers.

We would also like to thank the Teaching Assistants who supported us during the project. Their timely feedback, input, and suggestions helped us navigate the project and overcome the various challenges we encountered. The Teaching assistants spent countless hours grading our work, providing us with feedback, and answering all of our questions, which were crucial to our project's success.

Furthermore, we would like to thank our classmates who worked alongside us on this project. Their hard work, dedication, and collaboration were vital in delivering a high-quality project.

Last, we would like to thank Ontario Tech University for providing us with excellent educational and lab facilities, which helped us learn the fundamentals of SolidWorks over the semester.

In conclusion, we are very grateful for the opportunity to work on this project, which has provided valuable learning experiences and allowed us to refine our technical and soft skills. We are particularly grateful to the University, Professor Sgerman Parrera, Teaching Assistants, and our classmates for their support and guidance throughout this project.

References:

1. ASM Metal Recycling, “Is aluminum environmentally friendly? the Green Metal,” ASM Metal Recycling, 02-Mar-2021. [Online]. Available: https://www.asmrecycling.co.uk/blog/why-is-aluminium-environmentally-friendly/. [Accessed: 25-Mar2024].

2. R. B. Swanson, “Fall protection, training, inspection and design requirements of aerial lifts and scissor lifts/scaffolds.,” Fall protection, training, inspection and design requirements of aerial lifts and scissor lifts/scaffolds. | Occupational Safety and Health Administration, 02-Jun-2005. [Online]. Available: https://www.osha.gov/lawsregs/standardinterpretations/2000-02-23-1. [Accessed: 25-Mar-2024].

3. “Scissor lift market size & share: Industry report, 2020-2027,” Scissor Lift Market Size & Share | Industry Report, 2020-2027. [Online]. Available: https://www.grandviewresearch.com/industry-analysis/scissor-lift-market. [Accessed: 25- Mar-2024].

4. CSA Group, “CAN/CSA-B354.2-01 (R2013): Self-Propelled Elevating Work Platforms,” CSA Group, 2001. Available: https://www.csagroup.org/store/product/CAN-CSA-B354.2-01/?gclid=Cj0KCQiAz9i eBh CIARIsACB0oGIbmHE9EGODiNe2gJIpW6ubSlEAPLNzXxFsnnsbtgMu2-WrRbw Kgq caAnKOEALw_wcB [Accessed: 24-Mar-2024].

Appendix A: LogBook Entries

<table>
<tr><th>Date</th><th>Action</th></tr>
<tr><td>January 28, 2024</td><td>Group Formation - Messaged all group Members. Added everyone to a Discord Group.</td></tr>
<tr><td>February 3, 2024</td><td>First In-Person Meeting at the Library - Discussed tasks (market research, individual sketches, rough deadlines) and started a Gantt Chart to keep track of all things.</td></tr>
<tr><td>February 8, 2024</td><td>Online Meeting - Discussed our progress with the individual designs. We have a good variety of designs with different elements.,</td></tr>
<tr><td>February 15, 2024</td><td>In-Person Meeting in SHA - A concept selection matrix was created, and all 8 designs were ranked.</td></tr>
<tr><td>February 17, 2024</td><td>Online Meeting - The best elements from each design were chosen to make the final sketch.
<table>
<tr><th></th><th>Reason For Choice</th><th>Design</th><th>Any improvements</th></tr>
<tr><td>Cost</td><td>Material
-cradle: painted steel</td><td>AI
Esther</td><td>cover for the charging part</td></tr>
<tr><td>Durability</td><td>stainless steel hydraulic & Electrical battery</td><td></td><td></td></tr>
<tr><td>Weight (of lift)</td><td>Material:
Size:</td><td></td><td>cradle dimentions 1x1.5 m</td></tr>
<tr><td>Safety</td><td>Controls top and bottom:
emergency stop:
bumpers:</td><td>Alex
Sarah
Esther</td><td>change the ladder to single step
Horizontal thick bars</td></tr>
<tr><td>Low Maintenance</td><td>Parts are easily accessible for maintaining</td><td></td><td>modularity not too many parts</td></tr>
<tr><td>Easy to use</td><td>Location of Control Panel(s):
Maneuverability:</td><td></td><td>Switches: up/down , forward/backward/tu</td></tr>
<tr><td>Power efficiency</td><td>system:</td><td></td><td>electric hydrolic</td></tr>
<tr><td>Ease of assembly</td><td>based on parts:</td><td></td><td>battery
Use standard sizes</td></tr>
<tr><td>Aesthetic</td><td>Cool Factor:</td><td></td><td>(hint of white)</td></tr>
<tr><td>Capacity</td><td>up to 400 lbs.</td><td></td><td></td></tr>
<tr><td>Environment friendly</td><td>System:
Power:</td><td></td><td></td></tr>
<tr><td>Lifting Speed</td><td>based on system</td><td></td><td>-- sec (full loaded) depends on the load</td></tr>
</table>
</td></tr>
<tr><td>February 19, 2024</td><td>Online Meeting - The final Sketch of the design was made, and the final dimensions were fixed.</td></tr>
<tr><td>February 20, 2024</td><td>Online Meeting - Decade to start building the CAD model. Separated, they scissor lift parts among each group member

● Cradle, Upper Control Panel: Sarah, Esther</td></tr>
</table>

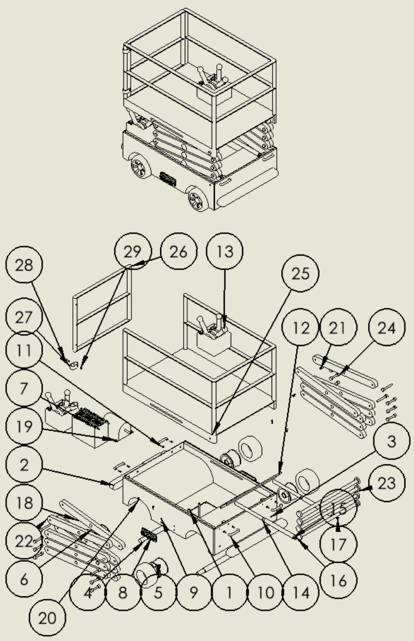
	• Scissors: Ivan • Body: Alexander Collings & Umer • Control Panel (lower), Hazard Lights: Quinn • Wheels, Bumpers, Control Panel (lower): Nabhil • Battery Compartments: Alex Sabatani • Scissors: Ivan • Hydraulics: Alex Sabatani • Hazard Lights: Quinn • Full Assembly: Alexander Collings
March 1, 2024	Online Meeting - Discussed Cost Analysis, environmental impact, safety features, human factors, and manufacturing process of the scissor lift.
March 5,2024	In-Person Meeting Library - Sit together to divide all of the parts among the group members • Final CAD Assembly - Ivan, Quinn, Alexander Collings • Website - Sarah • Cost Analysis - Alexander Collings • Report - Umer, Esther • Presentation & Script - Nabhil, Alex Sabatini • Brochure - Sarah
March 10, 2024	In-Person Meeting ERC- To sit together and fully assemble the design, Make small modifications to the dimension or design if needed.
March 20, 2024	Online Meeting - Finalized the business name and scissor lift name. Also made a basic sketch of the logo. Checked on everyone's progress.
March 23,2024	Online Meeting - Added finishing touches on the CAD model. Took screenshots to include in our report and presentation.
March 30, 2024	Final In-Person Meeting Library - Divide slides among the 8 group members. Do multiple practice runs for the presentation.

Appendix B: Brochure

Figure 14: Front Side of Brochure

Figure 15: Back Side of Brochure

Appendix C: Engineering Drawing of Exploded View



ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	Base		1
2	Bumper		2
3	Bumper Pegs		4
4	Axle		2
5	Wheel Frame		4
6	Wheel Tyre		4
7	Battery		1
8	Operating Light		2
9	Operating Light Bolt		8
10	Carry Handle		4
11	Carry Handle Bolt		8
12	Connector Rod		1
13	Control Box		2
14	Cylinder Ram		2
15	Cylinder Shell		2
16	Cylinder Cap		2
17	Main Connect		2
18	Top Connect		2
19	Motor		1
20	Motor Bolt		4
21	Base Pin		6
22	Scissor Arm		16
23	Mid Point Stabilizer		4
24	Scissor Pin		12
25	Carriage Body		1
26	Carriage Gate		1
27	Gate Hinge		2
28	Hinge Bolt		2
29	Hinge Nut		2

Full Assembly Exploded View Drawing and BOM

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Appendix D: Bill Of Materials:

ff	PART NUMBER	DESCRIPTION	QTY.
1	Base		1
2	Bumper		2
3	Bumper Pegs		4
4	Axle		2
5	Wheel Frame		4
6	Wheel Tyre		4
7	Battery		1
8	Operating Light		2
9	Operating Light Bolt		8
10	Carry Handle		4
11	Carry Handle Bolt		8
12	Connector Rod		1
13	Control Box		2
14	Cylinder Ram		2
15	Cylinder Shell		2
16	Cylinder Cap		2
17	Main Connect		2
18	Top Connect		2
19	Motor		1
20	Motor Bolt		4
21	Base Pin		6
22	Scissor Arm		16
23	Mid Point Stabilizer		4
24	Scissor Pin		12
25	Carriage Body		1
26	Carriage Gate		1
27	Gate Hinge		2
28	Hinge Bolt		2
29	Hinge Nut		2