85-131: Design Project Report

Submitted by:

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Sheylen Jagajodhy: [redacted]

Group 3-[redacted]

Abstract

The purpose of this design project was to design a conceptually innovative and unique wheelchair lift that provides all the standard capabilities and more features if possible. The problem of this project is to design a wheelchair lift that is unique from the competitor's design. This design must incorporate all of the necessary requirements in a properly functioning wheelchair lift.

To initiate the project, each member drew an ideation sketch representing different ideas in how to efficiently craft a unique wheelchair lift. Once all five sketches were made individually, they were analyzed as a group using a decision matrix. This matrix was used to decide which concepts would be selected to go under further analysis before the final product design was chosen. Justifications were created explaining each sketch and the decision matrix.

After two of the five original ideation sketches were chosen to go under further analysis by the decision matrix, a group concept sketch was created. This group sketch incorporated the best features of all previous sketches. Having three potential final products, another decision matrix was made to compare the three sketches. This decision matrix was the deciding factor in which sketch will go on to be the final design product. Justifications were made for the new sketch as well as for the second decision matrix.

Having the final product, a product design specification table was made. This table included a list of all functional requirements and constraints that the design had to meet and/or follow. Once the functional requirements were identified, a multi-view sketch was made as well as an isometric sketch. These sketches provided the basic structure to our wheelchair lift.

From the multi-view and isometric view sketches, labeled component design specifications sketches were created as well as a bill of materials and a systems design specification. The labeled component sketches and bill of materials were created to show the detailed features of the wheelchair lift such as things like: fasteners used, machinery to operate the lift, and materials incorporated into the final product. With these designs, we fashioned the systems design specifications table and the bill of materials. Justifications were made for each table.

The system design specifications table indicates all of the features that are provided by each system of the wheelchair lift. The bill of materials included list of all fasteners and other parts of assembly.

After all sketches and tables were completed, they were revised and edited making multiple versions of certain tables and/or sketches. These revisions were done to try and create the best possible wheelchair lift.

After all the revisions were done, a 3D animation of the final product was made to digitally portray the wheelchair lift. With these 3D animations, a clip of how the wheelchair lift is expected to operate was created to finalize the project.

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Introduction

As important as the wheelchair is itself as a method of transportation, travelling long distances may become very cumbersome. Vehicle accessibility is a necessary aspect of travel for those that require the use of a wheelchair. Many people may not be able to manually place those in a wheelchair efficiently into a vehicle; a wheelchair lift is used to aid the process.

There are many challenges in making a wheelchair lift efficient; all the systems must properly cooperate to make a smooth running machine. Not only do the functional requirements spark challenges, but also the constraints that arise with each functional requirement make the design process a very tedious stage of production. Designing systems that operate appropriately without the stress of the weight of the unit itself has been the most challenging aspect to this design.

From all of the ideation sketches provided to the group, the best one was chosen due to the fact that it scored the highest on most of the functional requirements. Some functions of the final design overlapped with functions of other sketches showing that many good ideas are the most common. However, the final design proved to be superior.

This wheelchair lift has a user interface that is very user-friendly allowing people of all ages to use. The detection safety precautions allow this device to be used safely around children as well. This wheelchair lift design also optimizes the use of reliable materials by trying to use as little materials as possible by choosing the ones that are the most durable. This may drive up the cost slightly from the average wheelchair lift, but the minimal amount of materials used is the key factor in keeping the increase of cost within a small margin.

This design aims to meet the initial goals set and even surpass standard expectations throughout North America. Each system working in the wheelchair lift provides the most reliable, safe and user friendly mechanism that results in a swift wheelchair transfer from a person on land to being secured in the vehicle.

With many minds working to reach one goal, this design can serve as evidence that innovative creations start in the classroom.

Conceptual Design

Product: Wheelchair Lift **Version:** 1.0 **Date:** November 15, 2012

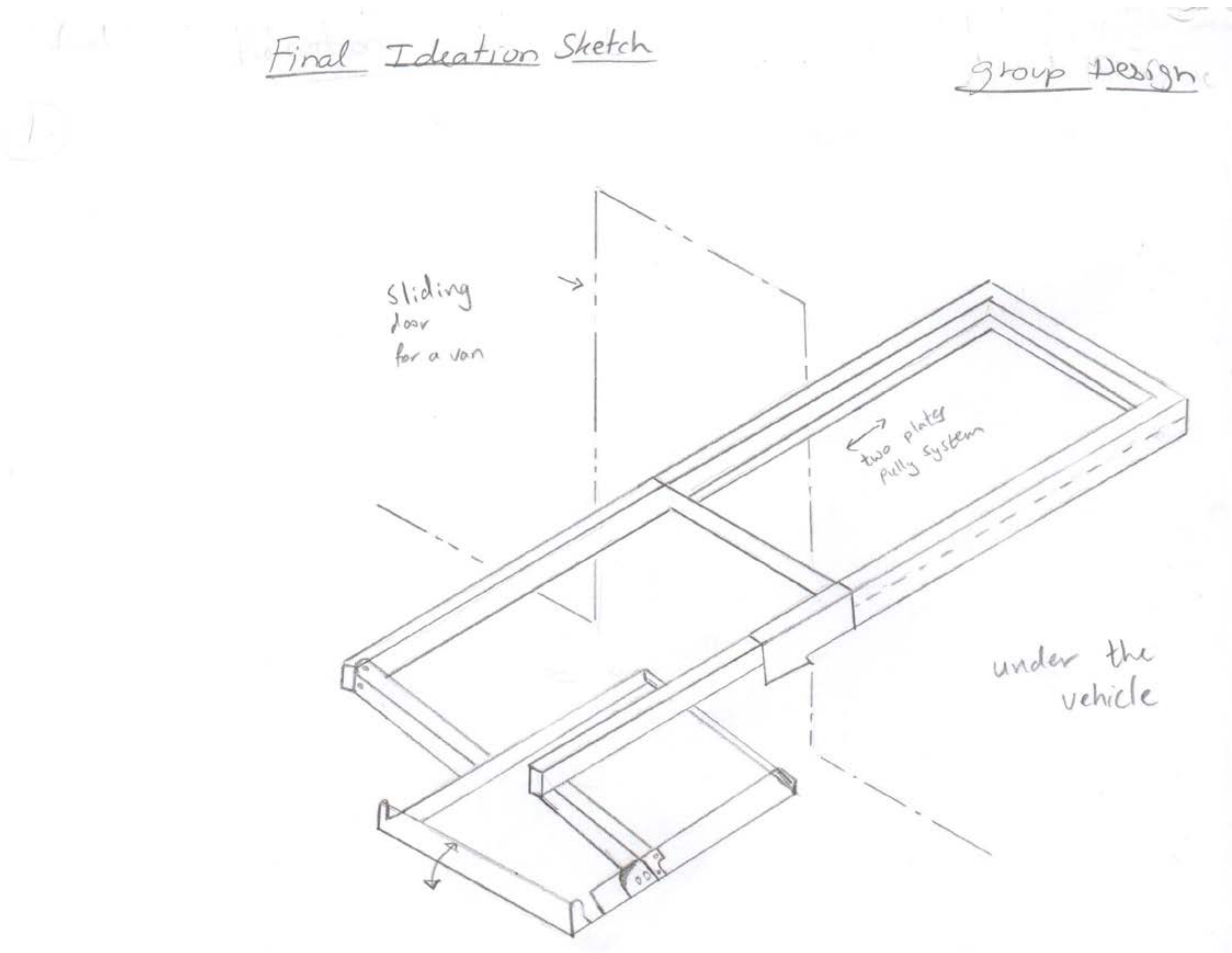
ISSUE	PARAMETERS		
	Competitor's Best	This design (intent)	World class (target)
1.0Performance Issues			
1.0.1 Lifetime			
Warranty	4 year's	4 Year's	4 year's
Life Span	5 year's	5 year's	5 year's
1.0.2 Loadings			
Mass	800-1000lbs	700lbs	800lbs
Load Distribution point	2	2	2
Balance of car	Balanced	Balanced	Balanced
1.0.3 Materials			
Durability /tensile strength	Excellent Suitable up to 800lb	Suitable for up to 700lb	Suitable for up to 700lb
Corrosion / Effects of use	None	Yes (some parts)	None
1.0.4 Operation			
Deploy Time	Max 20 seconds	Max 25 s	Max 20 s
Expected performance	Very Good (supports)	Fair	Excellent
Operational temperature	0-140 F		0-140 F
1.0.5 Safety			
Reliable	Yes	Yes	Yes
1.0.6 Size			
Restrictions	34"x54" (max), 33" x 51" (min), 54" (lift height)	30" X 45" (max), Lift height (5.6") Thickness: 0.5" solid metal.	34"x54" (max), Lift height (5.6")
Does use affect the vehicle	Yes	Yes	Yes
Usability costs	No (uses fuel)	No (uses fuel)	No (uses fuel)
1.0.7 Standards			
Meet safety requirements	Yes	Yes	Yes
Cost of manufacturing	$3500	$3850	$5000
1.0.8 Weight			
Desirable Weight	400 lbs.	340	400

Effect on systems	Wear and tear	Little	Little
1.0.9 Quality and Reliability			
Material	Steel Mesh & steel frame	Aluminum Platform	Material with high yield strength
Reputation of company (people standard)	Yes	Yes	Yes
1.1 User Issues			
1.1.1 Aesthetic			
Color choices	No choice	User preference	User preference
Effect on car appearance	No	Little	No
1.1.2 Customer's Needs/Desires			
Cost	$6000-$14000	$5000	$6000
Usability	User friendly	User friendly	User Friendly
1.1.3 Ergonomic			
User Interface	Wired Remote Control + Driver Control	Wireless Control + Backlit + Voice controls + IPhone support + Driver control override	Wired Remote Control + Driver Control
1.2 Engineering Issues			
1.2.1 Costs			
Does final cost include assembly	Yes	Yes	Yes
Upgrades	Yes	No	Yes
Shipping costs	Yes	Yes	Yes
1.2.2 Disposal			
Recycle Friendly	Yes	Yes	Yes
Disposable service	No	No	Yes
1.2.3 Documentation			
User agreement	Yes	Yes	Yes
User Manual	Yes	Yes	Yes
1.2.4 Environment (operational)			
Effects of weather on product	No	Slightly	No

Power source	Electric	Electric	Electric + Fuel
Care of Users	Yes	Yes	Yes
Green	No	No	No
1.2.5 Environment (manufacturing)			
Energy usage	Power Supply: 12VDC, Max. Current Consumption: 70A (12V)	Power Supply: 12VDC ,Current Consumption: 60A (MR)	Less
Material use	Complex, takes up inventory space (material waste)	Aluminum platform, rubber bottom	Aluminum platform, rubber bottom
Exposure to packaging	Yes	Yes	Yes
Use of Natural resources	Yes	Yes	Yes (minimal)
1.2.6 Installation			
Easy to install	No (need service)	No (slight modifications)	No (need service)
Modifications	Yes	Yes	Yes
1.2.7 Maintenance			
Maintenance time	1.5 hours	0.5 hours	1hour
User Do-able	No	No	No
1.2.8 Packaging			
On shelf product	No	No	No
Each component requires packing	No	No	No
1.2.9Projectmanagement			
Assembly Line	Yes (for each component)	Yes	Yes
Manufacturing speed	No mass production (built for buyer)	No mass production (built for buyer)	No mass production (built for buyer)
1.2.10Product quality			
Withstands Standard Conditions	Yes	Yes	Yes
1.2.11 Testing			
Strength of materials (Tensile Strength)	400Mpa	207Mpa	400Mpa
Special facilities	Yes (by	Yes (by	Yes (by

	government)	government)	government)
Resale	No (testing required)	No (testing required)	No (testing required)
1.3 Societal Issues			
1.3.1 Environment			
Fuel consumption/pollution	Yes	Yes	Yes
1.3.2 LegalImplications			
Fail safe	Yes	No	Yes
Is it unique	No	Yes	Yes
1.4 Corporate Issues			
1.4.1 Company Requirements			
Permanent attachment	Yes	Removable	Yes
Cost no more than 10% of present value	No	Yes	Yes
1.4.2 Marketing Requirements			
Sales (discounts)	Yes	No	Yes
Benefit discussion	No	Yes (by changing choice of materials)	No

Final Ideation Sketches



Ideation Sketch #1: Muhanad Kadhim

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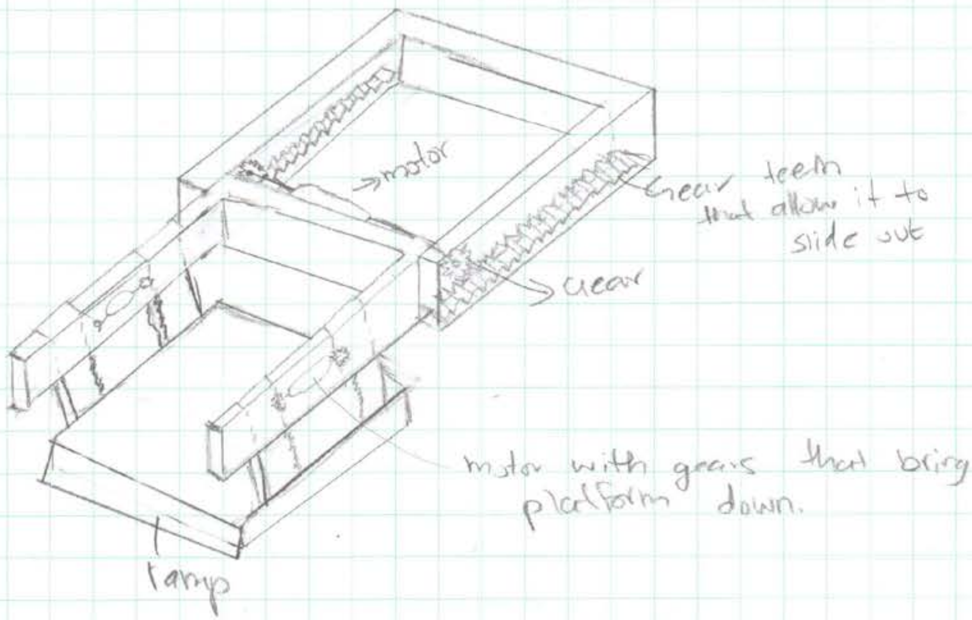
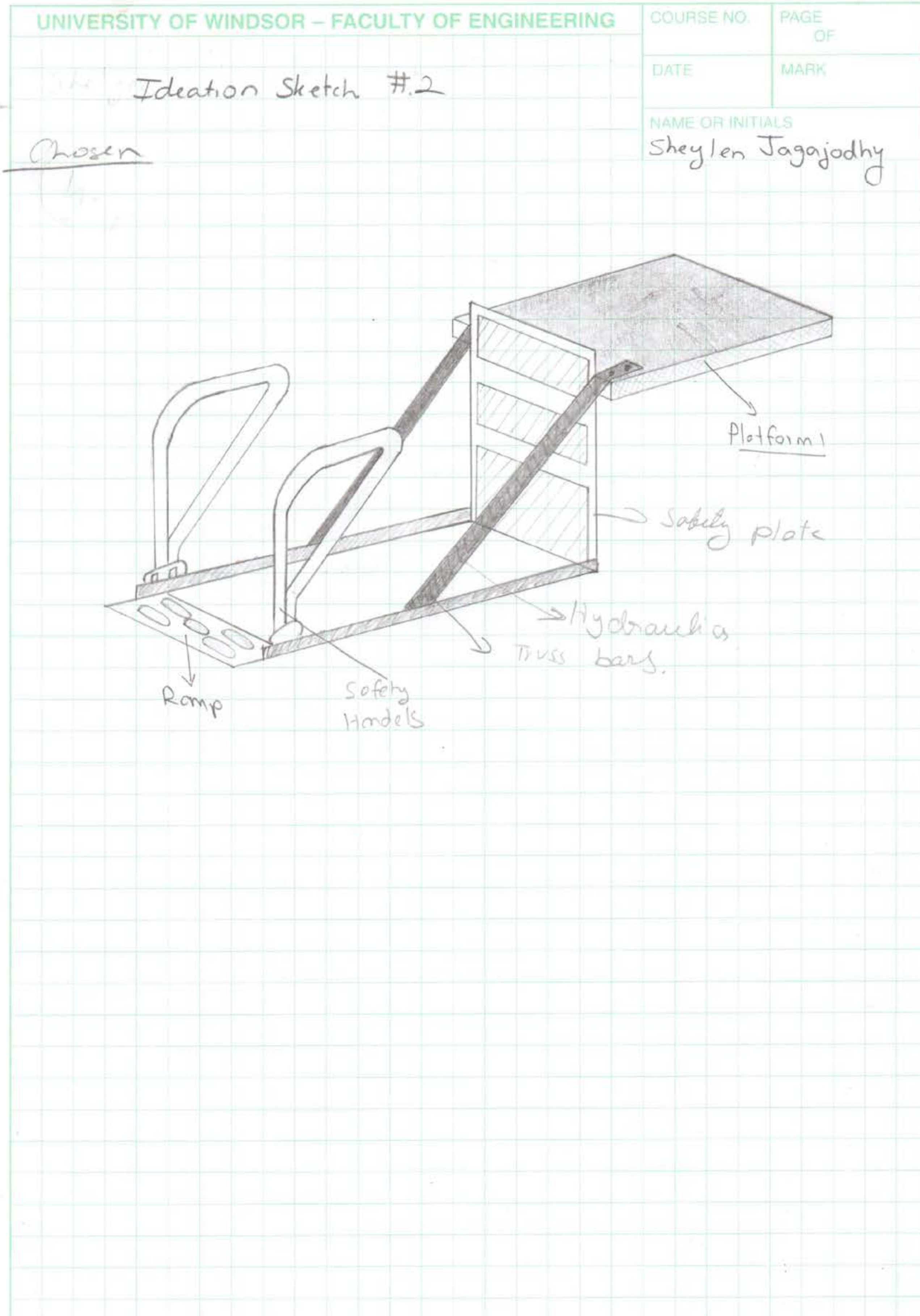
NAME OR INITIALS Muhanad Kadhim

Ideation sketch #1

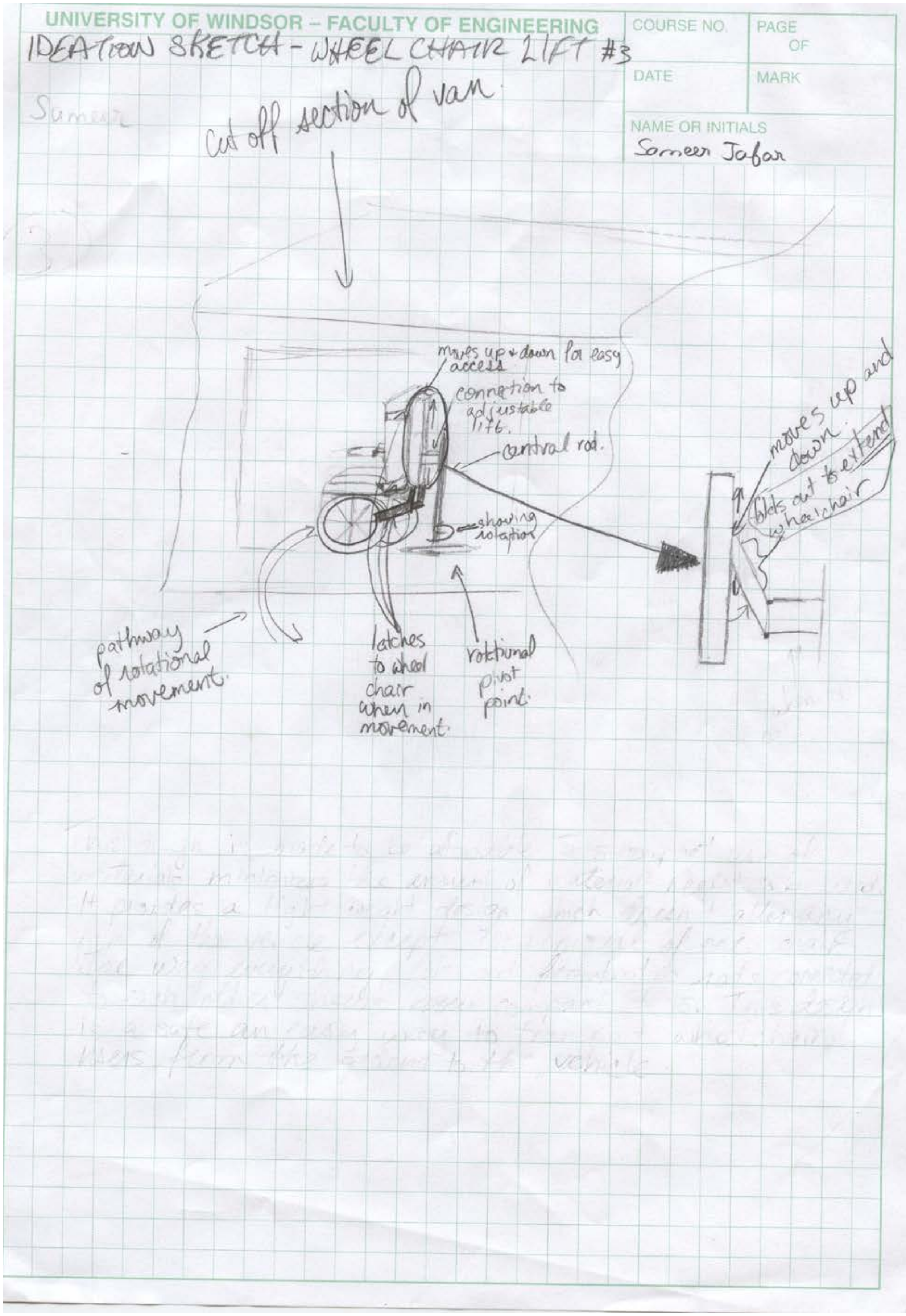
Chosen



Ideation Sketch #2: Sheylen Jagajodhy



Ideation Sketch #3: Sameer Jafar



Ideation Sketch #4: Sai Kiran Jonnalagada

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Sai Kiran Jonnalagadda	

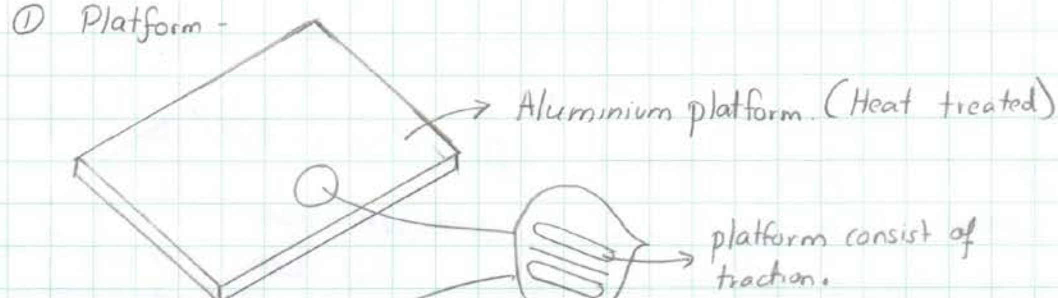
wheelchair - lift for van.

Ideation Sketch #.4

Question: You have to redesign a wheelchair lift for a van.

Components of lift. ① 2- Platforms - 1 extendable
② 2- hydraulic pumps
③ Bracket fictures - and side railing supports.

① Platform -



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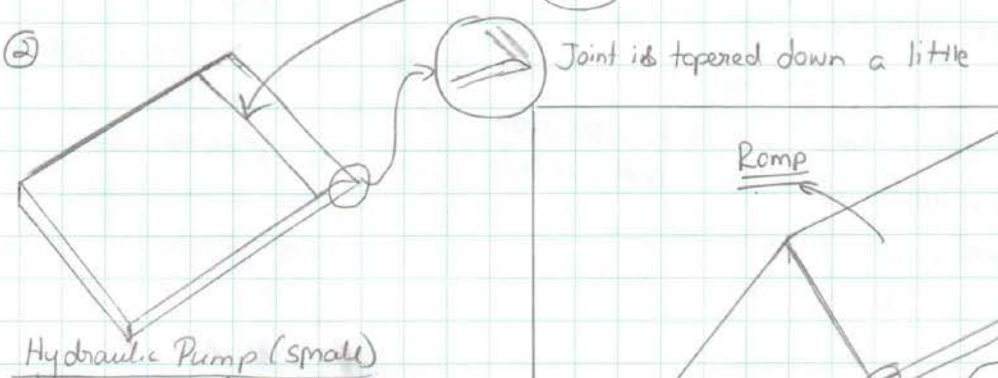
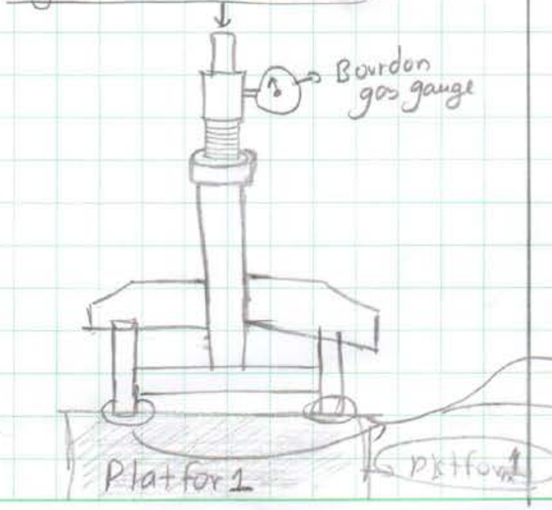
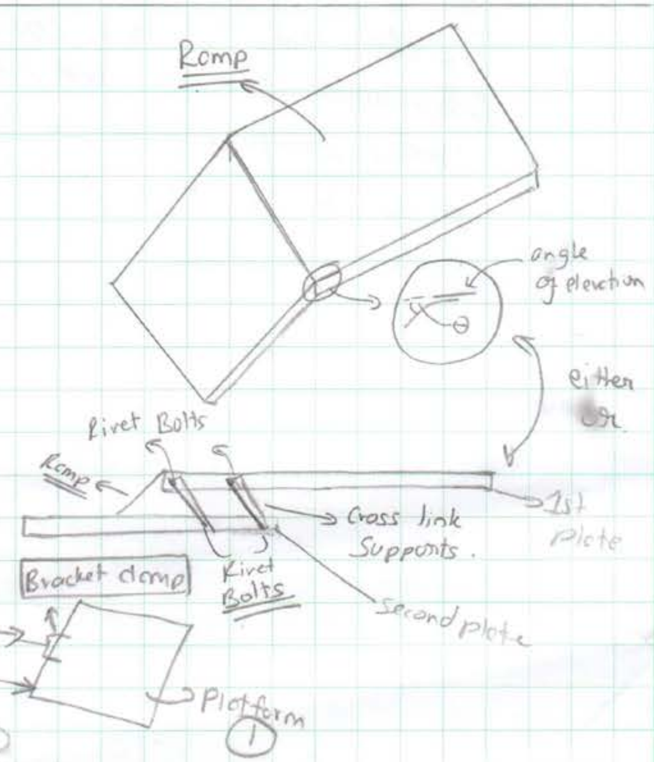
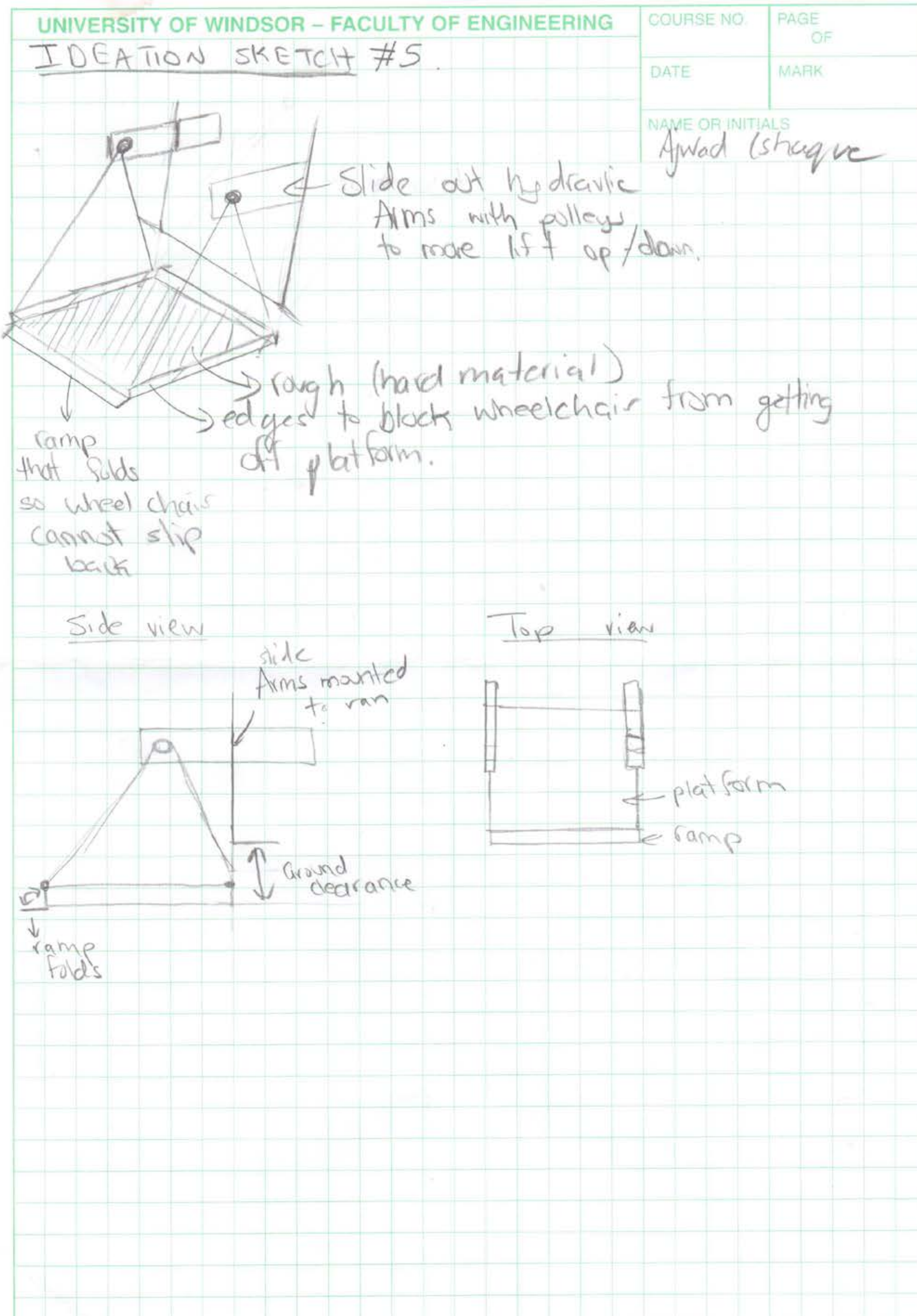






Ideation Sketch #5: Ajwad Ishaque



Ideation Sketch Justifications

Muhanad Kadhim (Ideation Sketch # 1)

My design incorporates the use of several motors that work on a gear based model. In fact, everything that is supposed to move (either up or down) involves the use of a motor. To start off, the main platform that slides out is attached by a motor which is connected to two vertical gears that walk along a teeth bar. This slides out the platform for use and triggers the second system of motors to operate that allow the platform on which the wheelchair will be placed to slide toward the ground. Furthermore, there is also a sensor attached to the ramp which allows it to change its position so that it functional and safe. This is also motor operated and is completely functional. I believe my design not only incorporates a safe and efficient way of transporting a wheelchair to the vehicle but allows a system that works. At this time there is nothing I can say about the structure or what type of material but I am confident that the price and usability of it will be overwhelming.

Sheylen Jagajodhy (Ideation Sketch # 2)

My ideation sketch would be ideal because, firstly, it has good safety mechanisms. Where there are handle bars on the side of the wheelchair platform that prevents the customer from falling off sideways in case of mishap. It also has a steel bored at the back of the wheelchair platform, that prevents the wheelchair from sliding backwards. And also, it is economical because, the material used in manufacturing it is steel, which is strong, but not as compared to aluminum, but is cheaper.

Sameer Jafar – Ideation Justification (Ideation Sketch # 3)

This design is made to be affordable. Its compact nature minimizes the amount of materials needed for assembly. It provides a lightweight design, which doesn’t alter much of the vehicles performance or aesthetics (other than the removal of one passenger chair). The way that every mechanism is compacted into two rods that are connected to each other shows its efficient use of materials. This design is a safe and easy way to transport wheelchair users from the ground to a vehicle.

Sai Kiran Jonnalagadda (Ideation Sketch # 4)

My design is a fairly efficient lift it uses a double-barreled hydraulic pump, which increases the deploy time and optimizes the user interface, making itself reliable. The design is meant to withstand cold and hot temperatures as it is made up of aluminum. Some of the downsides to this concept, is that it lacks in structure strength/stability. This could lead to more failures. However, as a whole the product is cheap and efficient and economically sound.

Ajwad Ishaque (Ideation Sketch # 5)

The design is made to be efficient and affordable. It incorporates a hydraulic and pulley based system that are both stored inside the vehicle. The hydraulics slide out bringing the platform along with them. At a certain point, which is computer controlled, the platform is lowered toward the ground and the ramp is rotated to its place via a motor. The ramp also locks as the platform is being risen up by the pulley based system to avoid the wheel chair from falling backwards. Furthermore, the ramp also goes back into its original position when the hydraulics are pulling the platform back in.

Decision Matrix (Group)

Column1	Weighting Factor	Concept A		Concept B		Concept C		Concept D		Concept E	
Group 3-2		Sheylen		Sai Kiran		Muhanad		Sameer		Ajwad	
		%	X	%	X	%	X	%	X	%	X
1.0 Performance Issues											
1.0.1 Lifetime											
Warranty	0.03	50	1.50	50	1.50	75	2.25	50	1.50	75	2.25
Life Span	0.027	50	1.35	75	2.03	90	2.43	75	2.03	75	2.03
1.0.2 Loadings											
Mass	0.05	75	3.75	50	2.50	90	4.50	50	2.50	50	2.50
Load Distribution point	0.02	75	1.50	50	1.00	90	1.80	50	1.00	90	1.80
Balance of car	0.008	50	0.40	50	0.40	75	0.60	50	0.40	100	0.80
1.0.3 Materials											
Durability /tensile strength	0.05	100	5.00	75	3.75	75	3.75	75	3.75	90	4.50
Corrosion / Effects of use	0.01	90	0.90	75	0.75	75	0.75	75	0.75	25	0.25
1.0.4 Operation											
Deploy Time	0.01	50	0.50	50	0.50	50	0.50	50	0.50	50	0.50
Expected performance	0.05	75	3.75	75	3.75	75	3.75	50	2.50	75	3.75
Operational temperature	0.02	75	1.50	25	0.50	50	1.00	50	1.00	50	1.00
1.0.5 Safety											
Reliable	0.045	75	3.38	75	3.38	75	3.38	50	2.25	90	4.05
1.0.6 Size											
Restrictions	0.03	90	2.70	25	0.75	90	2.70	50	1.50	100	3.00
Does use affect the vehicle	0.035	75	2.63	50	1.75	75	2.63	50	1.75	10	0.35
Usability costs	0.0015	75	0.11	50	0.08	50	0.08	50	0.08	25	0.04
1.0.7 Standards											
Meet safety requirements	0.03	75	2.25	90	2.70	75	2.25	50	1.50	90	2.70
Cost of manufacturing	0.015	50	0.75	50	0.75	75	1.13	25	0.38	75	1.13
1.0.8 Weight											
Desirable Weight	0.035	75	2.63	50	1.75	75	2.63	75	2.63	90	3.15
Effect on Systems	0.025	50	1.25	75	1.88	75	1.88	50	1.25	50	1.25
1.0.9 Quality and Reliability											
Material	0.05	100	5.00	90	4.50	90	4.50	90	4.50	90	4.50
Reputation of company (people standard)	0.0055	50	0.28	90	0.50	75	0.41	75	0.41	50	0.28
1.1 User Issues											

1.1.1 Aesthetic										
Color Choices	0.007	50	0.35	10	0.07	75	0.53	50	0.35	10	0.07
Effect on car appearance	0.007	50	0.35	25	0.18	90	0.63	75	0.53	10	0.07
1.1.2 Customer's Needs/Desires											
Cost	0.03	75	2.25	90	2.70	90	2.70	50	1.50	90	2.70
Usability	0.02	75	1.50	90	1.80	75	1.50	75	1.50	90	1.80
1.1.3 Ergonomic											
User Interface	0.02	75	1.50	75	1.50	75	1.50	50	1.00	90	1.80
1.2 Engineering Issues											
1.2.1 Costs											
Does final cost include assembly	0.001	50	0.05	100	0.10	75	0.08	75	0.08	100	0.10
Upgrades	0.005	0	0.00	50	0.25	0	0.00	50	0.25	10	0.05
Shipping costs	0.001	25	0.03	25	0.03	75	0.08	50	0.05	25	0.03
1.2.2 Disposal											
Recycle Friendly	0.01	90	0.90	90	0.90	75	0.75	75	0.75	75	0.75
Disposable service	0.01	75	0.75	50	0.50	50	0.50	50	0.50	75	0.75
1.2.2 Documentation											
User Agreement	0.02	75	1.50	75	1.50	75	1.50	50	1.00	90	1.80
User Manual	0.001	75	0.08	75	0.08	75	0.08	50	0.05	90	0.09
1.2.4 Environment (operational)											
Effects of weather on product	0.01	10	0.10	90	0.90	90	0.90	50	0.50	50	0.50
Power source	0.025	50	1.25	50	1.25	90	2.25	50	1.25	50	1.25
Care of Users	0.01	50	0.50	75	0.75	90	0.90	75	0.75	50	0.50
Green	0.001	75	0.08	75	0.08	75	0.08	50	0.05	10	0.01
1.2.5 Environment (manufacturing)											
Energy Usage	0.02	75	1.50	25	0.50	75	1.50	50	1.00	50	1.00
Material use	0.02	75	1.50	75	1.50	75	1.50	75	1.50	75	1.50
Exposure to packaging	0.001	25	0.03	50	0.05	50	0.05	50	0.05	10	0.01
Use of Natural resources	0.001	50	0.05	50	0.05	50	0.05	50	0.05	10	0.01
1.2.6 Installation											
Easy to install	0.001	50	0.05	50	0.05	90	0.09	75	0.08	50	0.05
Modifications	0.01	50	0.50	25	0.25	50	0.50	50	0.50	10	0.10
1.2.7 Maintenance											
Maintenance time	0.002	25	0.05	10	0.02	90	0.18	50	0.10	10	0.02
User Do-able	0.002	25	0.05	25	0.05	25	0.05	50	0.10	25	0.05
1.2.8 Packaging											
On shelf product	0.001	0	0.00	0	0.00	0	0.00	25	0.03	0	0.00
Each component requires packing	0.002	90	0.18	10	0.02	75	0.15	25	0.05	25	0.05

1.2.9 Project-management											
Assembly Line	0.02	90	1.80	90	1.80	75	1.50	50	1.00	90	1.80
Manufacturing speed	0.001	75	0.08	90	0.09	25	0.03	75	0.08	50	0.05
1.2.10 Product quality											
Withstands Standard conditions	0.025	90	2.25	90	2.25	75	1.88	75	1.88	90	2.25
1.2.11 Testing											
Strength of materials (Tensile Strength)	0.04	100	4.00	90	3.60	75	3.00	75	3.00	90	3.60
Special facilities	0.01	90	0.90	75	0.75	75	0.75	50	0.50	50	0.50
Resale	0.001	50	0.05	50	0.05	50	0.05	50	0.05	10	0.01
1.3 Societal Issues											
1.3.1 Environment											
Fuel Consumption/pollution	0.001	50	0.05	25	0.03	25	0.03	50	0.05	50	0.05
1.3.2 Legal Implications											
Fail safe	0.02	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Is it unique	0.005	75	0.38	75	0.38	90	0.45	50	0.25	75	0.38
1.4 Corporal Issues											
1.4.1 Company Requirements											
Permanent attachment	0.05	75	3.75	50	2.50	75	3.75	50	2.50	100	5.00
Cost no more than 10% of present value	0.04	50	2.00	50	2.00	75	3.00	50	2.00	50	2.00
1.4.2 Marketing Requirements											
Sales (discounts)	0.001	50	0.05	50	0.05	50	0.05	75	0.08	50	0.05
Benefit Discussion	0.001	75	0.08	75	0.08	90	0.09	75	0.08	50	0.05
Total	1	61.69	71.57	57.54	63.32	68.39	75.48	55.76	57.16	55.68	70.60
			✔				✔				

Therefore our two best ideation sketches are #1 and #3.

Decision Matrix (Two Best & Final)

Column1	Weighting Factor	Concept B		Concept C		Concept F	
Group 3-2		Sheylen		Muhanad		GROUP DESIGN	
		%	X	%	X	%	X
1.0 Performance Issues							
1.0.1 Lifetime							
Warranty	0.03	50	1.50	75	2.25	75	2.25
Life Span	0.027	50	1.35	90	2.43	90	2.43
1.0.2 Loadings							
Mass	0.05	75	3.75	90	4.5	90	4.50
Load Distribution point	0.02	75	1.50	90	1.8	90	1.80
Balance of car	0.008	50	0.40	75	0.6	90	0.72
1.0.3 Materials							
Durability /tensile strength	0.05	100	5.00	75	3.75	100	5.00
Corrosion / Effects of use	0.01	90	0.90	75	0.75	90	0.90
1.0.4 Operation							
Deploy Time	0.01	50	0.50	50	0.5	50	0.50
Expected performance	0.05	75	3.75	75	3.75	90	4.50
Operational temperature	0.02	75	1.50	50	1	75	1.50
1.0.5 Safety							
Reliable	0.045	75	3.38	75	3.375	75	3.38
1.0.6 Size							
Restrictions	0.03	90	2.70	90	2.7	90	2.70
Does use affect the vehicle	0.035	75	2.63	75	2.625	75	2.63
Usability costs	0.0015	75	0.11	50	0.075	75	0.11
1.0.7 Standards							
Meet safety requirements	0.03	75	2.25	75	2.25	75	2.25
Cost of manufacturing	0.015	50	0.75	75	1.125	50	0.75
1.0.8 Weight							
Desirable Weight	0.035	75	2.63	75	2.625	75	2.63
Effect on Systems	0.025	50	1.25	75	1.875	75	1.88
1.0.9 Quality and Reliability							
Material	0.05	100	5.00	90	4.5	90	4.50
Reputation of company (people standard)	0.0055	50	0.28	75	0.4125	75	0.41

1.1 User Issues							
1.1.1 Aesthetic							
Color Choices	0.007	50	0.35	75	0.525	75	0.53
Effect on car appearance	0.007	50	0.35	90	0.63	90	0.63
1.1.2 Customer's Needs/Desires							
Cost	0.03	75	2.25	90	2.7	75	2.25
Usability	0.02	75	1.50	75	1.5	75	1.50
1.1.3 Ergonomic							
User Interface	0.02	75	1.50	75	1.5	90	1.80
1.2 Engineering Issues							
1.2.1 Costs							
Does final cost include assembly	0.001	50	0.05	75	0.075	75	0.08
Upgrades	0.005	0	0.00	0	0	0	0.00
Shipping costs	0.001	25	0.03	75	0.075	75	0.08
1.2.2 Disposal							
Recycle Friendly	0.01	90	0.90	75	0.75	75	0.75
Disposable service	0.01	75	0.75	50	0.5	50	0.50
1.2.2 Documentation							
User Agreement	0.02	75	1.50	75	1.5	50	1.00
User Manual	0.001	75	0.08	75	0.075	50	0.05
1.2.4 Environment (operational)							
Effects of weather on product	0.01	10	0.10	90	0.9	50	0.50
Power source	0.025	50	1.25	90	2.25	50	1.25
Care of Users	0.01	50	0.50	90	0.9	75	0.75
Green	0.001	75	0.08	75	0.075	75	0.08
1.2.5 Environment (manufacturing)							
Energy Usage	0.02	75	1.50	75	1.5	50	1.00
Material use	0.02	75	1.50	75	1.5	75	1.50
Exposure to packaging	0.001	25	0.03	50	0.05	50	0.05
Use of Natural resources	0.001	50	0.05	50	0.05	75	0.08
1.2.6 Installation							
Easy to install	0.001	50	0.05	90	0.09	75	0.08
Modifications	0.01	50	0.50	50	0.5	75	0.75
1.2.7 Maintenance							
Maintenance time	0.002	25	0.05	90	0.18	90	0.18
User Do-able	0.002	25	0.05	25	0.05	50	0.10
1.2.8 Packaging							
On shelf product	0.001	0	0.00	0	0	50	0.05
Each component requires packing	0.002	90	0.18	75	0.15	90	0.18

1.2.9 Projectmanagent							
Assembly Line	0.02	90	1.80	75	1.5	75	1.50
Manufacturing speed	0.001	75	0.08	25	0.025	75	0.08
1.2.10 Product quality							
Withstands Standard conditions	0.025	90	2.25	75	1.875	90	2.25
1.2.11 Testing							
Strength of materials (Tensile Strength)	0.04	100	4.00	75	3	90	3.60
Special facilities	0.01	90	0.90	75	0.75	50	0.50
Resale	0.001	50	0.05	50	0.05	75	0.08
1.3 Societal Issues							
1.3.1 Environment							
Fuel Consumption/pollution	0.001	50	0.05	25	0.025	75	0.08
1.3.2 Legal Implecations							
Fail safe	0.02	0	0.00	0	0	50	1.00
Is it unique	0.005	75	0.38	90	0.45	90	0.45
1.4 Corporal Issues							
1.4.1 Company Requirements							
Permanent attachment	0.05	75	3.75	75	3.75	75	3.75
Cost no more than 10% of present value	0.04	50	2.00	75	3	75	3.00
1.4.2 Marketing Requirements							
Sales (discounts)	0.001	50	0.05	50	0.05	75	0.08
Benefit Discussion	0.001	75	0.08	90	0.09	75	0.08
Total	1	61.69	71.57	68.39	75.48	72.46	77.44

☑

Therefore our final design will be based off of the group ideation sketch.

<u>Product Design Specifications-Justification</u>

1.0 Performance Issues

1.0.1 Lifetime:

This design is meant to last a total of five years with a four-year warranty. With the materials we are using (under materials), this is an ideal lifetime.

1.0.2 Loading:

Our lightweight design can support up to 700lbs. It uses a strong, lightweight aluminum alloy that optimizes the loading weight. The placement of the lift under the car allows for a wider area of balance; this keeps the vehicle stable.

1.0.3 Materials:

We are using a lightweight, tensile aluminum alloy plate that can withstand very high temperatures and pressures. Since the lift is placed on the exterior of the vehicle, this provides more protection from corrosion.

1.0.4 Operation:

Our lift takes roughly 25 seconds to deploy by the use of motors and gears.

1.0.5 Safety:

With a slower deploy time, metal plate guarders and a traction pad platform, our design provides a safe passage to bring the wheelchair into the vehicle.

1.0.6 Size:

The lift has an area of 34” X 60” and a lift height of 5.6”. This provides ample space for easy access. When in use, the length extends to 34” X 105”

1.0.7 Standards:

We do meet the standard safety requirements while providing a very low cost design. This lowers the manufacturing costs to roughly $6000 per lift.

1.0.8 Weight:

Our design weighs 340lbs due to our lightweight aluminum alloy metal.

1.0.9 Quality and Reliability:

Aluminum alloy metal uses strong but lightweight support providing a reliable lift. Our company’s reputation will rise with this innovative design.

1.1 User Issues

1.1.1 Aesthetic:

An assortment of colours is provided to match the colours of the vehicle.

1.1.2 Customers Needs/Desires:

The price of the lift is roughly $6000. With a push of a button the lift is very simple and user friendly.

1.1.3 Ergonomics:

The wireless control is a new feature not seen in many models. It is also featured with a backlight, voice control, iPhone support and Driver control override for safety purposes.

1.2 Engineering Issues

1.2.1 Costs:

The price of the lift incorporates manufacturing/assembly as well as shipping. External parts (like safety winter cover) must be purchased separately.

1.2.2 Disposal:

The lift is made out of recyclable material allowing it to be recycled. The manufacturer takes back the lifts and disposes of them to reuse spare parts or recycle the metal.

1.2.3 Documentation:

The lift comes with a user agreement form as well as a manual for any assistance in operating the device.

1.2.4 Operational Environment:

Weather does slightly affect the lift due its external placement. The lift uses the car battery to power the electric motors.

1.2.5 Manufacturing Environment:

There is a 12VDC power supply followed by a current consumption of 60A. The materials used are aluminum for the platform and a rubber bottom with exposure to packaging. The plant uses natural resources for operation.

1.2.6 Installation:

Installation must be done on site of the manufacturer, where modifications on the lift and vehicle may be made.

1.2.7 Maintenance:

A manufacturing associate does all maintenance. This takes 0.5 hours

1.2.8 Packaging:

Since the lift is installed on-site, there is little packaging for the lift.

1.2.9 Project Management:

There is an assembly line but each lift is installed custom for the consumer.

1.2.10 Product Quality:

Our lift withstands the standard conditions set by previous models and expands its range of usage due to the very durable aluminum alloy plate.

1.2.11 Testing:

The maximum tensile strength of the materials used is 241Mpa. The government tests it and there is no resale.

1.3 Societal Issues

1.3.1 Environment:

The wheelchair lift consumes fuel efficiently and at a very minimal amount in order to run the motor.

1.3.2 Legal Implications:

We do not have a fail-safe but a unique design to our company is present.

1.4 Corporate Issues

1.4.1 Company Requirements:

Our lift is can be permanently placed into the vehicle and it runs within the range of 10% from the average wheelchair lift. However, the lift can also be removed when required.

1.4.2 Marketing Requirements:

The wheelchair lift may be covered under certain healthcare insurance policies but there are no discounts involved when purchasing the lift.

Systems Design

Systems Design Table

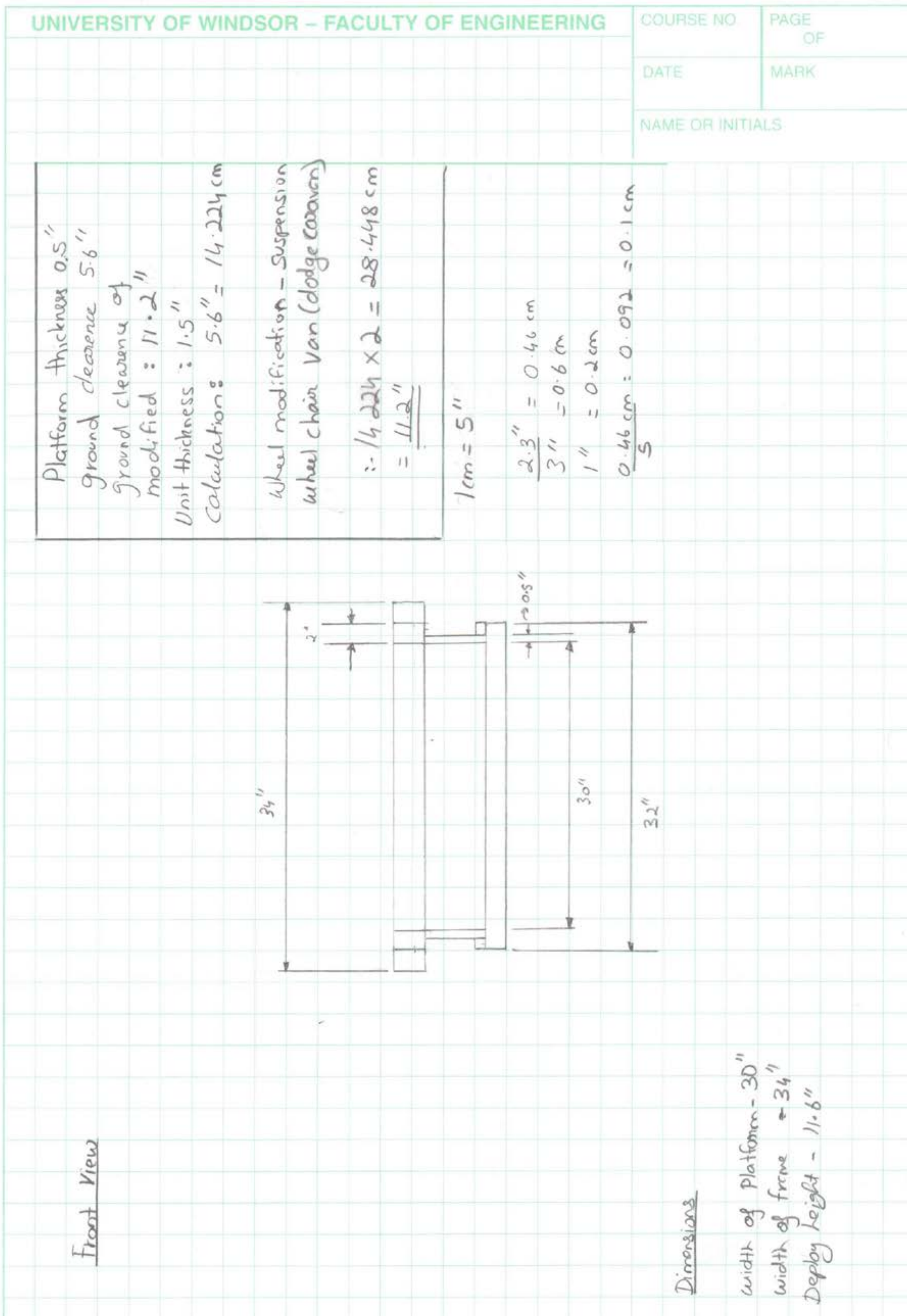
Functions	Systems			
	Structural	Motorized/Geared	User Interface	Material
1a Protect occupant	✓	✓		
1b Support loads	✓			✓
1c Move the occupant		✓		
1d Operate on different surfaces	✓			✓
1e Affect on car balance	✓	✓		
1f Deploy time		✓	✓	
1g eliminates noises	✓	✓		

Systems Design Specifications

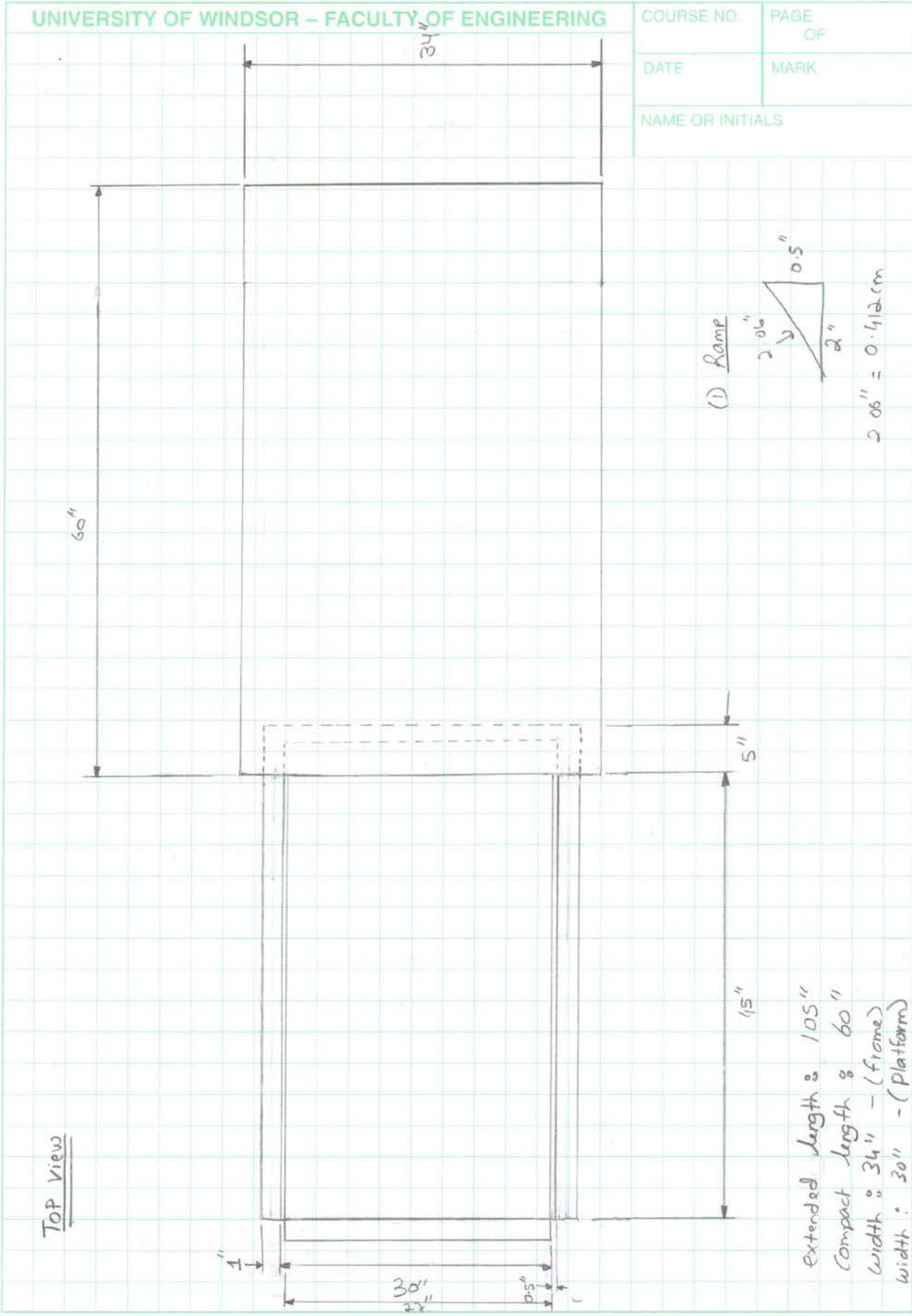
System: Structural	**Author: Ajwad Ishaque Version: 2 Date: 8-11-16**
Related Systems:	Motorized/Geared, Material
Function Explication	
1a Protects Occupants	- Stop the wheelchair from sliding off of the platform in any direction during lift/unloading.
1b Support Loads	- Has a maximum carrying capacity of 700lb
1d Operate on different surfaces	- Ability to withstand different road surfaces to operate on.
1e Balance the Vehicle	- The structure's weight/load capacity must be considered with the vehicle’s suspension
1g Eliminate Noises	- Material does not grind/squeak while being operated.
System: Motorized/Gears	Author: Muhanad Kadhim Version: 2 Date: 8-11-12
Related Systems:	Structural, Material
Function Explication	
1a Fail Safe	- Detects reaction forces and retracts.
	- Ensures that all mechanisms are working properly before operation.
1c/1f Move the Occupant	- Consistent slow speed for safety precautions
	- Capable of handling weight up to 700lb.
1e Balance on Car	- Wheelchair lift must be in it’s most extended position without throwing the car off balance.
1g Eliminates Noise	- Motors remain in fixed positions to avoid parts touching each other.
System: Material	Author: Sameer Jafar Version: 2 Date: 8-11-12
Related Systems:	Structural, Motorized/Geared
Function Explication	
Tensile Strength	-Material must be suitable for a load of 700lb+30 before it undergoes leading expansion and breaks.
Multi Surface environment	- Material is chosen to withstand any type of weather/surface without changing its tensile strength due to different temperatures.
System: User Interface	Author: Sai Kiran Jonnalagadda Version: 2 Date: 8-11-12
Related Systems:	None
Function Explication	
Ease of use	Must be simple and quick to operate efficiently

Component Design

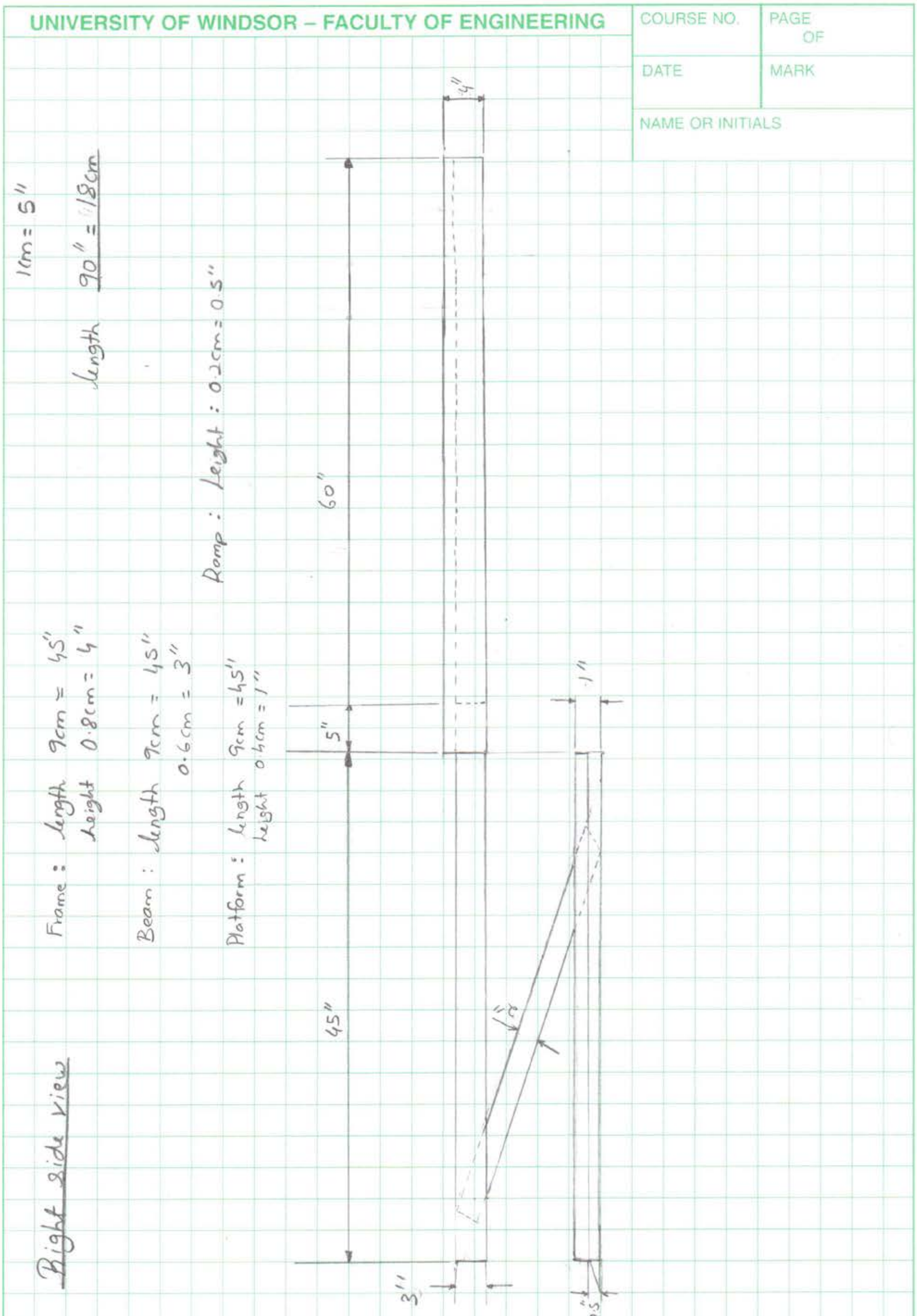
Front View of Final Design



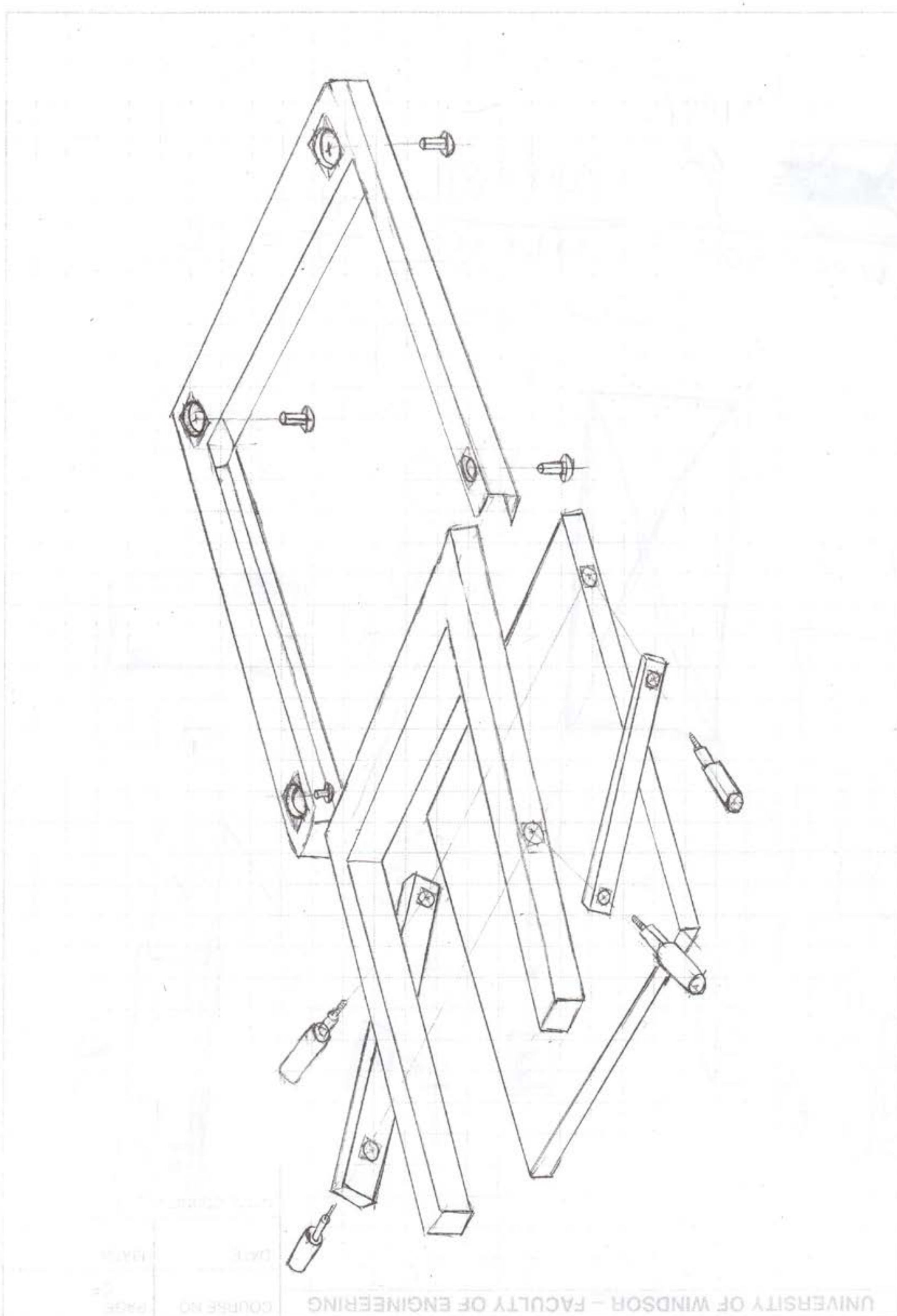
Top View of Final Design



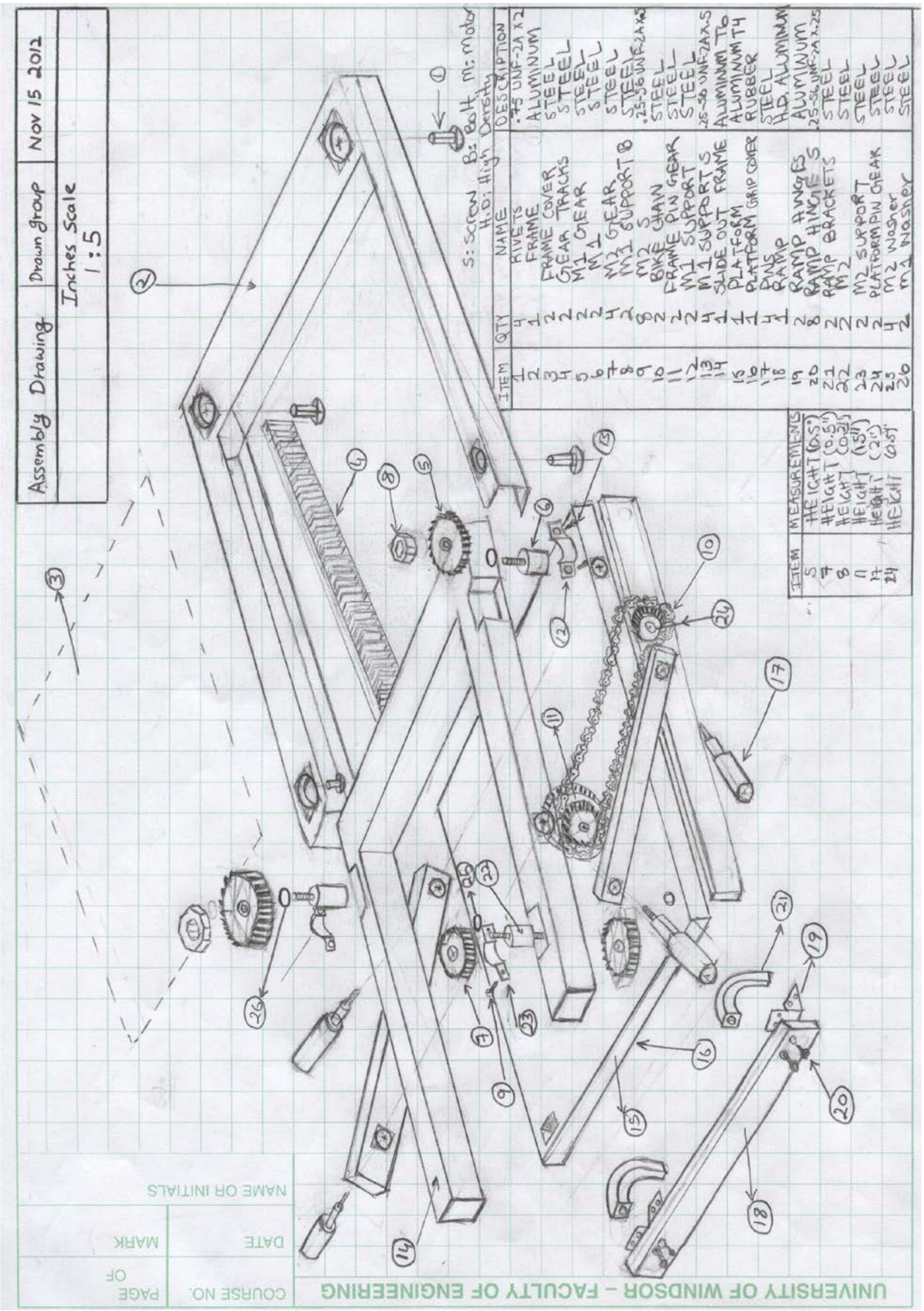
Right Side View of Final Design



Simplified Assembly View



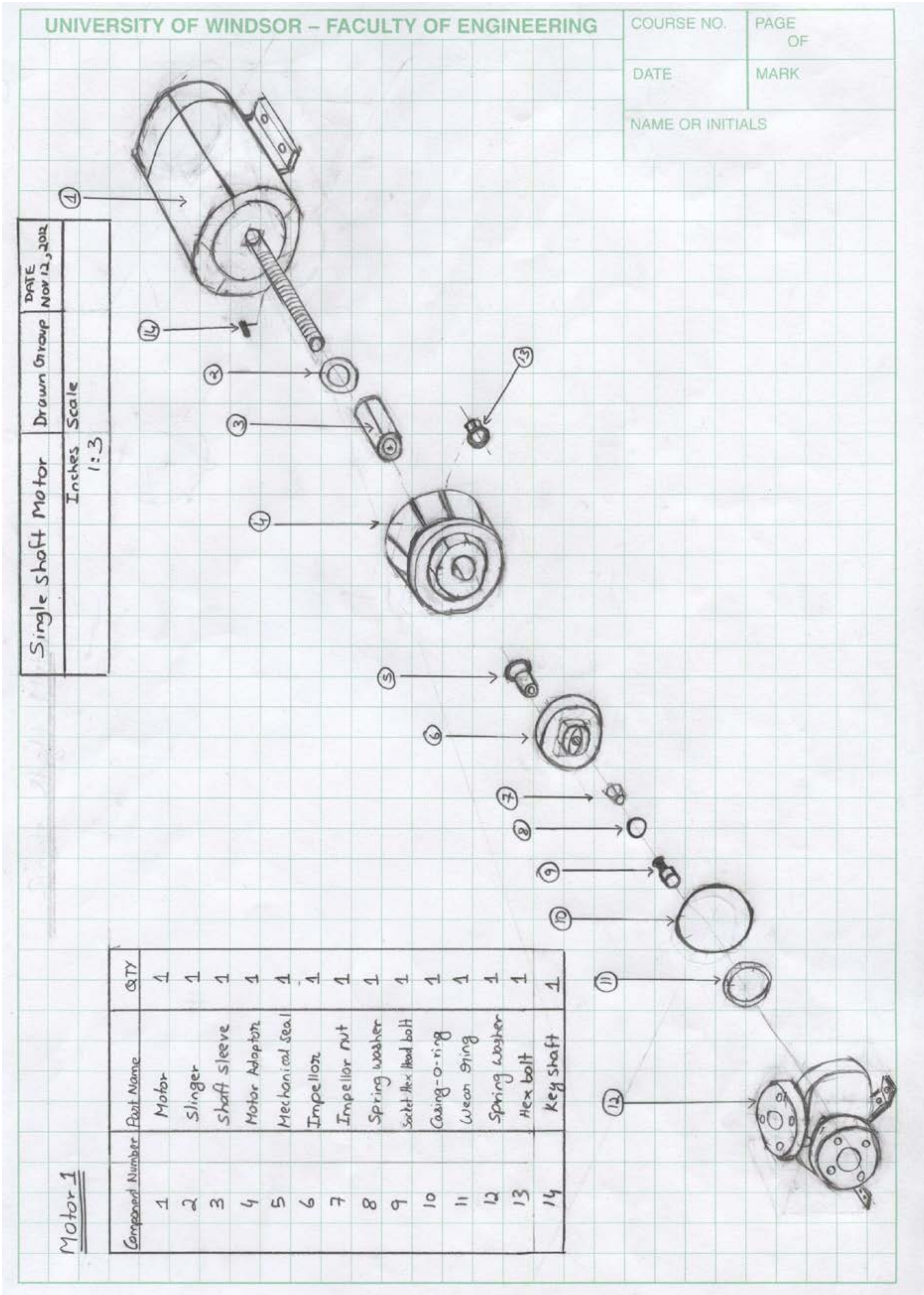
Component System (Modified Assembly View)



Component Design Specifications of Assembly View

Component Number	Part Name	Quantity	Material
1	Rivets	4	0.75 UNF-2A X 2
2	Frame	1	Aluminum
3	Frame Cover	2	Steel
4	Gear tracks	2	L (55") W(0.5") H(0.5)" Steel
5	Motor 1 Gear	2	H(0.5") Steel
6	Motor 1	2	Steel
7	Motor 2 Gear	4	H(0.5") Steel
8	Motor 1 Support Bolt	2	H(0.3") steel
9	Motor 2 Screw	8	0.25-56 UNF-2A X .5
10	Bike Chain	2	Steel
11	Pin Gear	4	D(2") W(1") H(1.5")
12	Motor 1 Support	2	Steel
13	Motor 1 Support Screw	4	0.25-56 UNF-2A X .5
14	Slide out Frame	1	Aluminum T6
15	Platform	1	Aluminum T4
16	Platform Grip Cover	1	Rubber
17	Pins	4	Stainless Steel D(1.5") L(2")
18	Ramp	1	High density Aluminum
19	Ramp Hinges	2	Aluminum
20	Ramp Hinge Screw	8	.25-56UNF-2A X .25
21	Ramp Brackets	2	Steel
22	Motor 2	2	Steel
23	Motor 2 support	2	Steel
24	Platform Pin Gear	2	Steel
25	Motor 2 Washer	4	Steel
26	Motor 1 Washer	2	Steel

Component View of a Single-shaft Motor

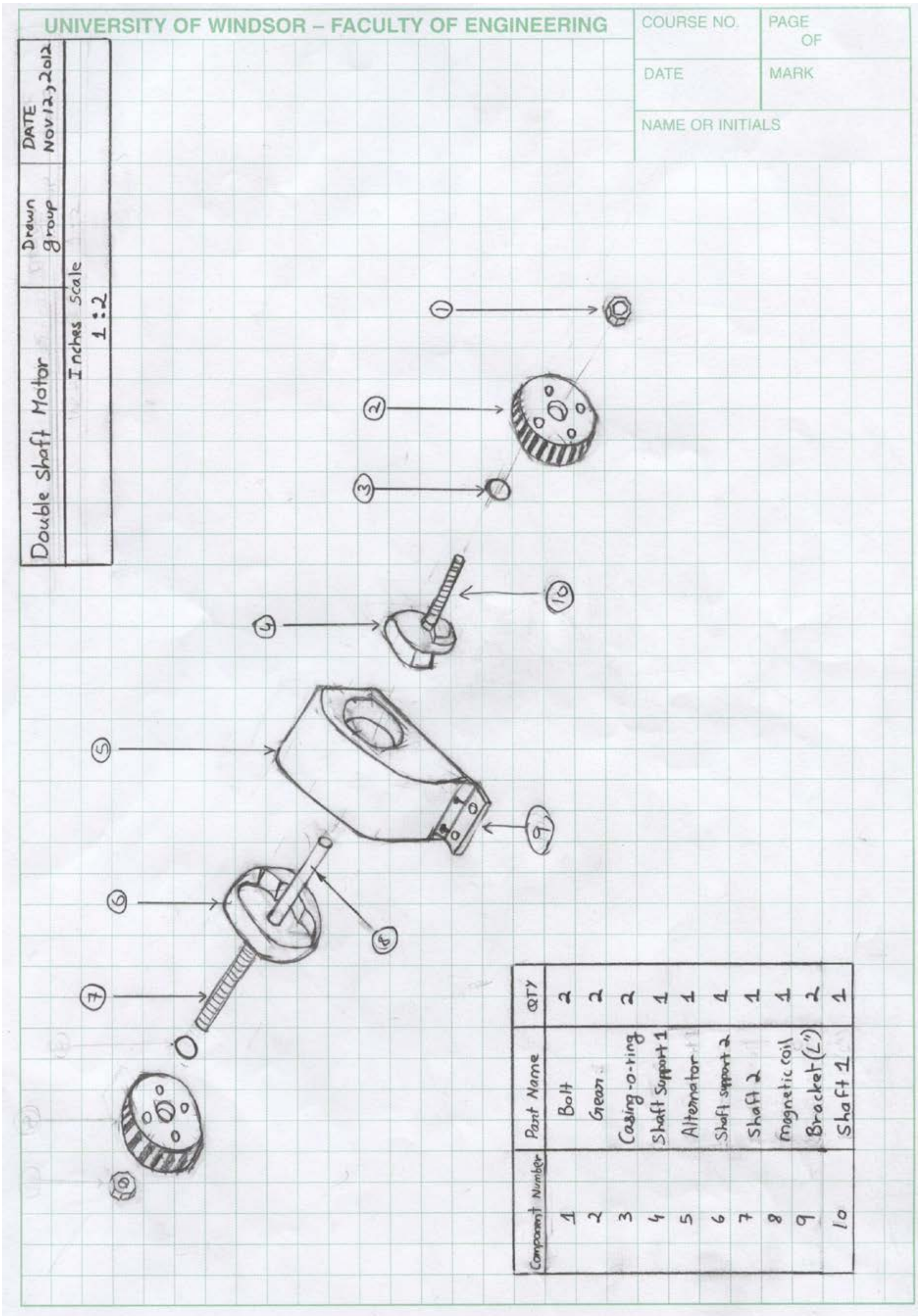


Component Design Specification for Single-shaft Motor

Component Number	Part Name (All quantities are 1)	Quantity
1	Motor	1
2	Slinger	1
3	Shaft Sleeve	1
4	Motor Adaptor	1
5	Mechanical Seal	1
6	Impellor	1
7	Impellor Nut	1
8	Spring Washer	1
9	Socket Hex Head bolt	1
10	Casing O-Ring	1
11	Wear Ring	1
12	Spring Washer	1
13	Hex bolt	1
14	Key Shaft	1

The materials are irrelevant because the motors are shipped from an individual manufacturer. We only provide the shaft lengths, in this case is 0.8”.

Component Design of a Dual-shaft Motor



<u>Component Design Specification for Dual-shaft Motor</u>

Component Number	Part Name (All quantities are 1)	Quantity
1	Bolt	2
2	Gear	2
3	Casing O-Ring	2
4	Shaft support 1	1
5	Alternator	1
6	Shaft support 2	1
7	Shaft 2	1
8	Magnetic Coil	1
9	Bracket (L")	2
10	Shaft 1	1

The materials are irrelevant because the motors are shipped from an individual manufacturer. We only provide the shaft lengths, in this case is 0.5”.

Component Justifications

Material Justification:

The main material used in the manufacturing of this wheelchair lift is tempered aluminum alloy. The reason we chose aluminum is because of its lightweight, high tensile strength of 241 MPa and a yield strength that makes the material suitable to withstand a maximum weight of 700 lb. It is generally corrosion resistant, and a durable metal to work with. In addition, one of the main advantages of using tempered aluminum means that is heat treated with an iron based alloy which has an aging temperature (320°F and 350°F).

There are also some disadvantages that come with the use of aluminum. Firstly, the cost is more expensive than steel. Second, due to the surface of the metal, it is abrasive to tooling, which makes it a delicate metal to handle. Finally, it is prone to recoil.

Operation Justification:

On the end of each side of the beams (located closest to the van), there is a motor that spins a vertical pole. This pole is connects a horizontal gear which is involved in extended and retracting the lift. The gear rotates on a set of gear tracks located inside of the bolted box. Rotating the gears one way extends the platform, rotating the gears the other way retracts the platform. This is how the beams holding the platform are extended and retracted from the bottom of the van.

Once the beams are extended, a similar system of gears is utilized. A pin connects the joint between the beams and cross-links. To rotate the pin, a vertically positioned motor has a vertical pole on each end. These poles connect to horizontal gears on each side, which spin in different directions. These two horizontal gears connect a vertically aligned gear. This gear connects to a chain linked gear system that follows its rotation.

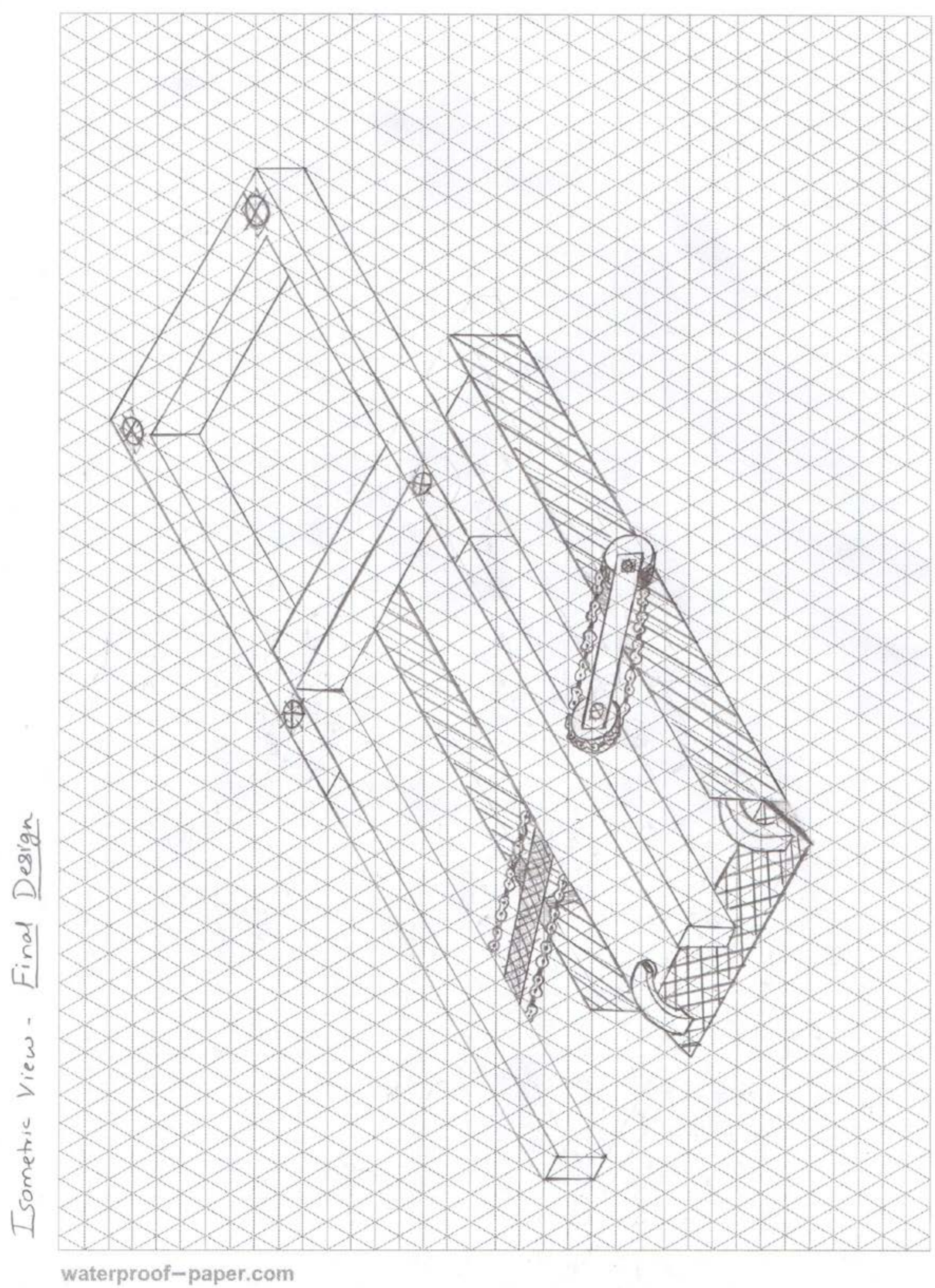
On the chain linked system, the gear on the top of the cross-link is chain linked with a gear at the bottom joint – from the cross-link to the platform. When the gears turn, they spin the pins which drop the platform.

Safety Justification:

To make sure that the safety of the users are considered, there are sensors in the mechanisms itself to provide this feature. If an obstruction blocks the movement of the lift in either direction (i.e. a child is underneath the lift), the lift will retract. If there is another obstruction during retraction, the lift will stop moving entirely.

Another safety feature is involved in the platform itself. The platform will be covered with a rubber traction pad that will stop the wheelchair user from sliding. Each side of the platform has four safety guarders (one of them turning into the ramp when fully deployed) that prevent the user from falling off the platform if the traction pad fails to work.

Isometric View of Final Design



Conclusion

After learning what it takes to successfully design a functional machine, the final product reflects everyone's ideas in one way or another. The wheelchair lift that we have created did not come easy. Different components were proposed, accepted, and/or rejected, and after plenty different meetings on making sure our wheelchair lift operated correctly a final decision was made.

To create a fully functioning wheelchair lift, we were to follow certain requirements and constraints that are expected in the competitive market. The standard requirements that needed to be met were as follows: designing a device that will lift a wheelchair user of all ages into a van; must stay within a 10% cost deviation margin from the competition; should be permanently attached to the vehicle; it must be user friendly and durable; it will be sold across the North American market; and it is safe.

All of the above requirements were met when designing our wheelchair lift. The carrying capacity is suitable to withstand the average child weight up to a person over 400lbs. This was accomplished by choosing specific materials that have a high tensile strength. Aluminum tempered - T4 and T6 were used, which contains a heat-treated iron based alloy. This material is very durable and has a very high tensile strength. With these characteristics, minimal amount of Aluminum-T4 was used in making the structure and platform. To be able to have operating gears under such a high pressure, Aluminum T6 was the best solution. These two components served as the major weight withstanding components.

Even with a machine that requires the use of four motors, the cost did not deviate too far away from the average wheelchair lift competitor. By the use of tempered aluminum, it minimized the amount of material needed in withstanding the full load compared to using steel (which has a similar tensile strength at a higher ratio of material needed).

The four motors minimize the amount of energy needed per motor by equally distributing the load in four different sections. Two identical gear/motor systems are responsible for extending the platform from underneath the car, and two different gear/motor systems are required for lowering the platform. The equal distribution of the load between four motors lowers the chance of high-pressure damage. This type of damage would be more common with a single motor expending a tremendous amount of torque for one whole system.

These two ways were the most challenging in keeping the cost low. Although hydraulics is recognized more in modern technology, our design represented the use of basic gear system in a very cost-low and efficient way. Many problems arose when creating the mechanism. A section of the machine requiring a gear and chain system could not connect to the original cross-link. The way this was fixed was by placing another gear adjacent to the cross-link and top gear of the chain system to avoid tangling.

To accommodate the requirement of permanent attachment in the vehicle, a functional requirement of appearance of the vehicle came largely into play. Instead of bolting the wheelchair lift inside of the car and removing interior space, the wheelchair lift mechanism is located on the exterior underneath the car. Two accommodations were made to make this possible: upon installation, the chassis of the car must be raised to accommodate for necessary clearance underneath the car; also the use of aluminum is light weight which does not give the fasteners as much stress in holding up the lift.

The only disadvantage of the lift being underneath the car is the fact that it is susceptible to weathering and any rubble that the car drives over. Aluminum is able to withstand a large range of temperatures and conditions but maintenance will be needed every six months.

The user interface of this wheelchair lift involves a modern computerized system that allows the user to control the movement of the lift by an LED touch screen. The source, coming from the battery is attached to the computerized motors that the LED screen interacts with. The LED screen allows the user to extend, retract, descend and lift the whole machine upon command.

Since this design is manufactured in North America, and it meets all of the standards required by the universal wheelchair lift administration, it can compete across North America and even Europe. One disadvantage found from selling it across North America is the cost of shipping varies to each local wheelchair lift provider.

To have a flawlessly operating machine is irrelevant if there are no safety features that are involved. A big focus in designing this machine was geared toward safety. Having a computerized motor system, the motors would sense any obstructions in its path (i.e. a child standing in front of the lift) and will retract the lift. By moving at a slow velocity, these sensors are able to work. The wheelchair lift must also contain the wheelchair within railings, which the extended beams become. Also the platform contains traction materials to prevent slippage in different weather conditions and raised sides to prevent the wheelchair from rolling off if the traction was to fail. A failsafe is also provided, which involves a crankshaft that connects directly to the gears may be used if the motors were to fail.

After meeting all of the initial requirements within the constraints that needed to be followed, many new sub-requirements were added. This was the only way to innovate a new and improved version of the modern wheelchair lift. This design has the potential to be one of the top competing lifts on the market. With all of the ideas combined from each member of this team, an outstanding wheelchair lift was created.

References

Aluminium - Advantages and Properties of Aluminium. (n.d.). *AZoMâ„¢ - The A to Z of Materials and AZojomo - The "AZo Journal of Materials Online"*. Retrieved November 11, 2012, from http://www.azom.com/article.aspx?ArticleID=1446

ASM Material Data Sheet. (n.d.). *ASM*. Retrieved November 12, 2012, from http://asm.matweb.com/search/SpecificMaterial.asp?bassnum=MA6061t6

Characteristics of Steel â€“ Advantages and Disadvantages â€“ Understand Buildings - understandbuildings.co.uk. (n.d.). *Understand Buildings - understandbuildings.co.uk*. Retrieved November 11, 2012, from http://understandbuildings.co.uk/materials/characteristics-of-steel-advantages-and-disadvantages/

KP-C Series Closed Coupled End Suction Centrifugal Pumps. (n.d.). *Kinetic Pump / Centrifugal Pumps*. Retrieved November 10, 2012, from http://kineticpump.com/products/kpc.html

Properties of Steel. (2004, January 1). *Matweb*. Retrieved November 12, 2012, from www.engineershandbook.com/Tables/steelprop.htm

Rotary Steam Engines: Page 6.. (n.d.). *The Douglas Self Site*. Retrieved November 11, 2012, from http://www.aqpl43.dsl.pipex.com/MUSEUM/POWER/rotaryengines/rotaryeng6.htm