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Portable Car Lift

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Joint Engineering Program

University of Missouri–St. Louis ▪ Washington University in St. Louis

ELEVATE YOUR FUTURE.
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This Senior Design Project discusses the design, construction and evaluation of a portable car lift. This lift will be hydraulically powered by a 4000 lb lifting capacity. The lift constructed in this project will be installed within a current four post drive on vehicle lift and allows the user to lift all four tires of a vehicle a few inches off the ground in order to remove the tires for servicing.

JME 4110
Mechanical Engineering
Design Project

Portable Car Lift

Ramiz Ahmed
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1 Introduction

1.1 Value proposition / project suggestion

Servicing your brakes or tires on your vehicle at home is not an easy job to do. It also is time consuming when you have to lift one side at a time with a floor jack and then install a floor jack where the vehicle was lifted. Also, people don't just own small compact sedan cars they also own light and heavy duty trucks. To help ease the pain of servicing brakes and or tires on either style of vehicle, we have come up with a design that can lift up one side of the vehicle enough to service two tires at the same time. If you had two of the designs, then you could lift both sides of your vehicle off the ground and service all four brakes and tires at the same time.

1.2 List of team members

Ramiz Ahmed
Nick Pusateri
Emel Saeidghafelpoor

2 Background Information Study

2.1 Design Brief

The project that was selected by the team is the "Portable Car Lift"**.** This project requirement is to have a car lift that is compact, affordable, and can lift up all four tires of a car one inch off the ground. One option for portable car lift is two sides stand hydraulic lifts which is welded steel frames on each side of a car, using two hydraulic jacks to lift the car. For safety purposes it will have lock system to lock the stand when its lifted. The weight capacity we are trying to reach with this car lift setup is at least 3000 pounds. We will need to pick strong structural steel and analyze the load in a CAE software to confirm the structure(s) will take the load applied.

Summary of design brief:

- Design needs
  - Left and right hand side version
  - Determine how the structure will be attached to floor jacks
  - Determine the potential risks and how to overcome them
  - Determine the budget
  - Determine the user needs
  - Create early prototype CAD drawings
- Run an analysis on the structure to see if it will take the applied loads.
  - Determine what material is strongest, lightest, and most affordable to use
  - Select material to manufacture
- Create final CAD drawings
- Order parts to be built
- Build the structure(s)
- Test equipment.
  - Determine there are no failures to applied loads

- The equipment is safe to use
- Determine the max amount of load can be lifted up
- Confirm the user needs

This project description was revised due to researching online existing equipment and seeing how they were made. Also, after researching safety codes and or standards we needed to take into consideration the type of welding, hardware, and just overall safety of using the equipment during setup while under applied loads.

2.2 Background summary

A search for existing designs that were close or similar to our chosen project topic lead are shown in the figures below.

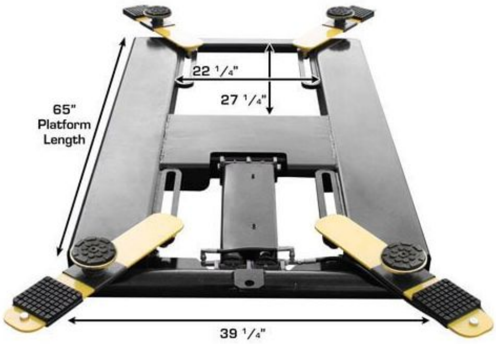


Fig. 1 Top View of Scissor Lift

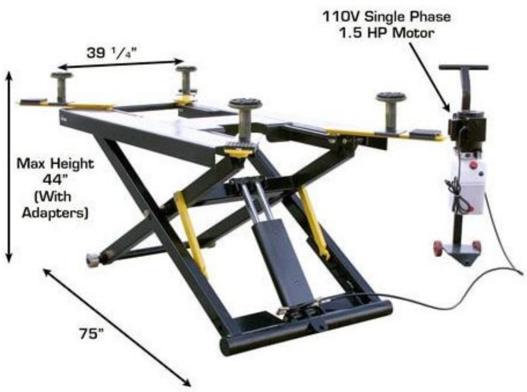


Fig. 2 Isometric View of Scissor Lift

This scissor portable car lift fits the description provided in our project which are cost, material, compatible, portable, light weight.

Website to figure 1 & 2:
https://www.amazon.com/Atlas-MR-06-Capacity-Portable-Midrise/dp/B071DVKZ4D?SubscriptionId=AKIAITSFERIYNIWRG7HQ&tag=allbesttop10-20&linkCode=alb&camp=2025&creative=165953&creativeASIN=B071DVKZ4Dhttps://www.amazon.com/Atlas-MR-06-Capacity-Portable-Midrise/dp/B071DVKZ4D?SubscriptionId=AKIAITSFERIYNIWRG7HQ&tag=allbesttop10-20&linkCode=alb&camp=2025&creative=165953&creativeASIN=B071DVKZ4D

The closest risk that we believe any manufacturer can face is the safety risk which can be caused by the material, machine, or the operator. In the attached web link below it explains improvements that they did in the car lift that were apparently flaws in the original design. After reviewing the web page you can see that what would make the lift not work would be weak structural material, non functioning safety locks to release and lock correctly, and safety stickers indicating pinch points and proper use of the equipment.

Web link to Car Lift Safety Features of a particular car lift manufacturer, https://www.bendpak.com/best-car-lift-guide/car-lift-safety/

3 Concept Design and Specification

3.1 USER NEEDS, METRICS, AND QUANTIFIED NEEDS EQUATIONS.

3.1.1 Record of the user needs interview

Table 1 - User Needs Interview

Project/Product Name:	Portable Car Lift	Interviewer(s):	Ramiz Ahmed Nick Pusateri Emel Saeidghafelpoor
Customer:	Craig Giesmann		
Address:	Washington University		
Willing to do follow up?	Yes	Date:	7-1-19
Type of User:	Mechanics & Anyone else	Currently Uses:	Standard floor jacks Standard hydraulic jack

Questions	Customer Statement	Interpreted Need	Importance
Compact	Should be able to move it around	The product should be reduced in size compared to other car lifts	Reduced size
Number of Operators	One person lift and move the device	A person should be able to use it anywhere	Convenient/Compatible
Adjustable Arms	Should be able to fold	The product should be able to have open and close arms, to save the space	Affordable parts
Light Weight	Should be able to pick it up move it around	The product should have less weight compared to other car lifts	Less weight material selection
Inexpensive	Should be affordable	The product material used in car lift should be inexpensive and strong	Less expensive material

3.1.2 List of identified metrics

Table 2 - Identified Metrics

Metric Number	Associated Need	Metric	Units	Min Value	Max Value
1	1,4	Length	inches/ft	45	75
2	2,3	Height	inches/ft	3	4.5
3	3,4,7	Load	lbs	1000	4000
4	6,8	Speed	inches/sec	0.5	2
5	1,2,3	Volume	cubic ft	6	8
6	2,3,4	Time	sec	0	60
7	1,2	Width	inches/ft	3	6

3.1.3 Quantified needs equations

Table 3 - Quantified needs Matrix

Cross Beam Lift Assembly		Metrics									
		Length	Height	Load	Speed	Volume	Time	Width	Need Happiness	Importance Weight (all entries should add up to 1)	Total Happiness Value
Need#	Need	1	2	3	4	5	6	7			
1	Length should be 210" max	1							0.94	**0.6**	0.564
2	Should be able to lift at least 1"		0.5	0.5					0.975	**0.4**	0.39
3	Needs to lift half ton load	0.1	0.1	0.25	0.15	0.15		0.15	0.8425	**0**	0
4	One person should operate it	0.25	0.25	0.15	0.1	0.1	0.1	0.1	0.9865	**0**	0
5	Should be affordable	0.25	0.25	0.25				0.25	0.9575	**0**	0
6	Should have a safety lock			0.5		0.5			0.95	**0**	0
7	should be lightweight	0.25	0.25	0.25				0.25	0.9575	**0**	0
8	110V motor for garages				1				0.85	**0**	0
Units		inches	inches	lbs	inches/sec	ft^3	sec	inches	Total Happiness		**0.954**
Best Value		10	20	10	15	10	20	15			
Worst Value		5	4	6	6	5	5	5			
Actual Value		3	3	4	3	5	5	6			
Normalized Metric Happiness		0.94	0.95	1	0.85	0.9	0.95	0.94			

3.2 CONCEPT DRAWINGS

Concept #1

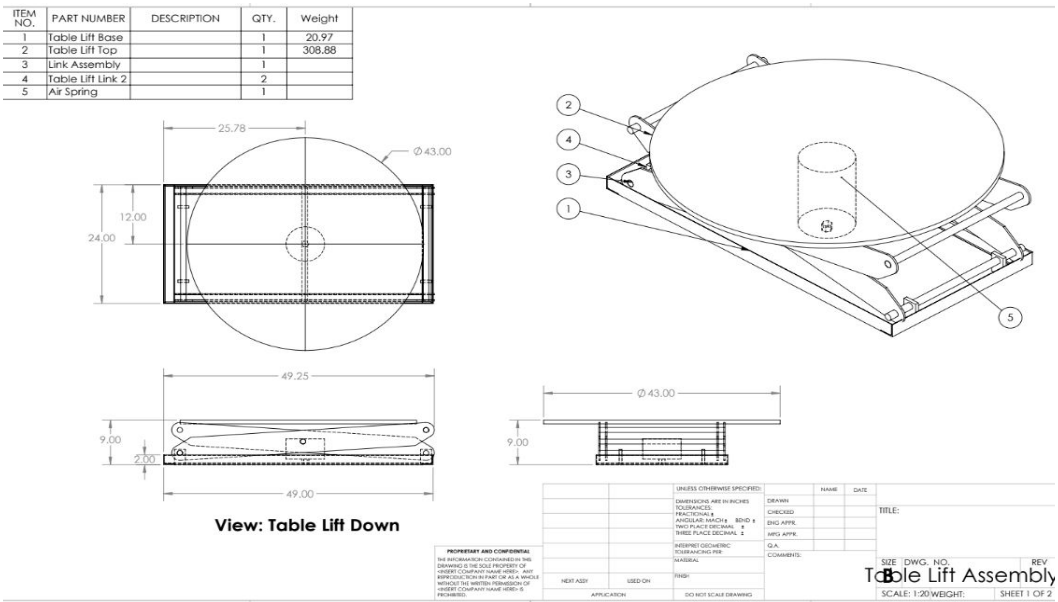


Fig. 3 Portable Airbag Scissor Lift

Concept #2

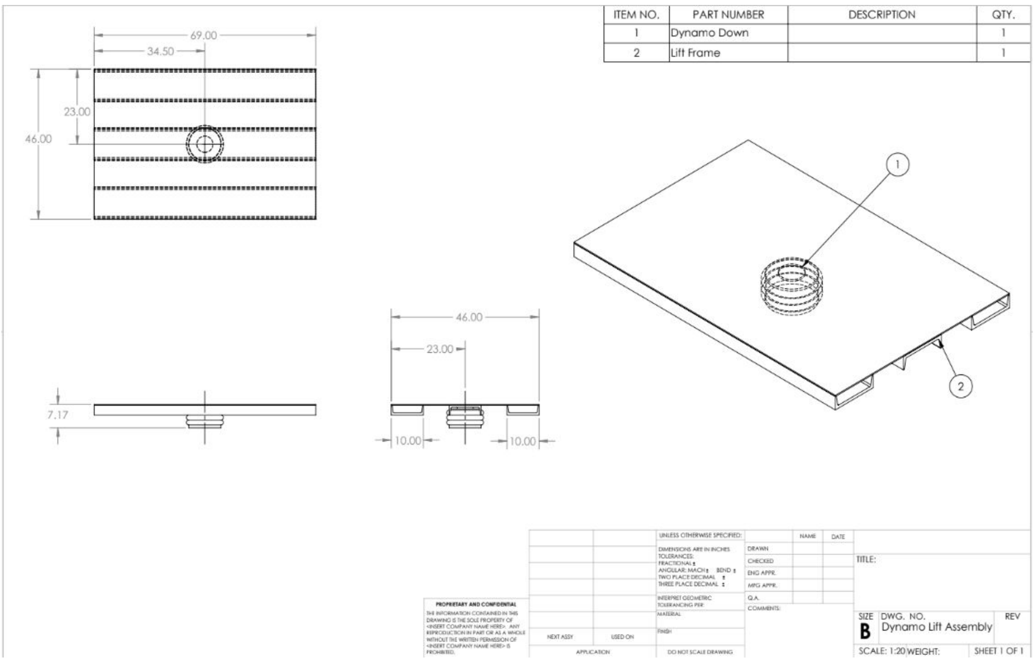


Fig. 4 Dynamo Lift Assembly

Concept #3

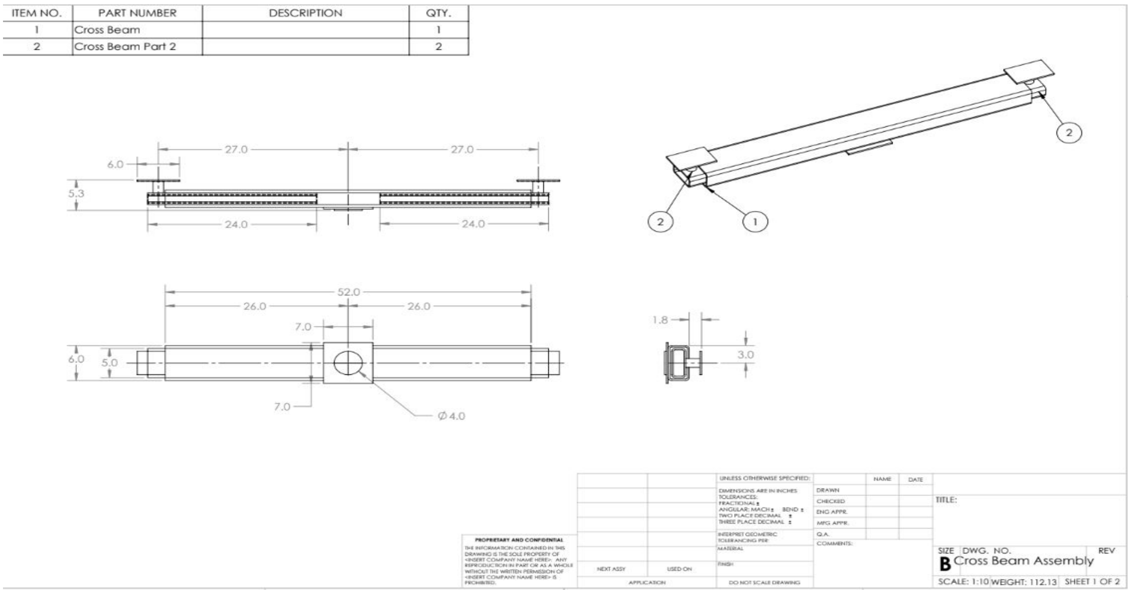


Fig. 5 Cross Beam Lift Assembly

Concept #4

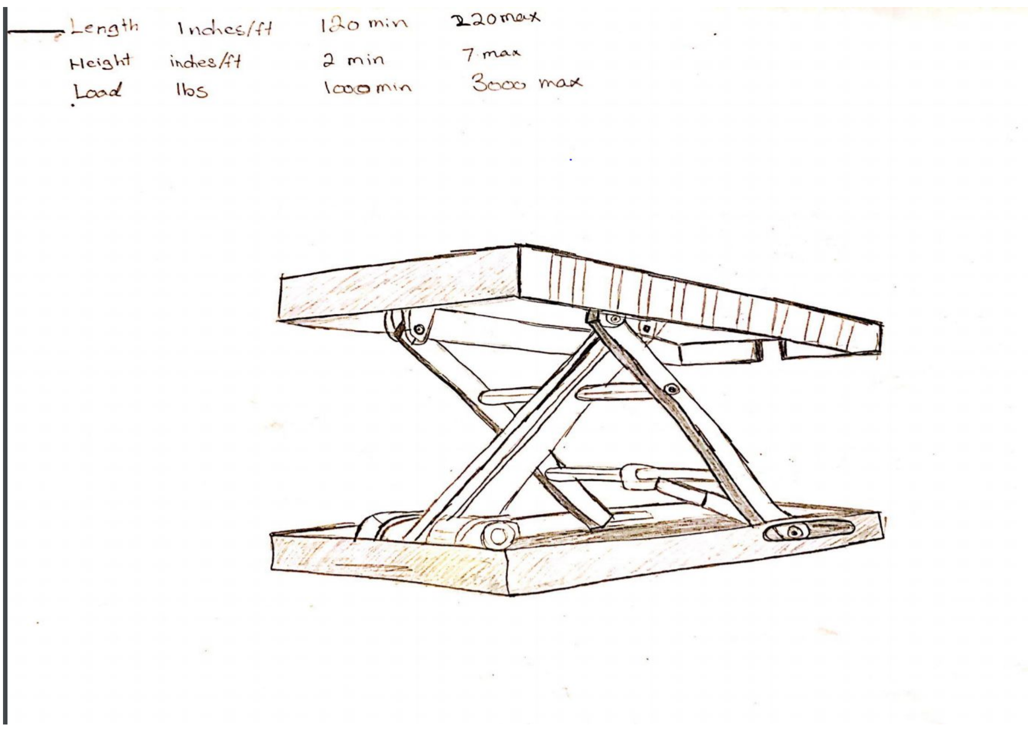


Fig. 6 Portable Hydraulic Scissor Lift

3.3 A concept selection process.

3.3.1 Concept scoring

Concept #1

Table 4 - Concept #1 Metrics Table

Portable Airbag Scissor Lift		Metric									
		Length	Height	Load	Speed	Volume	Time	Width	Need Happiness	Importance Weight (all entries should add up to 1)	Total Happiness Value
Need#	Need	1	2	3	4	5	6	7			
1	Length should be 210" max	1							0.94	0.6	0.564
2	Should be able to lift at least 1"		0.2	0.25					0.315	0.4	0.126
3	Needs to lift half ton load	0.15	0.1	0.25	0.15	0.2		0.25	0.7435	0	0
4	One person should operate it	0.25	0.1	0.1	0.15	0.25	0.1	0.1	0.76	0	0
5	Should be affordable	0.2	0.25	0.1				0.1	0.5505	0	0
6	Should have a safety lock			0.5		0.15			0.34	0	0
7	Should be light weight	0.15	0.3	0.1				0.1	0.551	0	0
8	110V motor for garages				1				0.5	0	0
Units		inches	inches	lbs	inches/sec	ft^3	sec	inches	Total Happiness		0.69
Best Value		10	20	10	15	10	20	10			
Worst Value		5	7	5	6	5	6	7			
Actual Value		3	5	5	3	5	3	4			
Normalized Metric Happiness		0.94	0.95	0.5	0.5	0.6	0.8	0.75			

Concept #2

Table 5 - Concept #2 Metrics Table

Dynamo Lift Assembly		Metric									
		Length	Height	Load	Speed	Volume	Time	Width	Need Happiness	Importance Weight (all entries should add up to 1)	Total Happiness Value
Need#	Need	1	2	3	4	5	6	7			
1	Length should be 210" max	1							0.94	0.6	0.564
2	Should be able to lift at least 1"		0.15	0.1					0.1925	0.4	0.077
3	Needs to lift half ton load	0.1	0.1	0.25	0.15	0.2		0.15	0.6015	0	0
4	One person should operate it	0.2	0.1	0.1	0.15	0.25	0.1	0.1	0.668	0	0
5	Should be affordable	0.1	0.15	0.1				0.1	0.3615	0	0
6	Should have a safety lock			0.5		0.15			0.325	0	0
7	Should be light weight	0.15	0.25	0.1				0.1	0.5035	0	0
8	110V motor for garages				1				0.5	0	0
Units		inches	inches	lbs	inches/sec	ft^3	sec	inches	Total Happiness		0.641
Best Value		10	20	10	15	10	20	10			
Worst Value		6	5	6	4	6	5	6			
Actual Value		3	5	4	3	2	3	4			
Normalized Metric Happiness		0.94	0.95	0.5	0.5	0.5	0.6	0.75			

Concept #3

Table 6 - Concept #3 Metrics Table

Cross Beam Lift Assembly		Metrics									
		Length	Height	Load	Speed	Volume	Time	Width	Need Happiness	Importance Weight (all entries should add up to 1)	Total Happiness Value
Need#	Need	1	2	3	4	5	6	7			
1	Length should be 210" max	1							0.94	0.6	0.564
2	Should be able to lift at least 1"		0.5	0.5					0.975	0.4	0.39
3	Needs to lift half ton load	0.1	0.1	0.25	0.15	0.15		0.15	0.8425	0	0
4	One person should operate it	0.25	0.25	0.15	0.1	0.1	0.1	0.1	0.9865	0	0
5	Should be affordable	0.25	0.25	0.25				0.25	0.9575	0	0
6	Should have a safety lock			0.5		0.5			0.95	0	0
7	Should be light weight	0.25	0.25	0.25				0.25	0.9575	0	0
8	110V motor for garages				1				0.85	0	0
Units		inches	inches	lbs	inches/sec	ft^3	sec	inches	Total Happiness		0.954
Best Value		10	20	10	15	10	20	15			
Worst Value		5	4	6	6	5	5	5			
Actual Value		3	3	4	3	5	5	6			
Normalized Metric Happiness		0.94	0.95	1	0.85	0.9	0.95	0.94			

Concept #4

Table 7 - Concept #4 Metrics Table

Portable Hydraulic Scissor Lift		Metric									
		Length	Height	Load	Speed	Volume	Time	Width	Need Happiness	Importance Weight (all entries should add up to 1)	Total Happiness Value
Need#	Need	1	2	3	4	5	6	7			
1	Portable Hydraulic Scissor Lift	1							0.94	0.6	0.564
2	Should be able to lift at least 1"		0.25	0.25					0.4875	0.4	0.195
3	Needs to lift half ton load	0.15	0.1	0.25	0.1	0.1		0.25	0.786	0	0
4	One person should operate it	0.25	0.1	0.1	0.15	0.25	0.1	0.1	0.8425	0	0
5	Should be affordable	0.15	0.15	0.15				0.1	0.5035	0	0
6	Should have a safety lock			0.5		0.15			0.6125	0	0
7	should be light weight	0.15	0.25	0.1				0.1	0.5485	0	0
8	110V motor for garages				1				0.5	0	0
Units		inches	inches	lbs	inches/sec	ft^3	sec	inches	Total Happiness		0.759
Best Value		10	20	10	15	10	20	10			
Worst Value		5	0	5	5	6	6	7			
Actual Value		3	1	5	3	5	3	4			
Normalized Metric Happiness		0.94	0.95	1	0.5	0.75	0.8	0.7			

3.3.2 Preliminary analysis of each concept's physical feasibility

Concept #1

This concept was somewhat feasible. With its low profile scissor style lifting you could slide it under a car with ease. The large diameter base plate would have been replaced with something more rectangular and also with extension arms that would swing out. The only downfall to this design is the cost of material and the amount of fabrication that would have needed to be done. The center lifting airbag alone may have cost as much as all the steel being used.

Concept #2

This concept was not feasible much at all. There was way too much steel considered in the design which would increase cost and weight and the center air lifting bag would have been expensive also. The design would not have been easy to move around do to its weight. Possible designing it with some kind of cart rolling system may have helped make the design more feasible.

Concept #3

This concept was really the best of them all. It was light in weight and the amount of material was a lot less than all the rest of the concept designs. It being adjustable in its arm lengths made it a good application for both car and truck lifting. The only thing with this design is it has to be used with a hydraulic floor jack and jack stands. Also, you will need two assemblies of it to raise a vehicle successfully off the ground. Since there's not much in material, buying two would not be very expensive to do.

Concept #4

This concept was a lot like concept number 1 in that it uses a scissor style lifting assemble to lift a vehicle. The only big difference is the fact that it would have to use a hydraulic pump or hydraulic jack pump which for either case can be very expensive. Also, there is a lot of steel that would need to be fabricated and a lot of hardware that would be needed to hold the structure together. All those things would increase the cost even more.

3.3.3 Final summary statement

It is great to invest in a good car lift for your home garage. It provides a comfortable and safe environment for you to work on your car. Most commercial car lifts can lift up to 9,000 pounds. Here's a design for the home to lift your car and work on it without taking your car to a mechanic. Below are the 4 designs that we created based on the user needs, we used this table to pick the winner that shows if each design complete the requirement (User needs provided as a customer statement shown in question 1 part a)

Table 8 - User Needs Checklist

Design	User Need 1	User Need 2	User Need 3	User Need 4	User Need 5
Table Lift	Yes	Yes	Yes	No	No

Cross Beam	Yes	Yes	Yes	Yes	Yes
Dynamo Lift	No	Yes	Yes	No	No
Portable Hyd. Scissor Lift	Yes	Yes	Yes	No	No

3.4 Proposed performance measures for the design

A car jack is a key piece of equipment used by a typical automotive mechanic or your at home do it yourself car mechanic. One important job a car jack can do is help ease in changing and or removing the tires are your car. So having a portable car jack at home can help to easily change the tires on your car and also help save you financially do to not having to bring it to your local shop that may charge you a good amount of money to do the same job. When using a car jack we need to also have faith that it will not only function properly, but hold the vehicle in place while it is jacked up in the air. Lifting a car can be dangerous when lifting a half ton vehicle into the air to service a car. Keeping these important key things in mind we decided to build a portable car jack that is cheap, easy to access and handle, and ultimately safe to use. By keeping all these needs in mind, the overall performance need this project requires would be the car jack needs to be cheap, compact, light in weight, and reliable to have on hand at home to tackle the occasional tire change.

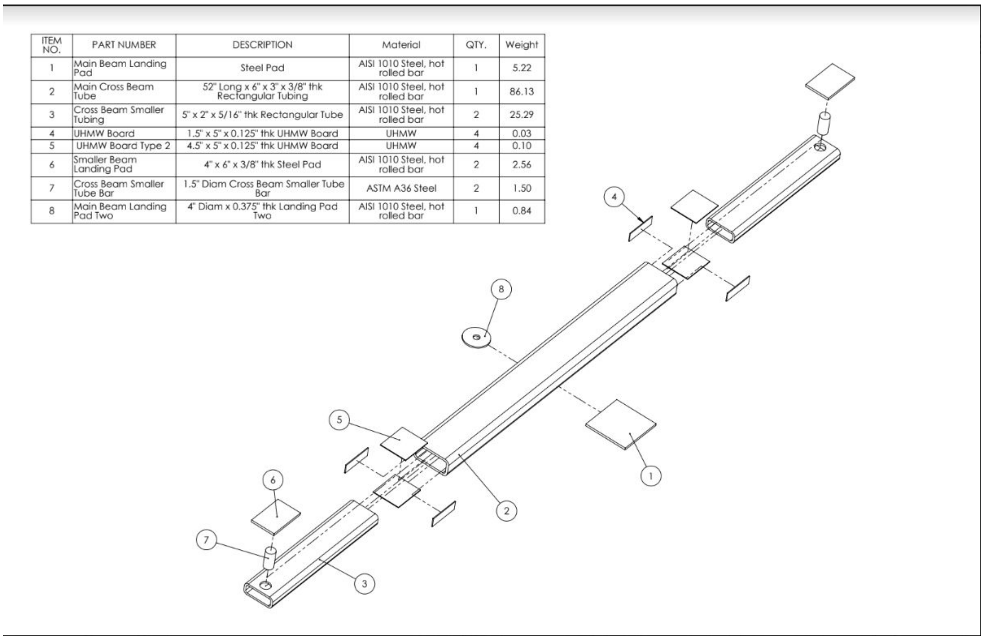
3.5 Revision of specifications after concept selection

Table 9 - Metric Table for Portable Car Lift

Metric Number	Associated Need	Metric	Units	Min Value	Max Value
1	1,4	Length	inches/ft	100	150
2	2,3	Height	inches/ft	3	6
3	3,4,7	Load	lbs	1000	3000
4	6,8	Speed	inches/sec	0.5	2
5	1,2,3	Volume	cubic ft	15	20.8
6	2,3,4	Time	sec	0	60
7	1,2	Width	inches/ft	4	7

4 Embodiment and fabrication plan

4.1 Embodiment/Assembly drawing



ITEM NO.	PART NUMBER	DESCRIPTION	Material	QTY.	Weight
1	Main Beam Landing Pad	Steel Pad	AISI 1010 Steel, hot rolled bar	1	5.22
2	Main Cross Beam Tube	52" Long x 6" x 3" x 3/8" thk Rectangular Tubing	AISI 1010 Steel, hot rolled bar	1	86.13
3	Cross Beam Smaller Tubing	5" x 2" x 5/16" thk Rectangular Tube	AISI 1010 Steel, hot rolled bar	2	25.29
4	UHMW Board	1.5" x 5" x 0.125" thk UHMW Board	UHMW	4	0.03
5	UHMW Board Type 2	4.5" x 5" x 0.125" thk UHMW Board	UHMW	4	0.10
6	Smaller Beam Landing Pad	4" x 6" x 3/8" thk Steel Pad	AISI 1010 Steel, hot rolled bar	2	2.56
7	Cross Beam Smaller Tube Bar	1.5" Diam Cross Beam Smaller Tube Bar	ASTM A36 Steel	2	1.50
8	Main Beam Landing Pad Two	4" Diam x 0.375" thk Landing Pad Two	AISI 1010 Steel, hot rolled bar	1	0.84

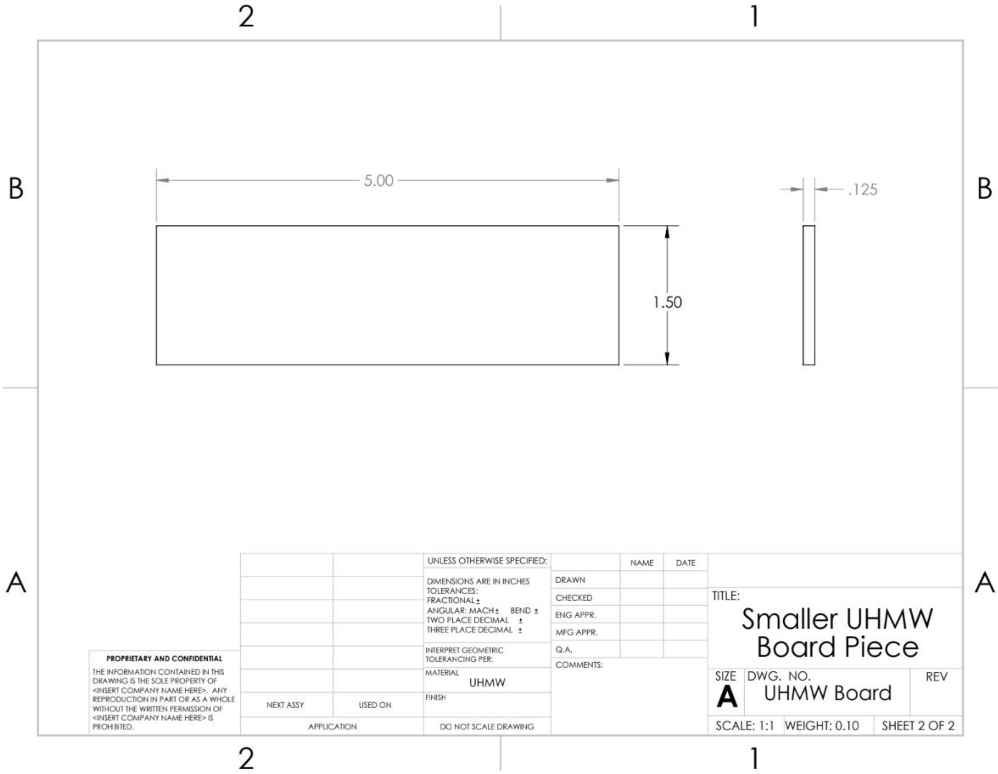
Fig.7 Cross Beam Lift Assembly

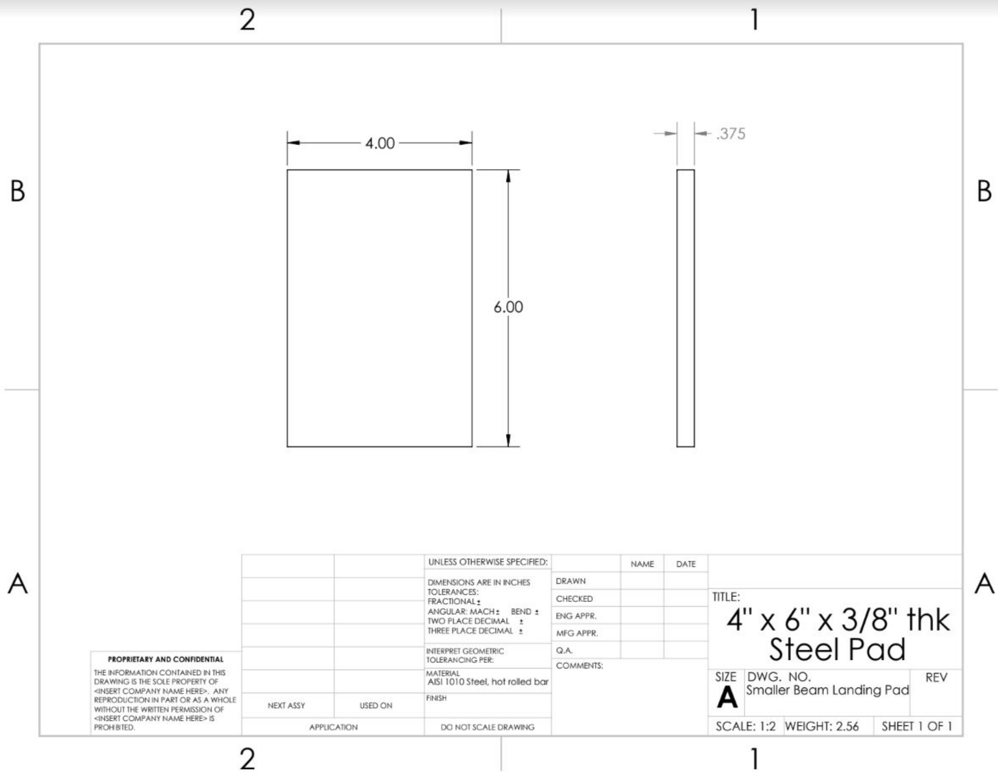
4.2 Part List

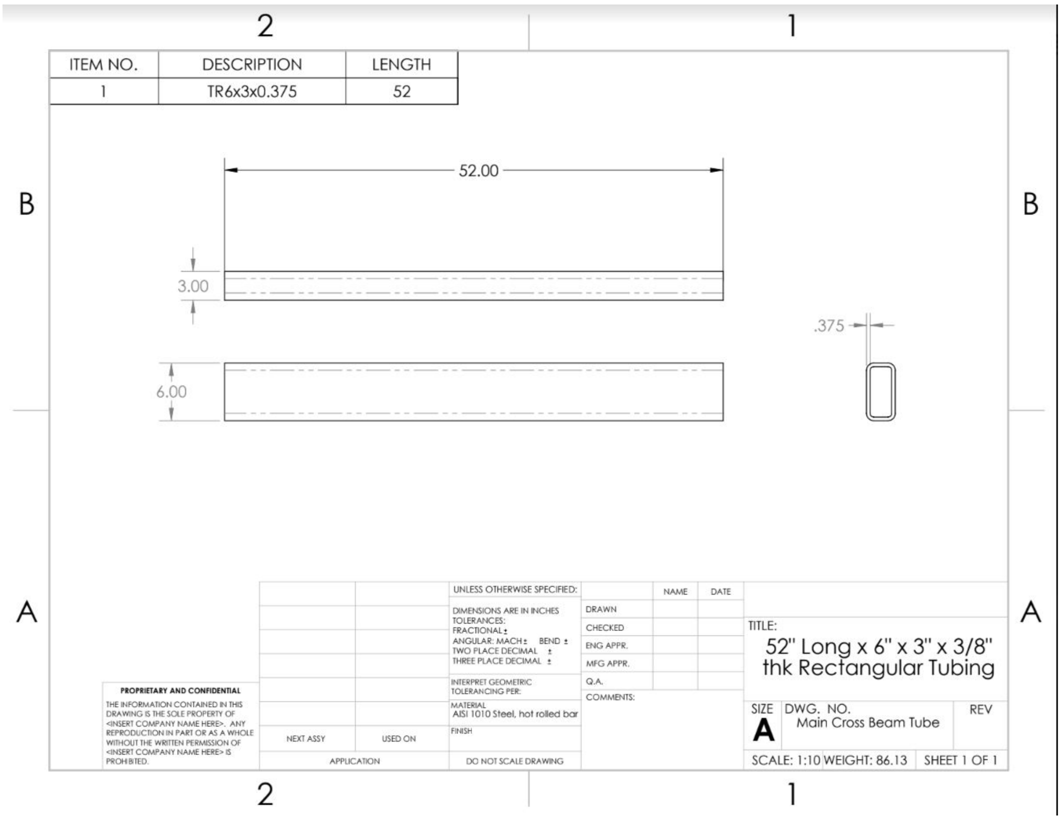
Table 10 - Initial Parts List

Type	Length (inches)	Width (inches)	Height (inches)	Diameter (inches)	Thickness (inches)	Material Type	Supplier	To Be Ordered By Wash U. (Y or N)	Quantity	Cost (each)	Total
Rectangular Tubing	52	6	3	-	0.25	1010 Hot Rolled Steel	Shapiro Metal Supply	Y	1	$80.00	$80.00
Rectangular Tubing	24	5	2	-	0.25	1010 Hot Rolled Steel	Shapiro Metal Supply	Y	2	$30.00	$60.00
Plate	6	4	-	-	0.25	1010 Hot Rolled Steel	Shapiro Metal Supply	Y	2	$5.00	$10.00
Plate	7	7	-	-	0.25	1010 Hot Rolled Steel	Shapiro Metal Supply	Y	1	$10.00	$10.00
Round Bar	3	-	-	1.5	-	A36 Hot Rolled Steel	Shapiro Metal Supply	Y	2	$12.50	$25.00
Plate	4	4	-	-	0.25	1010 Hot Rolled Steel	Shapiro Metal Supply	Y	1	$5.00	$5.00
UHMW Board (Part No. 84765K113)	12	12	-	-	0.25	Slippery, Abrasive Resistant, Glass Filled, UHMW	McMasterr CARR	Y	2	$22.12	$44.24
Epoxy (Part No. 1813A234)	-	-	-	-	-	Loctite 9460	McMasterr CARR	Y	1	$20.78	$20.78
Epoxy Gun (Part No. 74695A71)	-	-	-	-	-	-	McMasterr CARR	Y	1	$23.76	$23.76
Epoxy Gun Nozzle (Part No. 74695A12)	-	-	-	-	-	-	McMasterr CARR	Y	2	$1.30	$2.60
Welding Work	-	-	-	-	-	-	Gerling and Sons Welding	Y	1	$100.00	$100.00
										Total	$381.38

4.3 Draft detail drawings for each manufactured part



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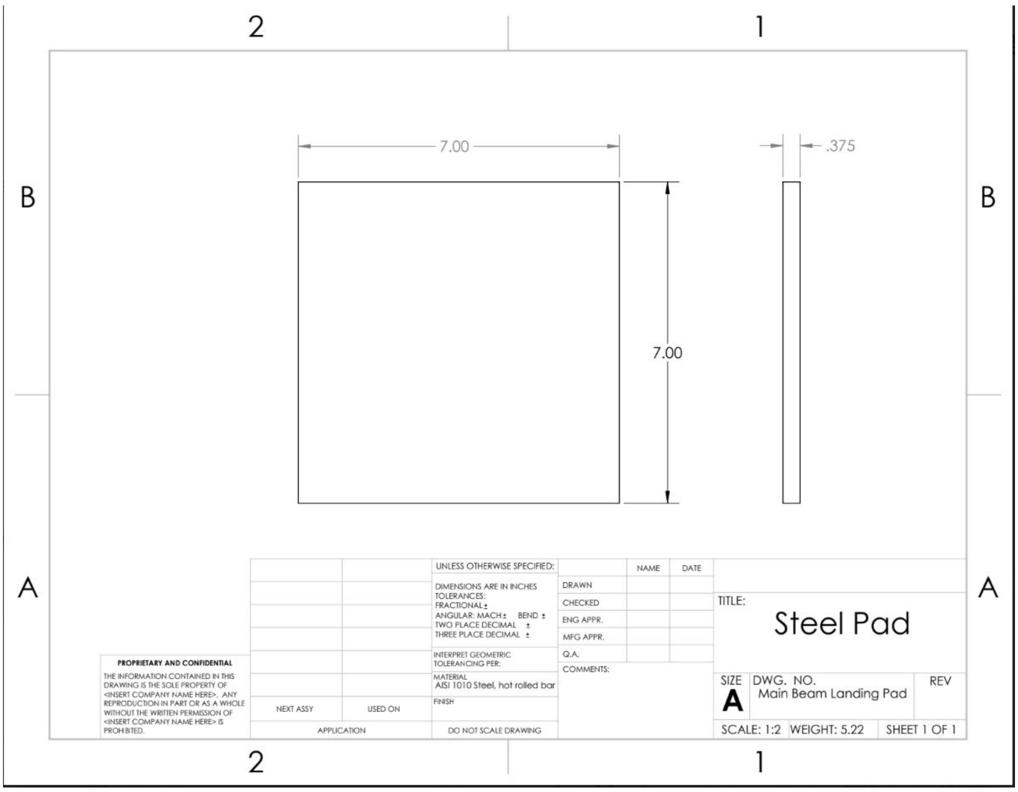
DESCRIPTION
LENGTH
1
TR6x3x0.375
52
52.00
3.00
6.00
.375
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ±
ANGULAR: MACH ± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±
INTERPRET GEOMETRIC TOLERANCING PER:
MATERIAL
AISI 1010 Steel, hot rolled bar
FINISH
DO NOT SCALE DRAWING
NEXT ASSY
USED ON
APPLICATION
NAME
DATE
DRAWN
CHECKED
ENG APPR.
MFG APPR.
Q.A.
COMMENTS:
PROPRIETARY AND CONFIDENTIAL
THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF <INSERT COMPANY NAME HERE>. ANY REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF <INSERT COMPANY NAME HERE> IS PROHIBITED.
TITLE:
52" Long x 6" x 3" x 3/8" thk Rectangular Tubing
SIZE
A
DWG. NO.
Main Cross Beam Tube
REV
SCALE: 1:10
WEIGHT: 86.13
SHEET 1 OF 1


7.00
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UNLESS OTHERWISE SPECIFIED:
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ANGULAR: MACH ± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±
INTERPRET GEOMETRIC TOLERANCING PER:
MATERIAL
AISI 1010 Steel, hot rolled bar
FINISH
DO NOT SCALE DRAWING
NEXT ASSY
USED ON
APPLICATION
NAME
DATE
DRAWN
CHECKED
ENG APPR.
MFG APPR.
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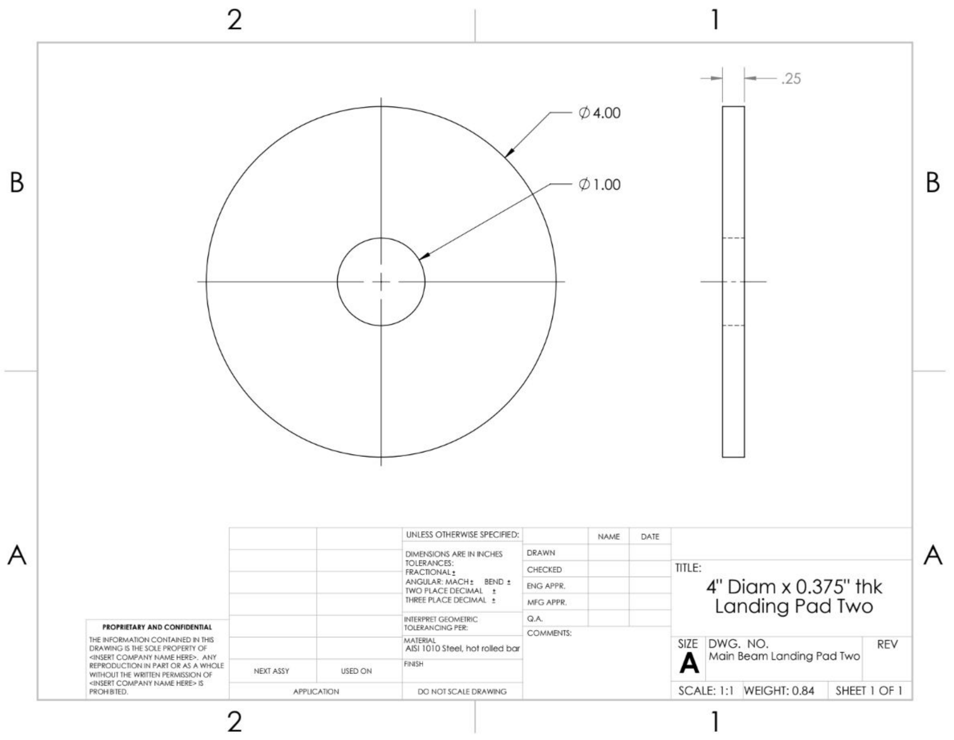
COMMENTS:
PROPRIETARY AND CONFIDENTIAL
THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF <INSERT COMPANY NAME HERE>. ANY REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF <INSERT COMPANY NAME HERE> IS PROHIBITED.
TITLE:
Steel Pad
SIZE
A
DWG. NO.
Main Beam Landing Pad
REV
SCALE: 1:2
WEIGHT: 5.22
SHEET 1 OF 1


Ø 4.00
Ø 1.00
.25
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ±
ANGULAR: MACH ± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±
INTERPRET GEOMETRIC TOLERANCING PER:
MATERIAL
AISI 1010 Steel, hot rolled bar
FINISH
NEXT ASSY
USED ON
APPLICATION
DO NOT SCALE DRAWING
NAME
DATE
DRAWN
CHECKED
ENG APPR.
MFG APPR.
Q.A.
COMMENTS:
TITLE:
4" Diam x 0.375" thk Landing Pad Two
SIZE A
DWG. NO.
Main Beam Landing Pad Two
REV
SCALE: 1:1
WEIGHT: 0.84
SHEET 1 OF 1
PROPRIETARY AND CONFIDENTIAL
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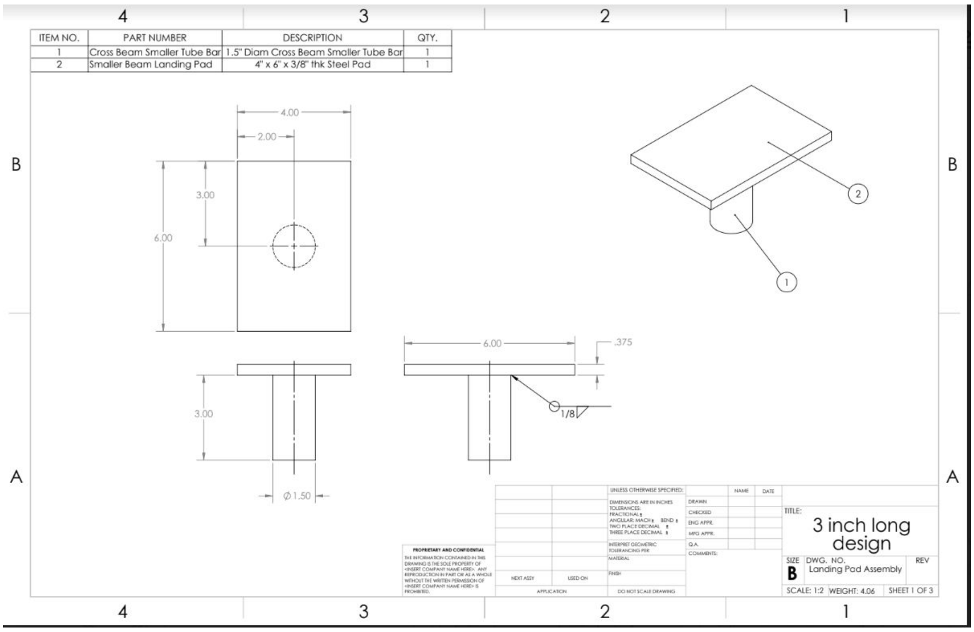
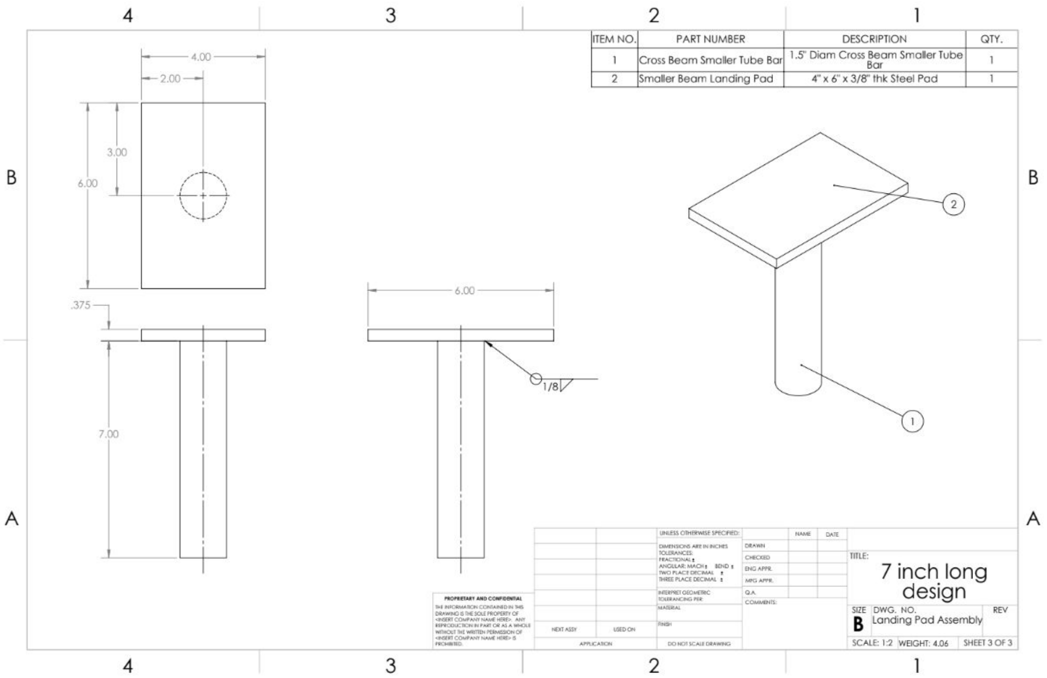
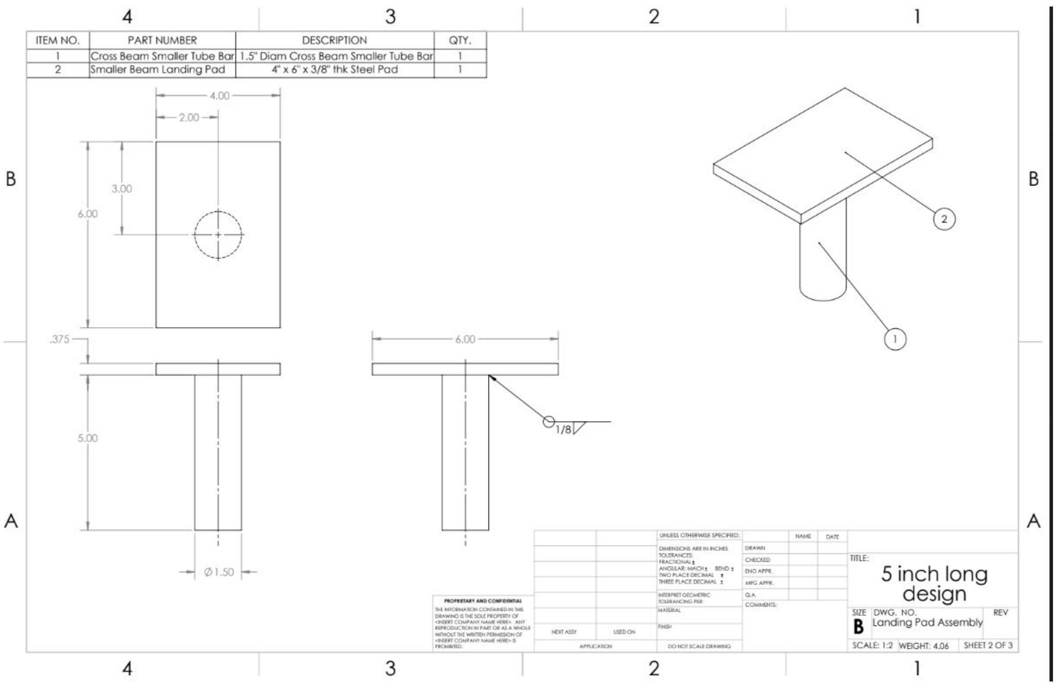

ITEM NO. | PART NUMBER | DESCRIPTION | QTY.
1 | Cross Beam Smaller Tube Bar | 1.5" Diam Cross Beam Smaller Tube Bar | 1
2 | Smaller Beam Landing Pad | 4" x 6" x 3/8" thk Steel Pad | 1
4.00
2.00
3.00
6.00
6.00
.375
1/8
3.00
Ø 1.50
TITLE:
3 inch long design
SIZE B
DWG. NO.
Landing Pad Assembly
REV
SCALE: 1:2
WEIGHT: 4.06
SHEET 1 OF 3


ITEM NO.
PART NUMBER
DESCRIPTION
QTY.
1
Cross Beam Smaller Tube Bar
1.5" Diam Cross Beam Smaller Tube Bar
1
2
Smaller Beam Landing Pad
4" x 6" x 3/8" thk Steel Pad
1
4.00
2.00
3.00
6.00
.375
7.00
6.00
1/8
TITLE:
7 inch long design
SIZE DWG. NO.
B Landing Pad Assembly
REV
SCALE: 1:2 WEIGHT: 4.06 SHEET 3 OF 3


ITEM NO.
PART NUMBER
DESCRIPTION
QTY.
1
Cross Beam Smaller Tube Bar
1.5" Diam Cross Beam Smaller Tube Bar
1
2
Smaller Beam Landing Pad
4" x 6" x 3/8" thk Steel Pad
1
4.00
2.00
3.00
6.00
.375
5.00
Ø1.50
6.00
1/8
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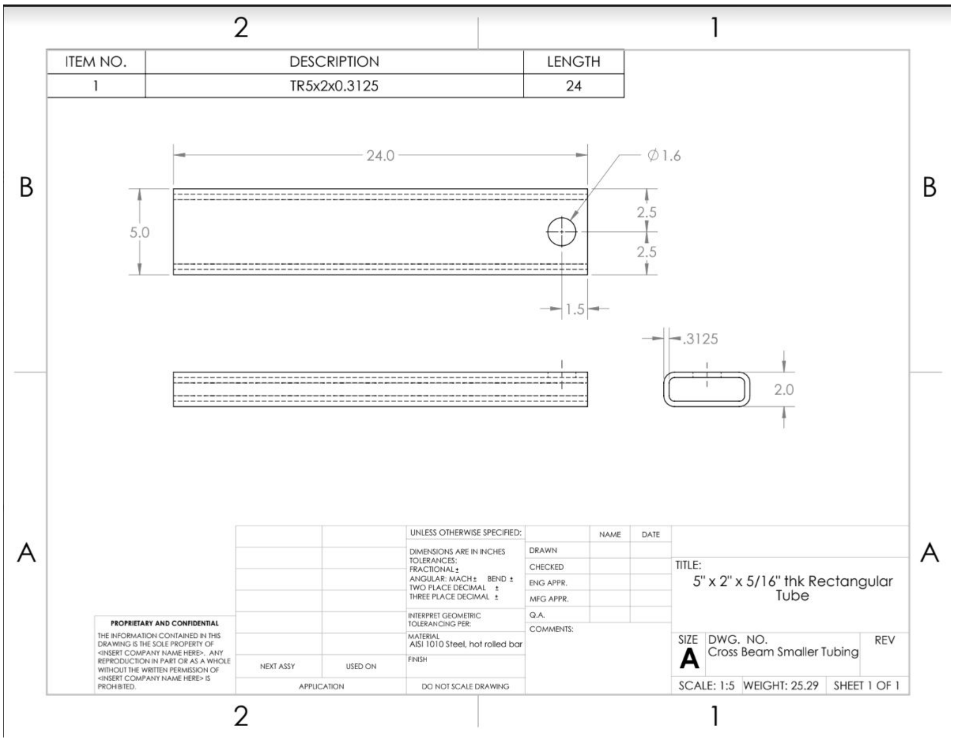
5 inch long design
SIZE DWG. NO.
B Landing Pad Assembly
REV
SCALE: 1:2 WEIGHT: 4.06 SHEET 2 OF 3



4.4 DESCRIPTION OF THE DESIGN RATIONALE

In the cross beam design, the FEA engineering analysis we did on the ¼" thick design came out to be too close for comfort to failing/yielding to the applied loads. We then switched the majority of the design to be ⅜" and 5/16" thick which turned out to be good enough to overcome the failure.

Some of the problems that were considered major and had a big impact on failing to meet requirements do to the applied loads were the design's thickness being ¼" thick which would fail 2000 lbs load on each pad which ultimately led to having to thicken the steel to ⅜" and 5/16" thick. See the attached PDF of FEA(Finite element analysis) showing where there is possible failure do to the applied loads. We also noticed that do to the style of load from the jackstand and the car/truck may not be lifted by center of gravity, we are highly suggesting the customer use jack stands with this design to stop the vehicle from wobbling in any way. The objects in our assembly that were close to failing were the smaller rectangular tubing and the square landing pad.

The second problem we faced was increasing the thickness and dimensions of the design also increased the cost and weight of the material.

5 ENGINEERING ANALYSIS

5.1 ENGINEERING ANALYSIS PROPOSAL

5.1.1 Signed engineering analysis contract

ANALYSIS TASKS AGREEMENT

PROJECT: Cross Beam Lift **NAMES**: Nick Pusateri **INSTRUCTOR**: Dr. Jakeila & C. Giesmann
Ramiz Ahmed
Emel Saeidghafelpoor

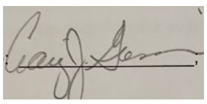
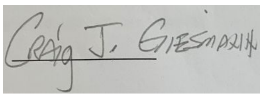
The following engineering analysis tasks will be performed:

Analysis before prototype:
1.) Maximum load determination for the design
 a) Using SOLIDWORKS Linear Static Simulation software
 b) Determine the max von Mises stress
 c) Determine the maximum displacement
2.) Choosing the preferred material type used for the application
 a) Determined using SOLIDWORKS software
3.) Determine the total weight and cost of material
 a) Determined using SOLIDWORKS software
 b) Use excel to formulate total cost of material from quote from manufacturer

Analysis after prototype:
1) Testing of the stability and rigidity of the structure loaded on small vehicle
 a) Physically move the adjustable arms in and out to minimum and maximum length for both a car and truck

The work will be divided among the group members in the following way:

- SOLIDWORKS model design by: Nick Pusateri
- FEA Linear Static analysis with SOLIDWORKS by: Ramiz Ahmed, Nick Pusateri, & Emel Saeidghafelpoor

Instructor signature:  ; Print instructor name: 

(Group members should initial near their name above.)
NP
ES
RA

5.2 ENGINEERING ANALYSIS RESULTS

5.2.1 Motivation

In our design, to ensure the prototype will work without any failure, several analysis tasks were done using solidworks FEA (Finite Element Analysis) Linear Static. In the FEA analysis using the quarter inch thickness it was too close to failing under the maximum load (2000 lbs) on each side of the assemblies lifting pads. To overcome the failure we had to use 3/8th inch thick material to which resulted in the assembly not failing the applied loads. Before any manufacturing was done, the FEA analysis had to be completed to make sure the prototype would qualify under the given requirements to perform as needed. The FEA analysis results concluded in the success of the design due to the maximum load requirement that was set by the Sponsor's needs. With the cost requirements known, it was important to size the material as well as the weight to ensure the assembly could lift the vehicle without any failure.

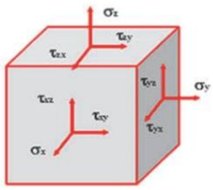
After the prototype is built, the stability and rigidity tests will be carried out to ensure that the design is strong enough to lift up a vehicle to change the tires.

5.2.2 Summary statement of analysis done

For our design we determined all of the stress calculation results using SOLIDWORKS Linear Static FEA analysis tool. Using SOLIDWORKS we could determine the maximum loads, material types, maximum material size, as well as the weight to make sure there is not any failure, to make sure we did everything wite we did several analysis tasks were done using FEA with solidworks. The calculation that we did is Linear static analysis, factor of safety, and Stress von mises. The von Mises yield criterion, also known as the maximum distortion energy criterion suggests that the yielding of a ductile material like steel begins when the second unequal stress invariants reach a critical value. It is part of plasticity theory that applies best to ductile materials, such as some metals.

The SOLIDWORKS FEA analysis software formulas that would have been used to find stresses are,

- Matrix Force Equation : [F]=[K]*[X]
- F = force
- K = stiffness
- X = displacement
- Von Mises Stress (3D): $\sigma_{eq} = \sqrt{0.5\left[(\sigma_x - \sigma_y)^2 + (\sigma_y - \sigma_z)^2 + (\sigma_z - \sigma_x)^2\right] + 3\left(\tau_{xy}^2 + \tau_{yz}^2 + \tau_{zx}^2\right)}$,

- ○ 

3D representation of variables used in Von Mises equation
  - ○ σ_x, σ_y, σ_z are the Principle Stresses
  - ○ τ_{xy}, τ_{yz}, τ_{zx} are the Shear Stresses
- von Mises Yield Criterion: $\frac{Max\ von\ Mises\ Stress}{Stress\ Limit} < 1$

5.2.3 Methodology

For the analysis done prior to manufacturing the car lift prototype, FEA using Solidworks Static Simulation was carried out to calculate the Von Mises stress using the load of 2000 lbs on each side of the pad which concluded failure could occur using the 1/4th inch thick material.

Since we initially took advantage of using SOLIDWORKS software to test for failure under applied loading there was no need to do any real experimentation or building of a test rig. The purpose of using the software is to test the application in the analysis tool instead of buying a bunch of material to test with possible a wooden structure which is not a true or close representation of what is being considered to be built.

After the prototype was built. It was lifted up and down using a hydraulic jack to check the performance in the loaded and unloaded conditions. We also tested the prototype in its fully extended and fully closed position to confirm the structure would work and take the applied loads under those conditions.

5.2.4 Results

Using load values of 2000 lbs on each side of the structure. We determine the Von Mises stress and displacement which was concluded in the analysis. Using the displacement of 0.43 inches there will be a movement in our design after the applied load of a motor vehicle. Using the stress in SOLIDWORKS FEA analysis tool we found the max or yield stress to be 26,106 psi for AISI 1010 Hot Rolled steel which is what are structure is made out of. The FEA results agreed with the above calculations, as well as pointing out some other possible areas of concern, such as higher stresses in the pads as well as using different vehicle could result in higher stresses and displacements. Figures 1 to 3 below show the max von Mises stress, max displacement, and Factor of Safety. These results show where there is the possible failure in the structure under the applied load(s).

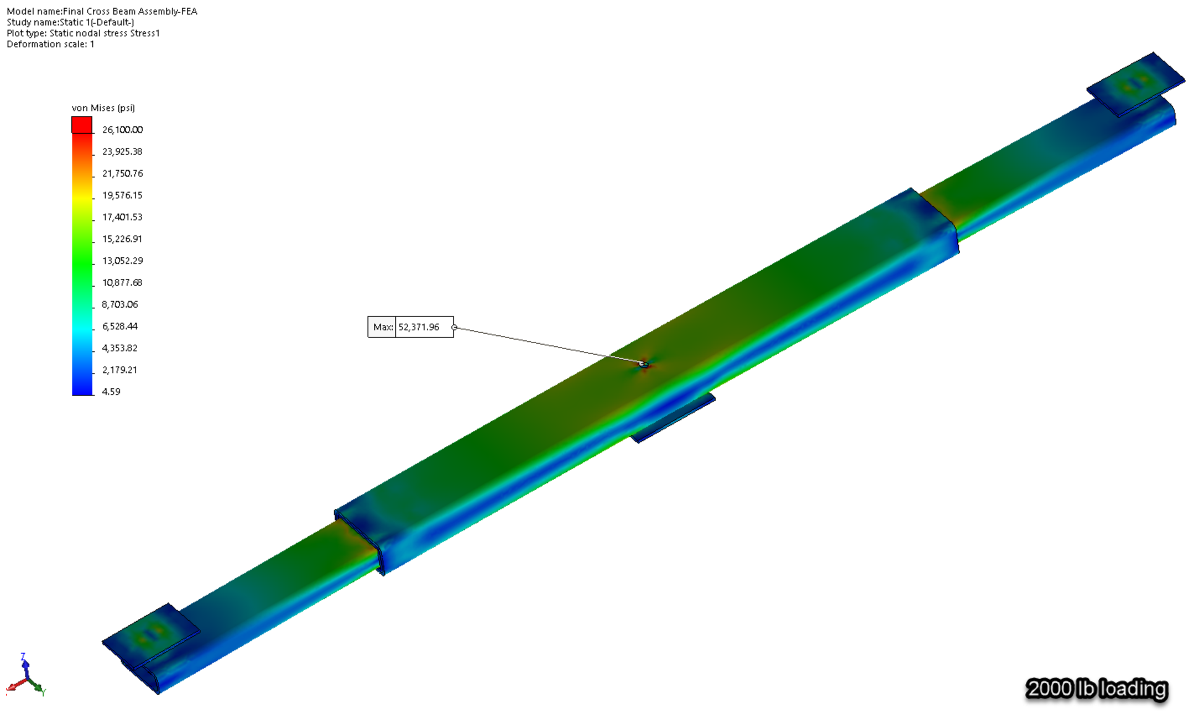


Fig. 8 Max von Mises Stress Top View of Assembly

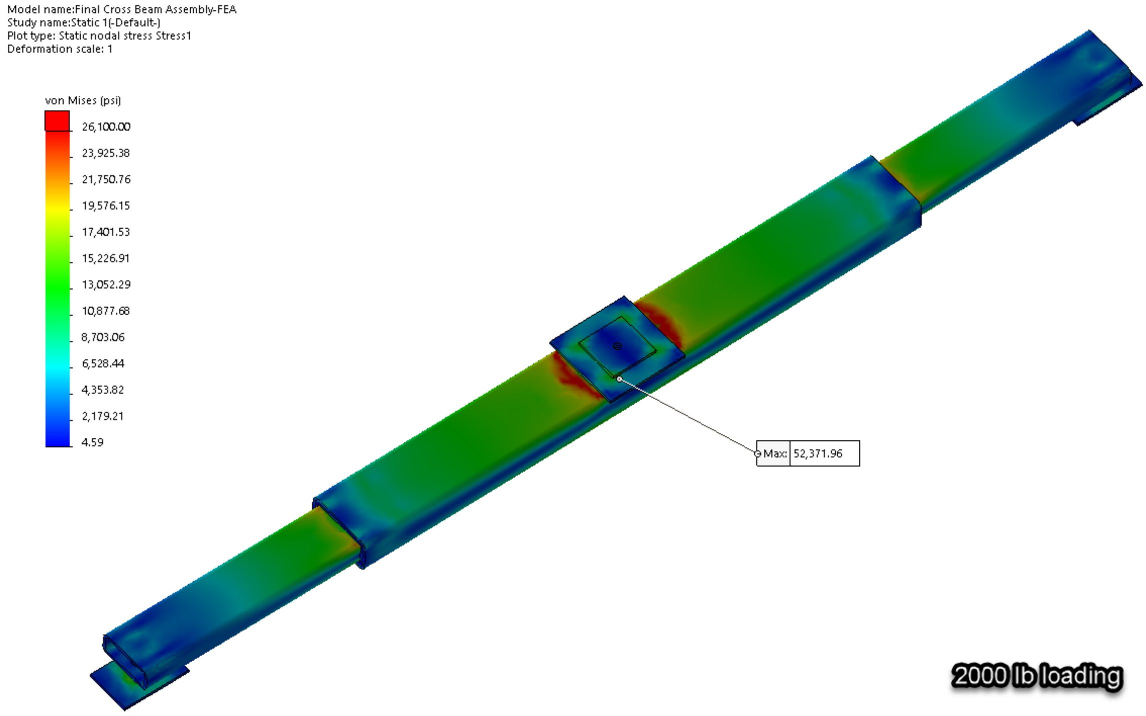


Fig. 9 Max von Mises Stress Bottom View of Assembly

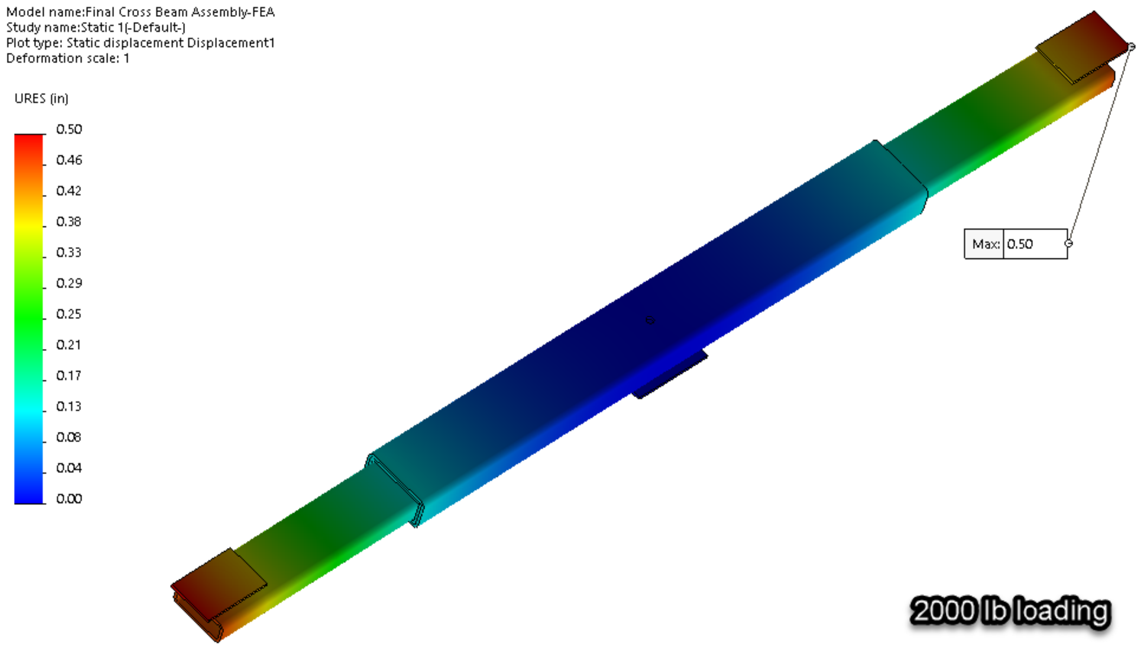


Fig. 10 Max Displacement of Assembly Under Load

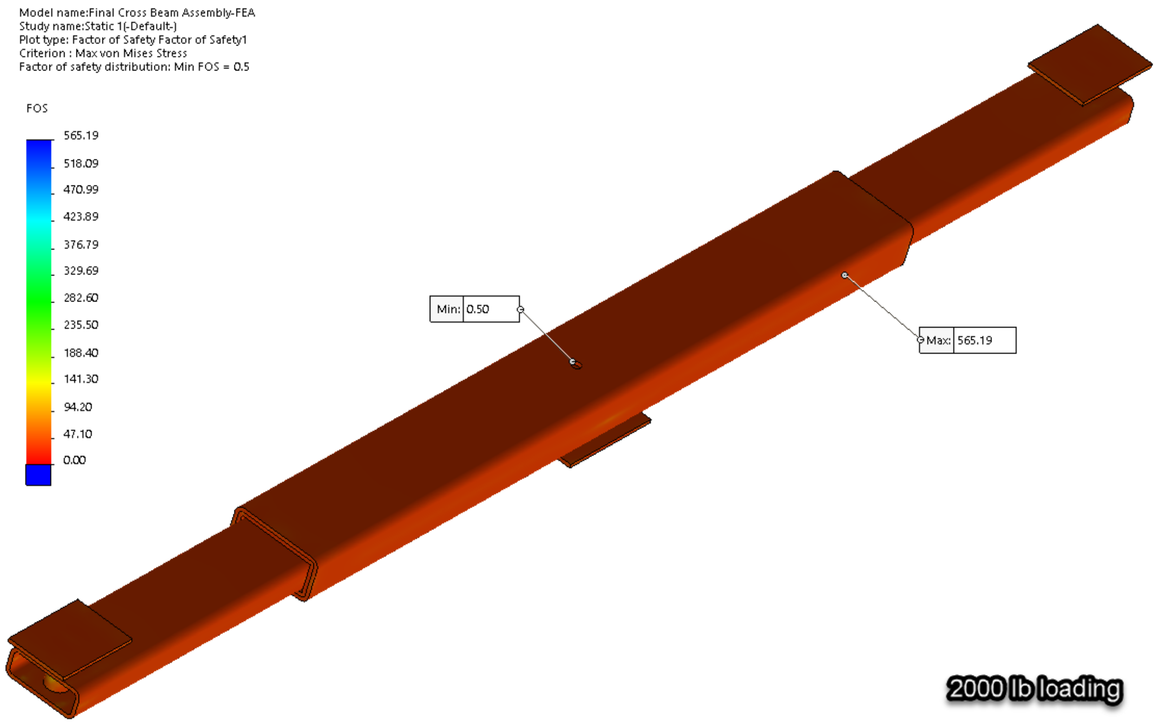


Fig. 11 Max and Min Factor of Safety Location of Assembly Under Load

5.2.5 Significance

After using the FEA max load that would be exerted on the lifting frame, we performed the analysis with two different thickness (¼” thk and ⅜” thk) using SOLIDWORKS FEA software. The software confirmed which material thickness would perform better under the 2000 lbs loading on each side of the lifting frame.

A difference that you will see between the first embodiment drawing and the final documentation drawing will be the structure will no longer be welded together. Is now going to be bolted together. This change was due to the cost to get the weld work was beyond the budget quote. Another change will be the BOM will now have hardware listed as an item in and the exploded view will have hardware showing in it. Lastly, since we're not welding it then we went ahead and removed the weld symbol off the layout drawings.

Some of the conflict that are in the final prototype are actual vehicle load(s) which can be more than our analysis loads, displacement on the vehicle, and dimensions of our material can be off based on the vehicle fitment.

The width of the frame was 52 inches in the embodiment drawing was increased due to the size of the vehicle in our user needs. The welded parts were designed to attach it to the frame instead of using the bolts connection in the assembly. Jack stands were added to stop the unbalancing of the vehicle from on each side while lifted in the air. Safety chain locks were also added into the final drawing to lock the Cross Beam assembly when its lifted up to prevent the vehicle from falling down and the smaller tubes from sliding out of the main tube.

6 Risk Assessment

A portable car jack is an assembly that is being lifted using a hydraulic lifting equipment that is used to raise cars/vehicles off the ground to enable the operator to gain access to the underparts of the vehicle. This assembly is put in the center of a hydraulic jack then one end of the assembly is placed under the vehicle at a suitable load bearing point and then the long handle is used to ‘pump’ the hydraulic fluid causing the vehicle to be raised. Some of the risks that can occur during the operation of this product are slips,trips, or falls.

6.1 Risk Identification

Vehicle may fall while changing the tires.

In the event that:

- The jack is not positioned correctly
- A jack stand is not used after lifting the vehicle up

- The hydraulic jack is placed on an uneven surface

6.2 Risk Analysis

Cost:

Cost can be reduced using the cheaper structural material and hardware. Also, reducing the overall size of certain components would reduce the cost of material.

Performance Specification:

Using the assembly on an uneven surface could occur in major problem and using the lighter product could reduce the risk of harming a person.

Schedule:

Complicated designs increase the schedule of completion.

6.3 Risk Prioritization

Based on the prototype built, we considered using a shorter length beam which could reduce the weight and cost of the material. We also had to build the structure rigid enough to service both regular sedan vehicles and light duty trucks. In order to complete the requirement of the product which is lifting the tires one inch off the ground to service the vehicle. Lastly, the additional components needed to be used in the assembly were the jack stands which are used to keep the vehicle balanced and not wobble in the air.

7 Codes and Standards

7.1 Identification

Industry Standard:

ASME B30.1-2015: Safety Standards for Cableways, Cranes, Derricks, Hoists, Hooks, Jacks, and Slings

SECTION 1-1.8: INSPECTION, REPAIR, AND REMOVAL

All inspections shall be performed by a designated person. Any deficiencies identified shall be examined and a determination made by a qualified person as to whether they constitute a hazard.

1-1.8.1 Initial Inspection

Prior to use, all new, altered, modified, or repaired mechanical jacks shall be inspected to verify compliance with the applicable provisions of this Chapter. Written records are not required.

1-1.8.2 Frequent Inspection

(a) A visual and functional inspection shall be performed each shift before the mechanical jack is used.

(b) Conditions such as those listed in para. 1-1.8.4 or any other condition that may be a hazard shall cause the mechanical jack to be removed from service. Mechanical jacks shall not be returned to service until approved by a qualified person.

(c) Written records are not required for frequent Inspections.

1-1.8.4 Removal Criteria

Mechanical jacks shall be removed from service if damage such as the following is present and shall only be returned to service when approved by a qualified person:

(a) missing or illegible identification

(b) pawl or rack teeth that are chipped, cracked, broken, or excessively worn

(c) cracked or damaged housing

(d) excessive pitting or corrosion

(e) excessive nicks or gouges

(f) improper engagement between rack bar and the pawls or wear plate

(g) indications of structural damage due to heat, or evidence of unauthorized welding

(h) excessive wear, bending, or other damage to threads

(i) improperly functioning or damaged load cap or integral auxiliary load point

(j) loose bolts or rivets

(k) damaged or improperly assembled accessory equipment

(l) other conditions including visible damage that cause doubt as to the continued use of the mechanical jack

(m) other items as specified in manufacturer's instruction that may affect operation

Listing of other Industry Standards:

ANSI/ALI ALCTV-2017: Safety Requirements for the Construction, Testing and Validation of Automotive Lifts

ANSI/ALI ALOIM:2008 (R2013): Standards for Automotive Lifts - Safety Requirements for Operation, Inspection and Maintenance

D1.3/D1.3M:2018: Structural Welding Code Sheet Steel

D1.4/D1.4M:2018: Structural Welding Code -Steel Reinforcing Bars

ASME STD (B18.2.6 - 2019): Fasteners for Use in Structural Applications

ASME (STD Y14.5-2018): Dimensioning and Tolerancing

ASME STD (STP-NU-020 - 2008): Verification of Allowable Stresses in ASME Section III, Subsection NH for Alloy 800H

OSHA Standards:

1926.959(a)

General requirements.

1926.959(a)(1)

Other applicable requirements. Mechanical equipment shall be operated in accordance with applicable requirements in this part, including Subparts N, O, and CC of this part, except that § 1926.600(a)(6) does not apply to operations performed by qualified employees.

1926.959(a)(2)

Inspection before use. The critical safety components of mechanical elevating and rotating equipment shall receive a thorough visual inspection before use on each shift.

1926.959(b)

Outriggers.

1926.959(b)(1)

Extend outriggers. Mobile equipment, if provided with outriggers, shall be operated with the outriggers extended and firmly set, except as provided in paragraph (b)(3) of this section.

1926.959(b)(2)

Clear view. Outriggers may not be extended or retracted outside of the clear view of the operator unless all employees are outside the range of possible equipment motion.

1926.959(b)(3)

Operation without outriggers. If the work area or the terrain precludes the use of outriggers, the equipment may be operated only within its maximum load ratings specified by the equipment manufacturer for the particular configuration of the equipment without outriggers.

1926.959(c)

Applied loads. Mechanical equipment used to lift or move lines or other material shall be used within its maximum load rating and other design limitations for the conditions under which the mechanical equipment is being used.

7.2 Justification

Justification for all the listed ASME, ANSI/ALI, and D1.X

These standards are designed for the safety of a person and a vehicle that needs a car lift for his or her garage when needed to change the tires. This lift will be equipped with a safety lock that would release and hold the lift when in use. Due to the fact that most of the designs have already been built using the government regulations and requirements, it is imperative that the design does not interfere with a government mandated safety apparatus.

Justification for OSHA Standard 1926.959(a)(b)(c)

These regulations are to protect the user from any kind of failure that would cause harm to the user while using the equipment do to the fact that it is built to regulated standards.

7.3 Design Constraints

Constraints for all the listed ASME, ANSI/ALI, and D1.X

All the safety and regulations are being applied to our design which is needed to complete the design requirements. Some of the restrictions that can be a safety issue are cost, load, and material which will be addressed in our next meeting.

Constraints for OSHA Standard 1926.959(a)(b)(c)

7.3.1 Functional

The design should fit the need of what the customer or sponsor has requested. The design is to be able to lift the tires of either a standard sedan or small compact car or a light duty truck one inch off the ground to service the tires or brakes.

7.3.2 Safety

The design should have the proper equipment attached to the assembly to protect the user from any pinch points or stop the user from exceeding the maximum weight capability.

7.3.3 Quality

Not much of quality was declared from the customer for this piece of equipment. What could be a case of a quality need could be to use a different type of steel or different metal altogether. Possible switching to an aluminum frame instead of a steel frame which would make the component significantly lighter in weight.

7.3.4 Manufacturing

After manufacturing of each component of the assembly, it should be easy to assemble with basic tools and hardware.

7.3.5 Timing

The assembly should have short setup and teardown time when being fabricated and when its being used on a vehicle.

7.3.6 Economic

The design should be affordable to both professional automotive shop owners and pedestrians who would do mechanical work on their vehicle at home.

7.3.7 Ergonomic

The movable components of the assembly should be easy to move and clean if need be.

7.3.8 Ecological

The design should be able to last for a long time in any work environment and not cause any health/environmental hazards.

7.3.9 Aesthetic

The design should somewhat pleasant to the eye and possible colored with a bright color to be able to be seen from a distance that it is being used.

7.3.10 Life cycle

The device should be able to withstand a long life cycle of loads and not need constant maintenance.

7.3.11 Legal

Before this design is released to the public a product manual should be made and included with purchase of the component to clearly show the purpose of the device, max and min loads that can be applied, what additional components are to be used with it, and what codes and standards were followed in making the design of the component.

7.4 SIGNIFICANCE

Significance for all the listed ASME, ANSI/ALI, and D1.X

These standards helped in confirming the total size, material type, weld type, and fastener type that could be used. They also confirmed the type of dimensioning to be used on drawings and the allowable stresses that needed to either be confirmed by hand calculations or by an approved FEA analysis tool/software.

At first we went with too high a safety factor in our design, but upon reading the standards it was we found that we could downsize the thickness of the support rectangular beams. We also found out the structure should have a maximum size and or weight for one person to handle on their own.

Significance for OSHA Standard 1926.959(a)(b)(c)

These regulations confirmed the structure not only needed to be built and firmly welded together, but before using it the end user is to inspect the device for any kind of damage that could have occurred from its last use. When being used, the maximum length the smaller rectangular tubing could go had to also be taken into consideration do the structure being tested with a maximum load and arm extension length for safety purposes. Also, the equipment needed to have a certain material type to take do to the max load the structural steel members could take.

8 Working prototype

8.1 prototype Photos

Fig. 12 Full assembly closed

In Figure 12 we are showing the top view of Cross Beam assembly in its completed fully closed state.

Fig. 13 Full assembly open

In Figure 13 we are showing the top view of Cross Beam assembly in its completed fully open state.

Fig. 14 Complete layout of the Cross Beam and additional equipment

Figure 14 shows the completed Cross Beam assembly with a 3 ton hydraulic jack and two 3 ton jack stands. The hydraulic jack is used in conjunction with the Cross Beam assembly to lift a vehicle in the air. The two 3 ton jack stands are to be used while the vehicle is in the air to eliminate any wobbling that may occur while lifted in the air.

Figures 12 through 14 are only showing one assembly. In reality you would need two assemblies to lift a vehicle completely off the ground by one inch. Therefore, you would need two 3 ton hydraulic jacks and four 3 ton jack stands.

8.2 Working Prototype Video

https://youtu.be/06RRoNgm6cM (Video link to lift being used on a car)

https://www.youtube.com/watch?v=HjDNW3rbV9Q&t (Video link to lift being used on a truck)

8.3 Prototype components

Fig. 15 Main rectangular beam view one

In Figures 15 and 16 we are showing a top view of main rectangular beam which will be used with a hydraulic jack to lift a vehicle.

Fig. 16 Main rectangular beam view two

Fig. 17 Smaller insert tube set one

In Figure 17 we are showing a front view of one smaller tube which will be inserted in the main rectangular beam to be put toward the front side of vehicle frame.

Fig. 18 Smaller insert tube set two

In Figure 18 we are showing a front view the second smaller tube which will be inserted in the main rectangular beam to be put toward the back side of the vehicle frame.

Fig. 19 Lift pad assembly set one

In Figure 19 we are showing a front view of one of the lifting pad assemblies that will be used on one of the smaller insert tubes to hold the assembly to the frame of the vehicle.

Fig. 20 Lift pad assembly two

In Figure 20 we are showing a front view of the other lifting pad assemblies that will be used on one of the smaller insert tubes to hold the assembly to the frame of the vehicle.

Fig. 21 UHMW insert set one

In Figure 21 we are showing an end view of a set of UHMW plates which were epoxied inside the main rectangular beam to avoid the friction caused by the smaller insert tube.

Fig. 22 UHMW insert set two

In Figure 22 we are showing an end view of a set of UHMW plates again which were epoxied to the inside of the main rectangular beam to avoid the friction caused by the smaller insert tube.

9 Design documentation

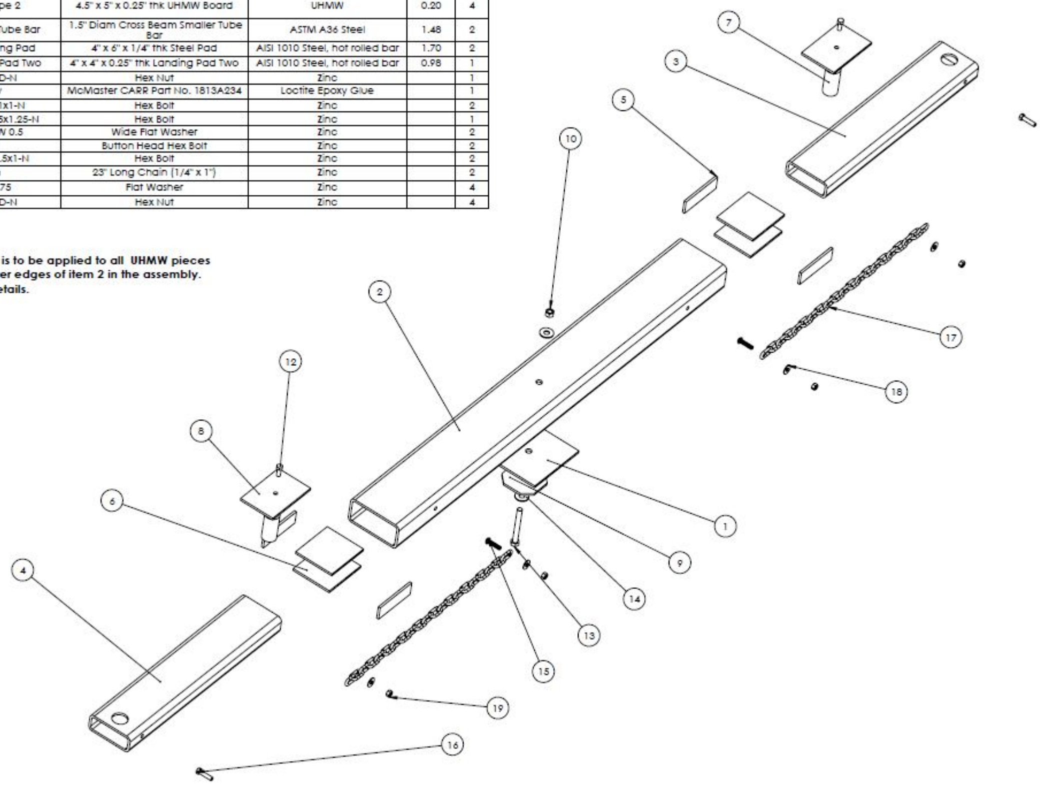
9.1 Final Drawings and Documentation

9.1.1 Engineering Drawings

ITEM NO.	PART NUMBER	DESCRIPTION	MATERIAL	Weight	QTY.
1	Main Beam Landing Pad	7" x 7" x 0.25" thk Steel Pad	AISI 1010 Steel, hot rolled bar	3.46	1
2	Main Cross Beam Tube	52" Long x 6" x 3" x 1/4" thk Rectangular Tubing	AISI 1010 Steel, hot rolled bar	60.39	1
3	Cross Beam Smaller Tubing_Opposite Side	5" x 2" x 1/4" thk Rectangular Tube	AISI 1010 Steel, hot rolled bar	20.92	1
4	Cross Beam Smaller Tubing	5" x 2" x 1/4" thk Rectangular Tube	AISI 1010 Steel, hot rolled bar	20.92	1
5	UHMW Board	1.5" x 5" x 0.25" thk UHMW Board	UHMW	0.07	4
6	UHMW Board Type 2	4.5" x 5" x 0.25" thk UHMW Board	UHMW	0.20	4
7	Cross Beam Smaller Tube Bar	1.5" Diam Cross Beam Smaller Tube Bar	ASTM A36 Steel	1.48	2
8	Smaller Beam Landing Pad	4" x 6" x 1/4" thk Steel Pad	AISI 1010 Steel, hot rolled bar	1.70	2
9	Main Beam Landing Pad Two	4" x 4" x 0.25" thk Landing Pad Two	AISI 1010 Steel, hot rolled bar	0.98	1
10	HNUT 0.5000-13-D-N	Hex Nut	Zinc		1
11	Loctite Epoxy	McMaster CARR Part No. 1813A234	Loctite Epoxy Glue		1
12	HBOLT 0.3750-16x1x1-N	Hex Bolt	Zinc		2
13	HBOLT 0.5000-20x4.25x1.25-N	Hex Bolt	Zinc		1
14	Preferred Wide FW 0.5	Wide Flat Washer	Zinc		2
15	92949A628	Button Head Hex Bolt	Zinc		2
16	HBOLT 0.3750-16x1.5x1-N	Hex Bolt	Zinc		2
17	Safety Chain	23" Long Chain (1/4" x 1")	Zinc		2
18	Regular FW 0.375	Flat Washer	Zinc		4
19	HNUT 0.3750-16-D-N	Hex Nut	Zinc		4

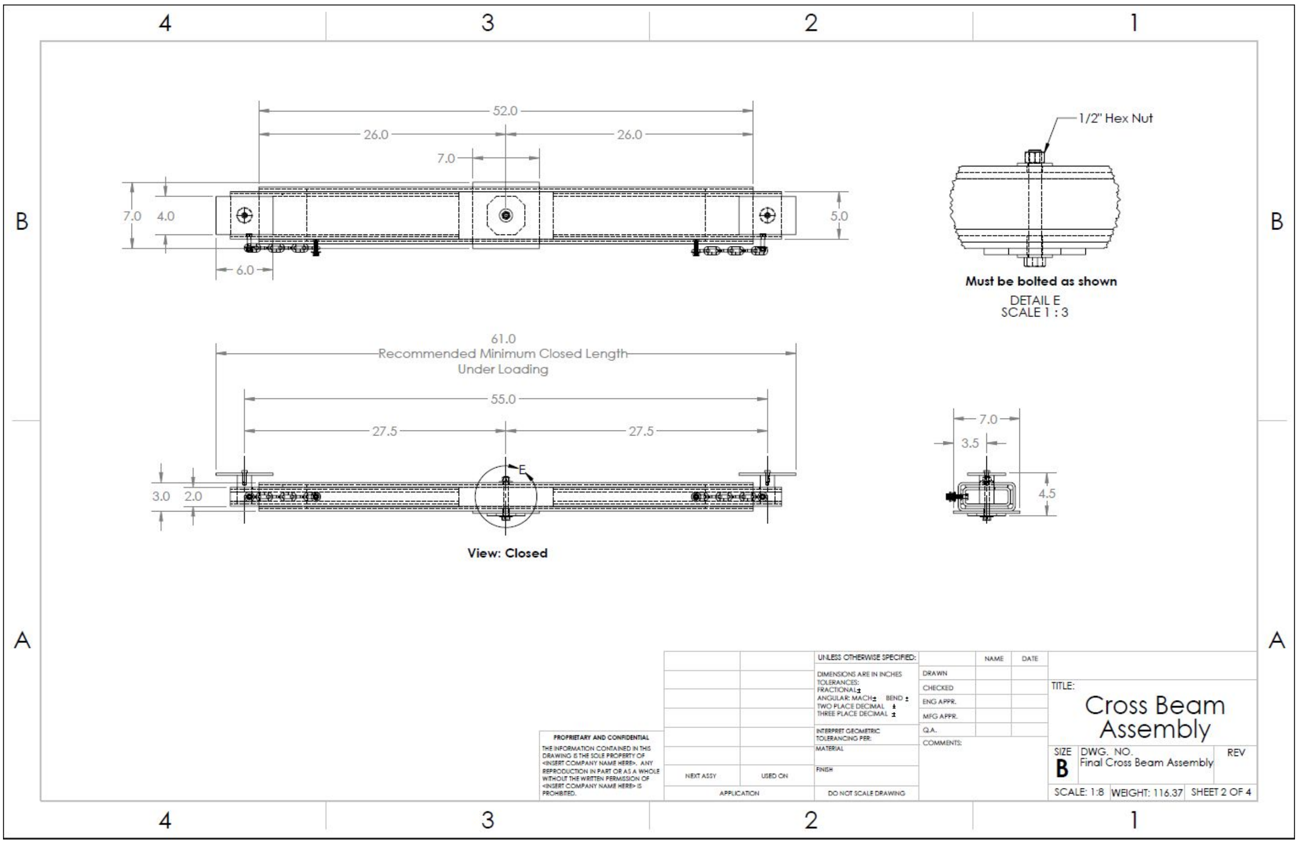
Note:

- **Item 11 (Loctite Epoxy) is to be applied to all UHMW pieces and glued to inside outer edges of item 2 in the assembly.**
- **See sheet 4 for more details.**



Sheet 1 of 4

Fig. 23 Final Assembly Drawing (**Note: All dimensions are in inches**)


52.0
26.0
26.0
7.0
7.0
4.0
5.0
6.0
1/2" Hex Nut
Must be bolted as shown
DETAIL E
SCALE 1 : 3
61.0
Recommended Minimum Closed Length
Under Loading
55.0
27.5
27.5
E
3.0
2.0
7.0
3.5
4.5
View: Closed
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL±
ANGULAR: MACH± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±
INTERPRET GEOMETRIC TOLERANCING PER:
MATERIAL
FINISH
DO NOT SCALE DRAWING
NAME
DATE
DRAWN
CHECKED
ENG APPR.
MFG APPR.
Q.A.
COMMENTS:
TITLE:
Cross Beam Assembly
SIZE
B
DWG. NO.
Final Cross Beam Assembly
REV
SCALE: 1:8
WEIGHT: 116.37
SHEET 2 OF 4
PROPRIETARY AND CONFIDENTIAL
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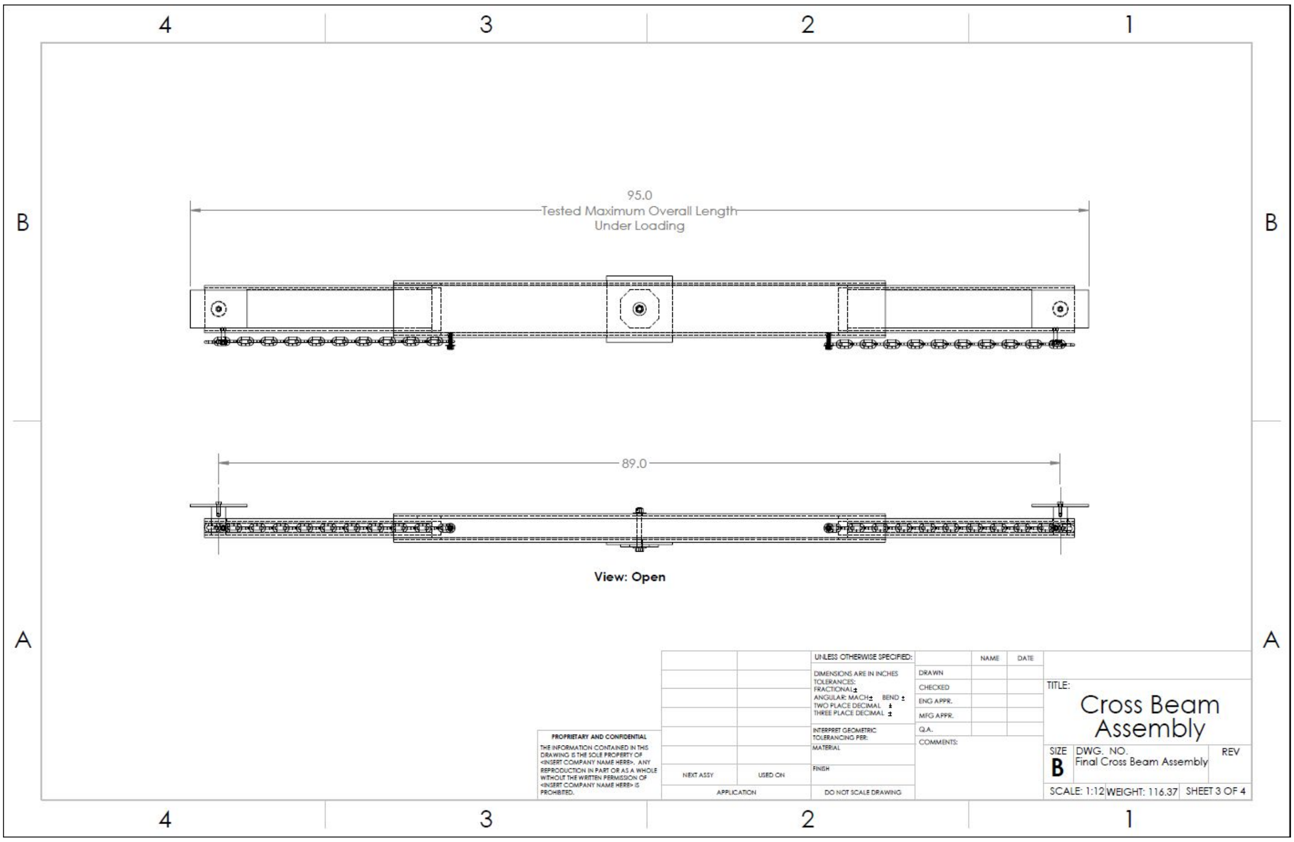
NEXT ASSY
USED ON
APPLICATION


95.0
Tested Maximum Overall Length
Under Loading
89.0
View: Open
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL±
ANGULAR: MACH± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±
INTERPRET GEOMETRIC TOLERANCING PER:
MATERIAL
FINISH
DO NOT SCALE DRAWING
NAME
DATE
DRAWN
CHECKED
ENG APPR.
MFG APPR.
Q.A.
COMMENTS:
TITLE:
Cross Beam Assembly
SIZE
B
DWG. NO.
Final Cross Beam Assembly
REV
SCALE: 1:12
WEIGHT: 116.37
SHEET 3 OF 4
PROPRIETARY AND CONFIDENTIAL
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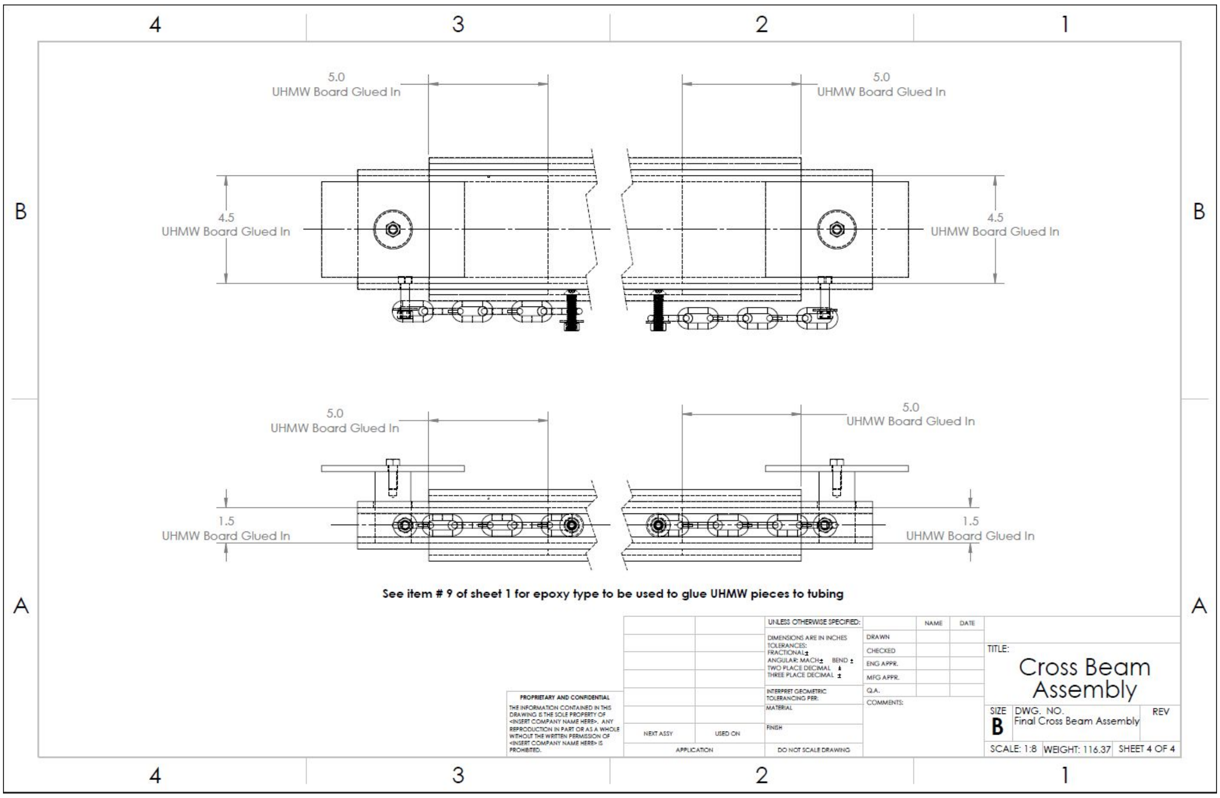
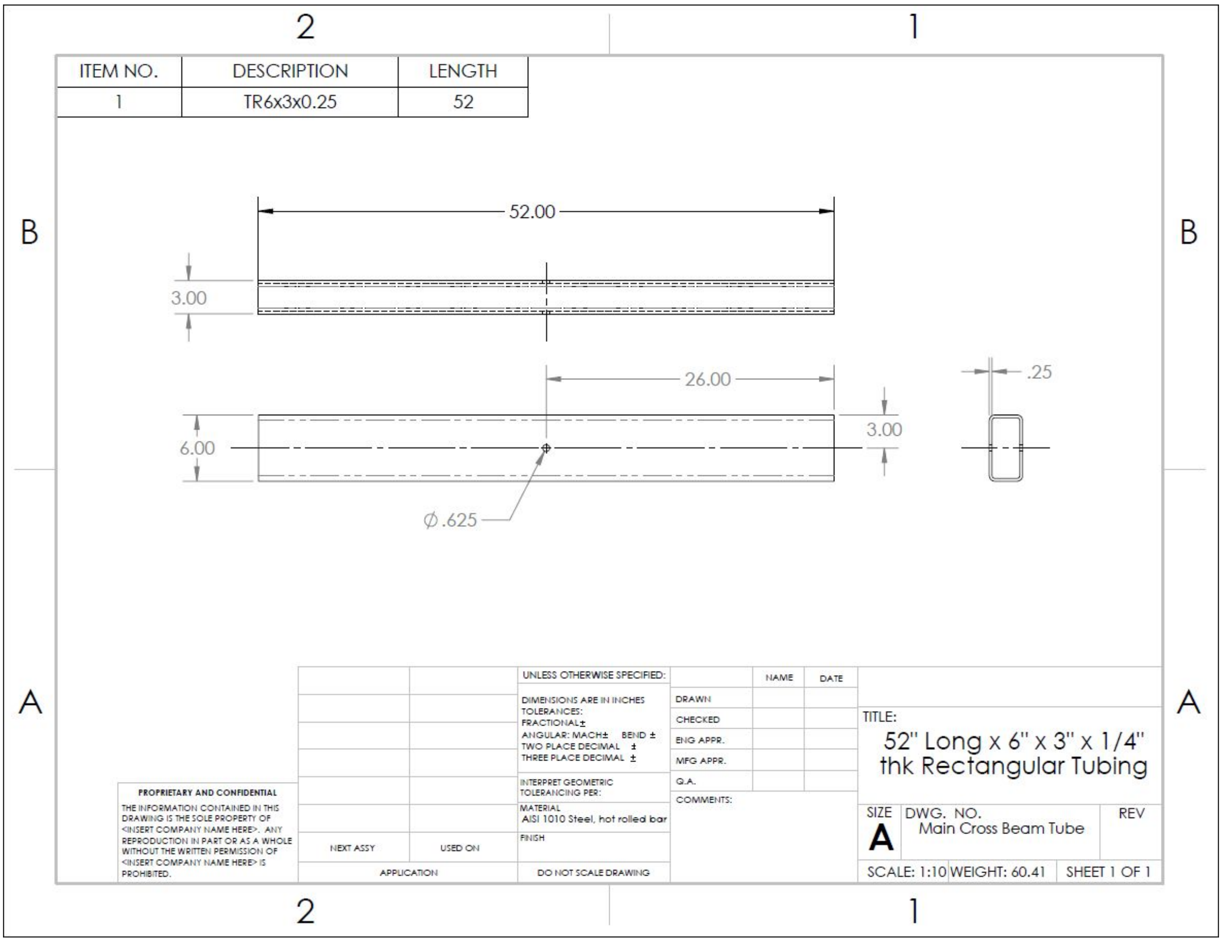
NEXT ASSY
USED ON
APPLICATION


5.0
UHMW Board Glued In
4.5
UHMW Board Glued In
1.5
UHMW Board Glued In
See item # 9 of sheet 1 for epoxy type to be used to glue UHMW pieces to tubing
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
PROPRIETARY AND CONFIDENTIAL
TITLE:
Cross Beam Assembly
SIZE B
DWG. NO. Final Cross Beam Assembly
REV
SCALE: 1:8
WEIGHT: 116.37
SHEET 4 OF 4


ITEM NO.
DESCRIPTION
LENGTH
1
TR6x3x0.25
52
52.00
3.00
26.00
6.00
3.00
.25
Ø .625
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL±
ANGULAR: MACH± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±
INTERPRET GEOMETRIC TOLERANCING PER:
MATERIAL
AISI 1010 Steel, hot rolled bar
FINISH
DO NOT SCALE DRAWING
NAME
DATE
DRAWN
CHECKED
ENG APPR.
MFG APPR.
Q.A.
COMMENTS:
NEXT ASSY
USED ON
APPLICATION
PROPRIETARY AND CONFIDENTIAL
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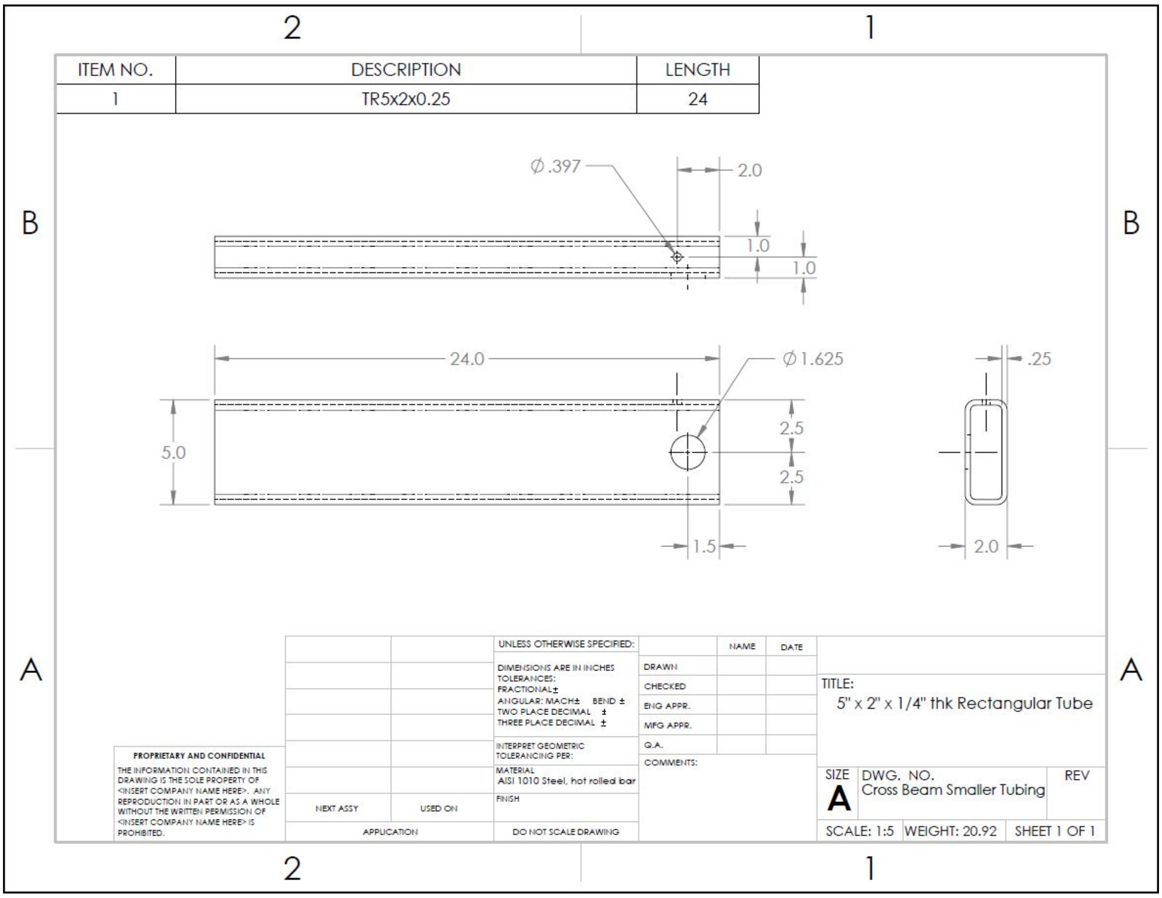
TITLE:
52" Long x 6" x 3" x 1/4" thk Rectangular Tubing
SIZE A
DWG. NO.
Main Cross Beam Tube
REV
SCALE: 1:10
WEIGHT: 60.41
SHEET 1 OF 1


ITEM NO.
DESCRIPTION
LENGTH
1
TR5x2x0.25
24
⌀.397
2.0
1.0
1.0
24.0
⌀1.625
.25
5.0
2.5
2.5
1.5
2.0
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL±
ANGULAR: MACH± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±
INTERPRET GEOMETRIC TOLERANCING PER:
MATERIAL
AISI 1010 Steel, hot rolled bar
FINISH
DO NOT SCALE DRAWING
NAME
DATE
DRAWN
CHECKED
ENG APPR.
MFG APPR.
Q.A.
COMMENTS:
TITLE:
5" x 2" x 1/4" thk Rectangular Tube
SIZE
A
DWG. NO.
Cross Beam Smaller Tubing
REV
SCALE: 1:5
WEIGHT: 20.92
SHEET 1 OF 1
NEXT ASSY
USED ON
APPLICATION
PROPRIETARY AND CONFIDENTIAL
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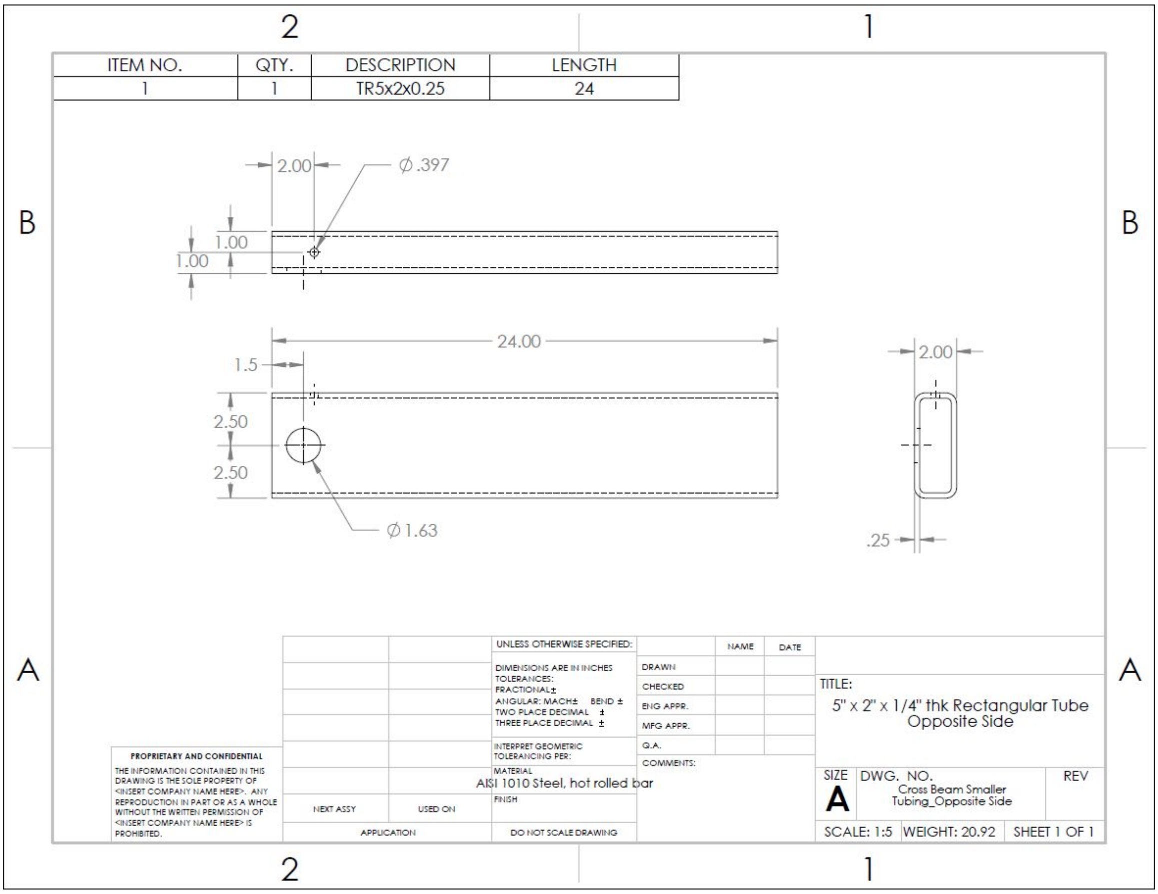
ITEM NO.
QTY.
DESCRIPTION
LENGTH
1
1
TR5x2x0.25
24
2.00
⌀.397
1.00
1.00
24.00
1.5
2.00
2.50
2.50
⌀1.63
.25
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL±
ANGULAR: MACH± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±
INTERPRET GEOMETRIC TOLERANCING PER:
MATERIAL
AISI 1010 Steel, hot rolled bar
FINISH
DO NOT SCALE DRAWING
NAME
DATE
DRAWN
CHECKED
ENG APPR.
MFG APPR.
Q.A.
COMMENTS:
TITLE:
5" x 2" x 1/4" thk Rectangular Tube
Opposite Side
SIZE
A
DWG. NO.
Cross Beam Smaller Tubing_Opposite Side
REV
SCALE: 1:5
WEIGHT: 20.92
SHEET 1 OF 1
NEXT ASSY
USED ON
APPLICATION
PROPRIETARY AND CONFIDENTIAL
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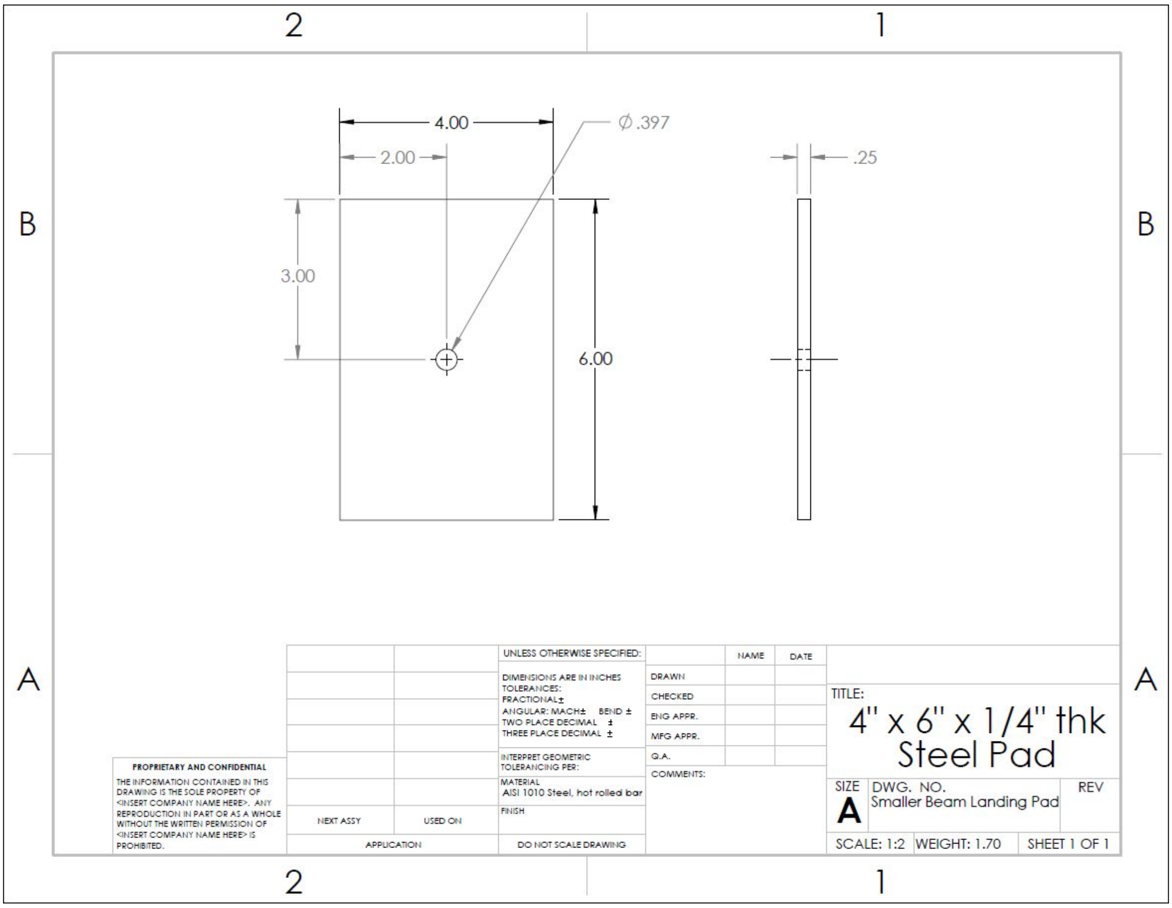
4.00
2.00
Ø .397
.25
3.00
6.00
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ±
ANGULAR: MACH ± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±
INTERPRET GEOMETRIC TOLERANCING PER:
MATERIAL
AISI 1010 Steel, hot rolled bar
FINISH
DO NOT SCALE DRAWING
NAME
DATE
DRAWN
CHECKED
ENG APPR.
MFG APPR.
Q.A.
COMMENTS:
TITLE:
4" x 6" x 1/4" thk Steel Pad
SIZE A
DWG. NO.
Smaller Beam Landing Pad
REV
SCALE: 1:2
WEIGHT: 1.70
SHEET 1 OF 1
PROPRIETARY AND CONFIDENTIAL
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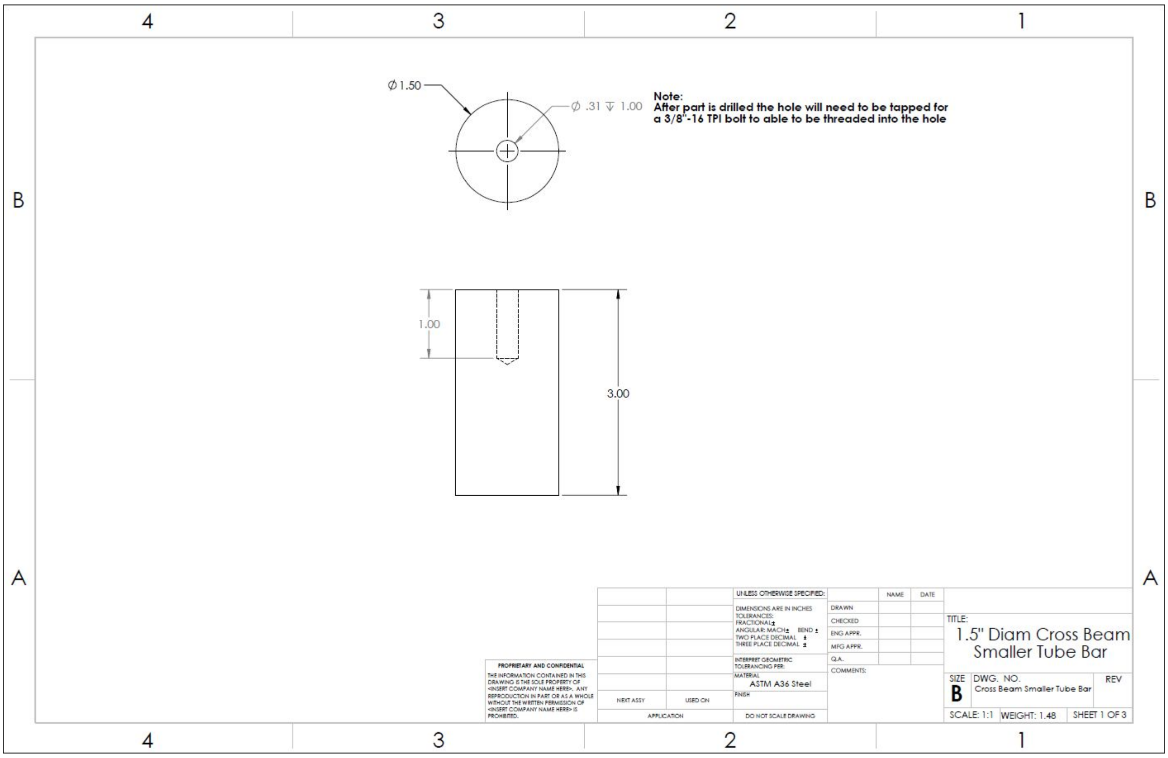
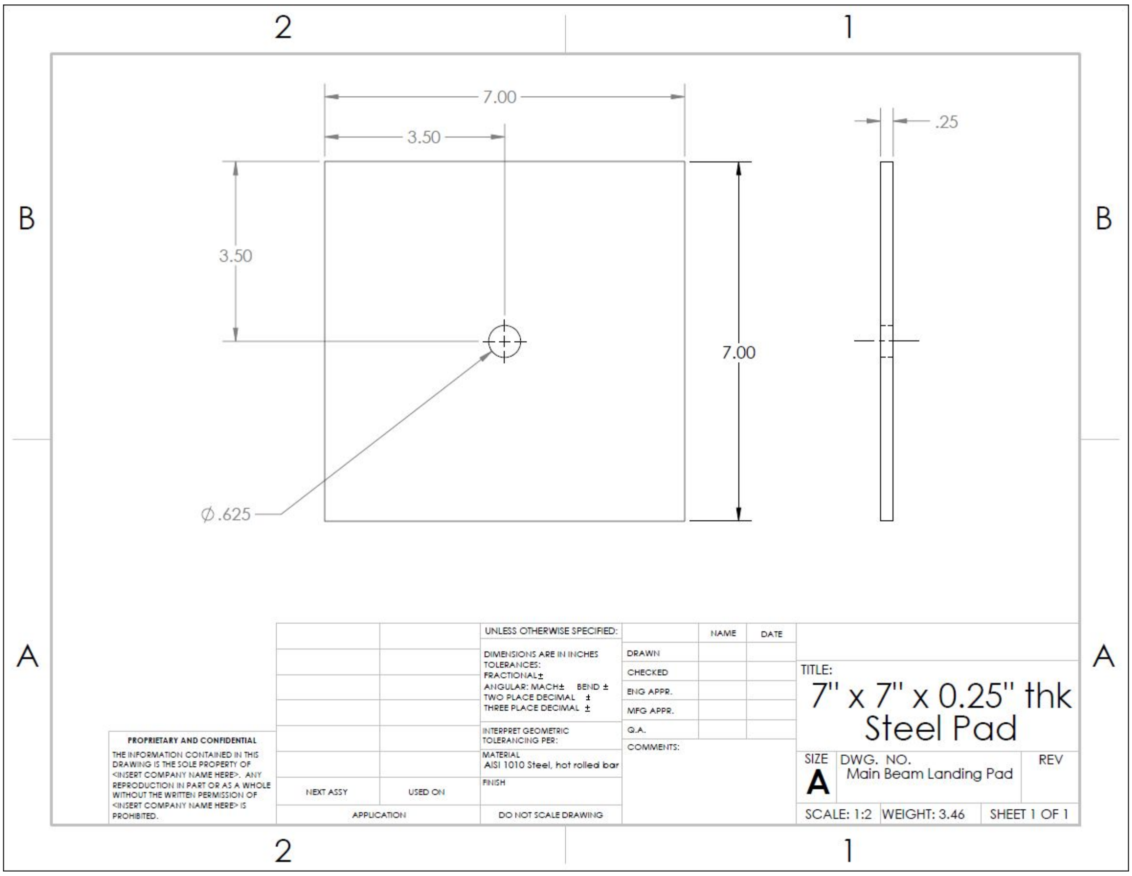
NEXT ASSY
USED ON
APPLICATION


Ø 1.50
Ø .31 ↧ 1.00
Note:
After part is drilled the hole will need to be tapped for a 3/8"-16 TPI bolt to able to be threaded into the hole
1.00
3.00
MATERIAL
ASTM A36 Steel
TITLE:
1.5" Diam Cross Beam Smaller Tube Bar
SIZE B
DWG. NO.
Cross Beam Smaller Tube Bar
REV
SCALE: 1:1
WEIGHT: 1.48
SHEET 1 OF 3



7.00
3.50
.25
3.50
7.00
Ø.625
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL±
ANGULAR: MACH± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±
INTERPRET GEOMETRIC TOLERANCING PER:
MATERIAL
AISI 1010 Steel, hot rolled bar
FINISH
DO NOT SCALE DRAWING
NAME
DATE
DRAWN
CHECKED
ENG APPR.
MFG APPR.
Q.A.
COMMENTS:
TITLE:
7" x 7" x 0.25" thk Steel Pad
SIZE A
DWG. NO.
Main Beam Landing Pad
REV
SCALE: 1:2
WEIGHT: 3.46
SHEET 1 OF 1
NEXT ASSY
USED ON
APPLICATION
PROPRIETARY AND CONFIDENTIAL
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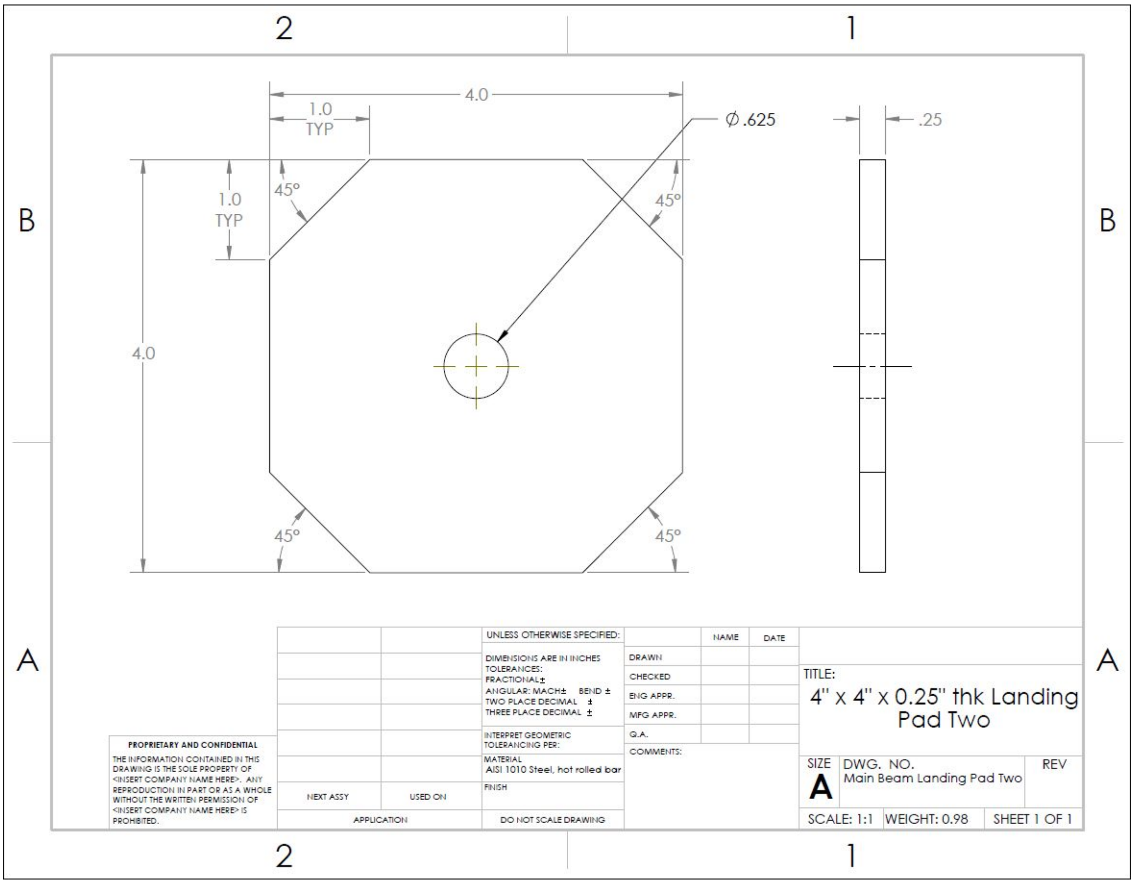

4.0
1.0 TYP
Ø.625
.25
1.0 TYP
45°
45°
4.0
45°
45°
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL±
ANGULAR: MACH± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±
INTERPRET GEOMETRIC TOLERANCING PER:
MATERIAL
AISI 1010 Steel, hot rolled bar
FINISH
DO NOT SCALE DRAWING
NAME
DATE
DRAWN
CHECKED
ENG APPR.
MFG APPR.
Q.A.
COMMENTS:
TITLE:
4" x 4" x 0.25" thk Landing Pad Two
SIZE A
DWG. NO.
Main Beam Landing Pad Two
REV
SCALE: 1:1
WEIGHT: 0.98
SHEET 1 OF 1
NEXT ASSY
USED ON
APPLICATION
PROPRIETARY AND CONFIDENTIAL
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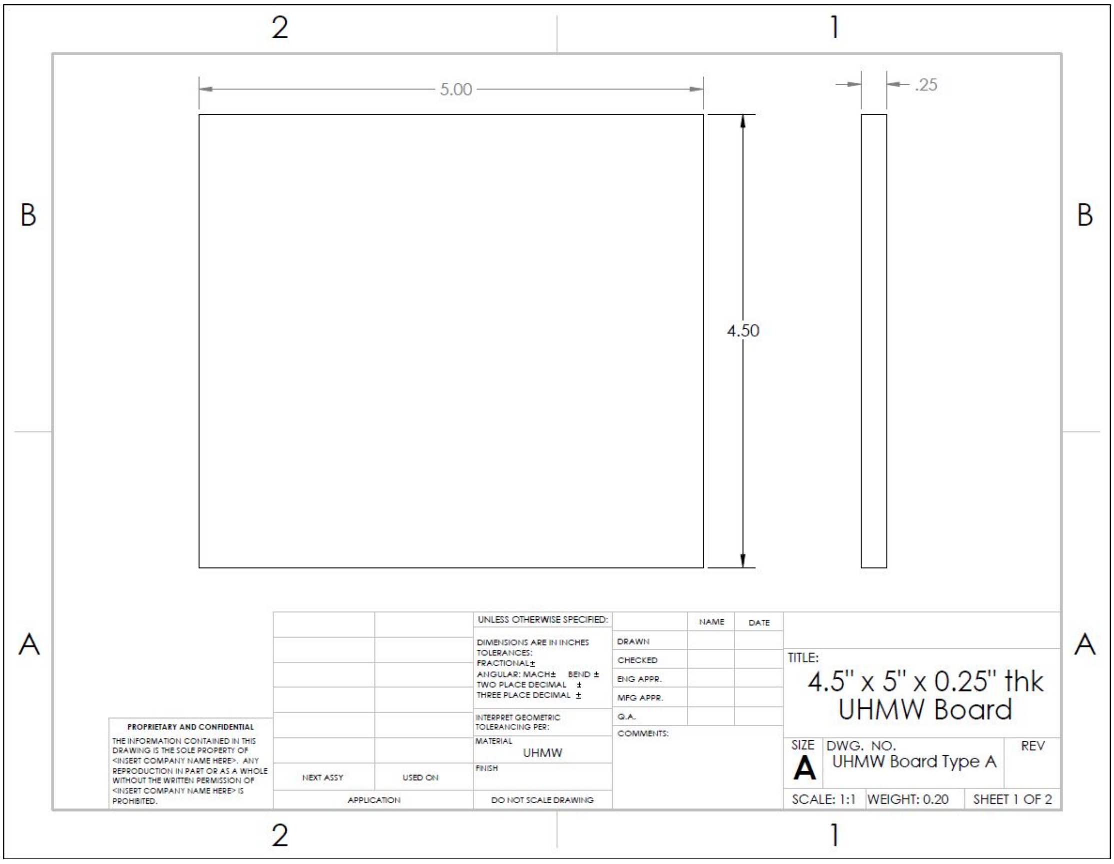
2
1
B
A
5.00
.25
4.50
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL±
ANGULAR: MACH± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±
INTERPRET GEOMETRIC TOLERANCING PER:
MATERIAL
UHMW
FINISH
NEXT ASSY
USED ON
APPLICATION
DO NOT SCALE DRAWING
NAME
DATE
DRAWN
CHECKED
ENG APPR.
MFG APPR.
Q.A.
COMMENTS:
PROPRIETARY AND CONFIDENTIAL
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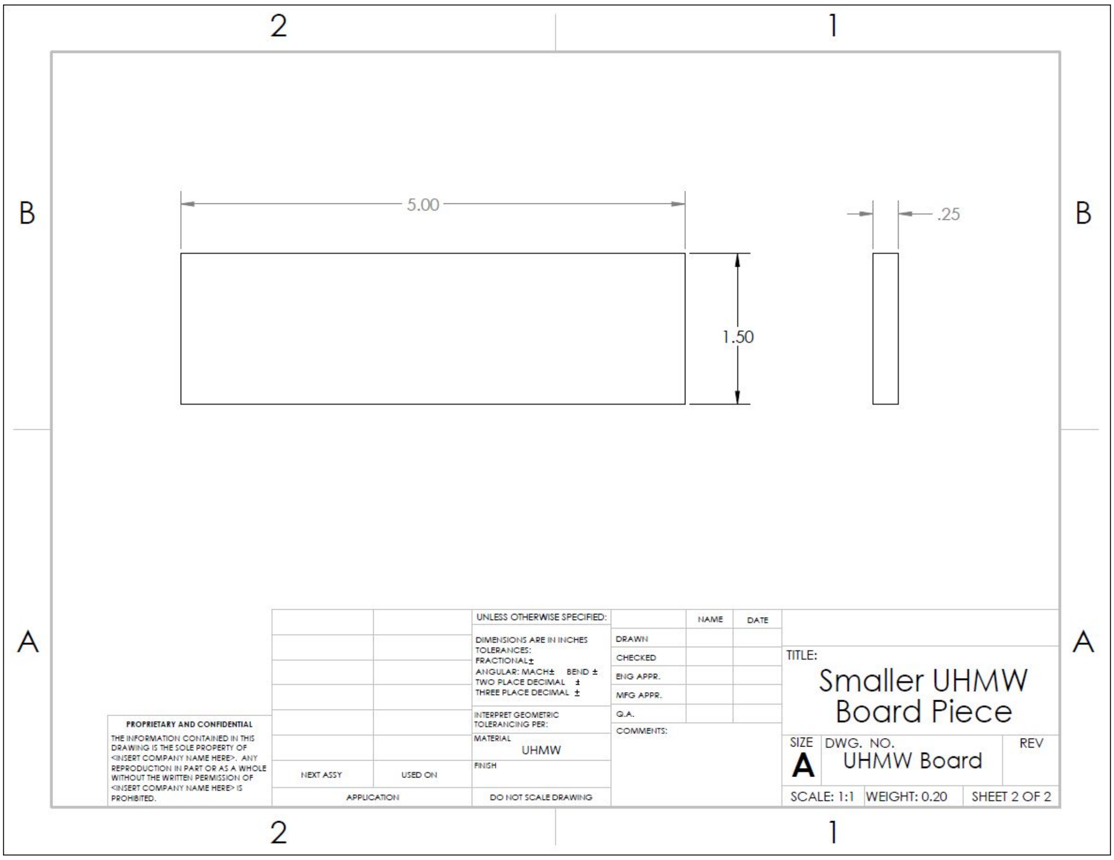
TITLE:
4.5" x 5" x 0.25" thk
UHMW Board
SIZE
A
DWG. NO.
UHMW Board Type A
REV
SCALE: 1:1
WEIGHT: 0.20
SHEET 1 OF 2


2
1
B
A
5.00
.25
1.50
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL±
ANGULAR: MACH± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±
INTERPRET GEOMETRIC TOLERANCING PER:
MATERIAL
UHMW
FINISH
NEXT ASSY
USED ON
APPLICATION
DO NOT SCALE DRAWING
NAME
DATE
DRAWN
CHECKED
ENG APPR.
MFG APPR.
Q.A.
COMMENTS:
PROPRIETARY AND CONFIDENTIAL
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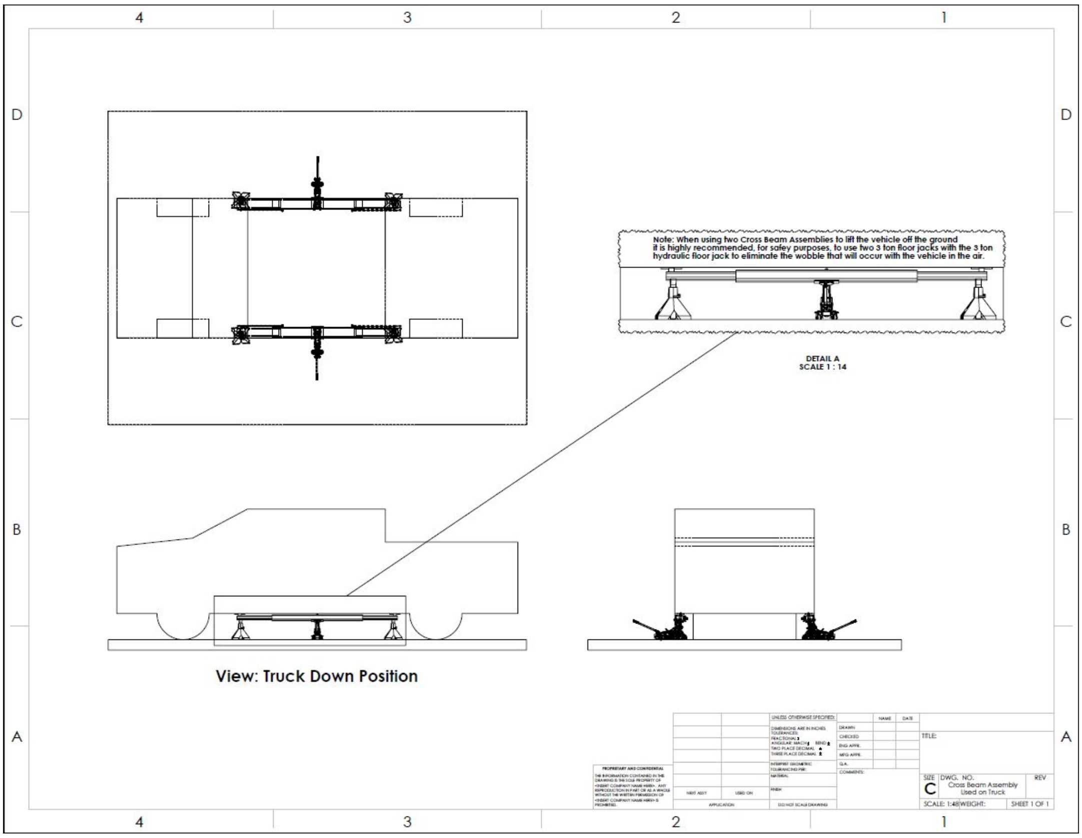
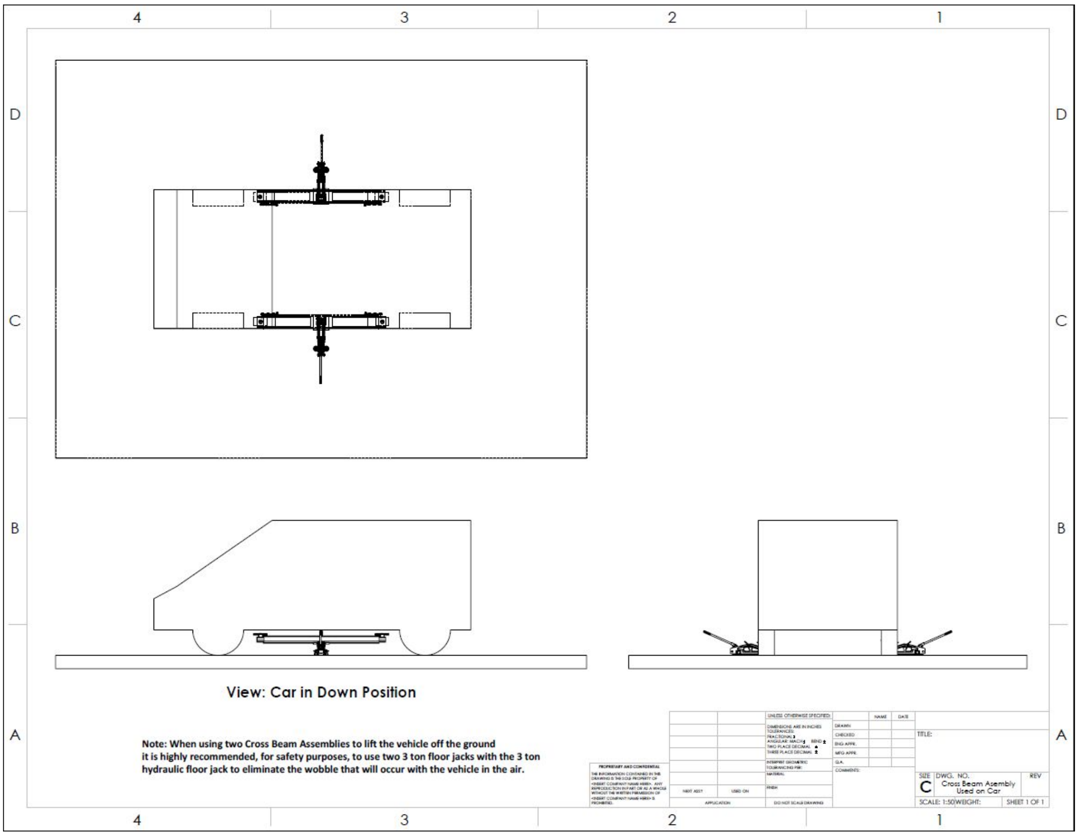
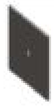
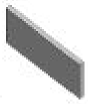
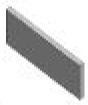
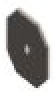
TITLE:
Smaller UHMW
Board Piece
SIZE
A
DWG. NO.
UHMW Board
REV
SCALE: 1:1
WEIGHT: 0.20
SHEET 2 OF 2


Note: When using two Cross Beam Assemblies to lift the vehicle off the ground
it is highly recommended, for safey purposes, to use two 3 ton floor jacks with the 3 ton
hydraulic floor jack to eliminate the wobble that will occur with the vehicle in the air.
DETAIL A
SCALE 1 : 14
View: Truck Down Position
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
TITLE:
SIZE C
DWG. NO.
Cross Beam Assembly
Used on Truck
REV
SCALE: 1:48
WEIGHT:
SHEET 1 OF 1
DO NOT SCALE DRAWING


View: Car in Down Position
Note: When using two Cross Beam Assemblies to lift the vehicle off the ground
it is highly recommended, for safety purposes, to use two 3 ton floor jacks with the 3 ton
hydraulic floor jack to eliminate the wobble that will occur with the vehicle in the air.
UNLESS OTHERWISE SPECIFIED:
TITLE:
SIZE C
DWG. NO.
Cross Beam Assembly
Used on Car
REV
SCALE: 1:50
WEIGHT:
SHEET 1 OF 1

9.1.2 Sourcing instructions

Table 11 - Sourcing Instruction Listing

SOURCING INSTRUCTIONS		
Cross Beam Assembly Components	**Name of Part**	**Description of Purpose**
	Main Beam Landing Pad	Main landing pad which will be connected under the center of rectangular beam to support the car jack
	Main Cross Beam Tube	Main cross beam rectangular tubing to be used on a car jack to lift up the vehicle
	Cross Beam Smaller Tubing (Opposite Side)	Main cross beam to be inserted in rectangular beam
	Cross Beam Smaller Tubing	Main cross beam to be inserted in rectangular beam
	UHMW Board Type 1	UHMW board to be used inside the main rectangular beam in order to decrease the friction cause by the inserted small tube
	UHMW Board Type 2	UHMW board to be used inside the main rectangular beam in order to decrease the friction cause by the inserted small tube
	Cross Beam Smaller Tube Bar	Cross beam smaller tube bar to be connected on cross beam landing pad
	Smaller Beam Landing Pad	Main landing pad which will be used on a small tube under vehicle assembly
	Main Beam Landing Pad Two	Main landing pad which will be connected under the center of rectangular beam to support the car jack
	Hex Nut 3/8-16	Hex nut to be used to hold the lock chain between rectangular beam and small tube
	Loctite Epoxy	Loctite epoxy to attach UHMW board inside rectangular beam (McMaster Carr Part No. 1813A2354)
	Hex Bolt 3/8-16x1	Hardware used to attach the safety chain to the smaller rectangular tubes of the assembly
	Hex Bolt 1/2-20x4.25	Harware used to hold the center octogan and square shaped steel plates the assembly

	Wide Flat Washer 1/2	Hardware used with 1/2" bolt
	Button Head Hex Bolt Part	Hardware used to attach the safety chain to the large rectangular tube of the assembly (Fastenal Part No. 92949A628)
	Hex Bolt 3/8-16x1.5	Hardware used to attach the safety chain to the smaller rectangular tubes of the assembly
	Safety Chain	Lock chain connected between the rectangular beam and small tube
	Regular Flat Washer 3/8	Hardware used to attach the safety chain to the smaller rectangular tubes of the assembly
	Hex Nut 3/8-16	Hardware used to attach the safety chain to the smaller rectangular tubes of the assembly

9.2 Final Presentation

The link below is to a pre-recorded video of our final presentation:

https://www.youtube.com/watch?v=L4a4JdFYRkc&feature=youtu.be

10 TEARDOWN

TEARDOWN TASKS AGREEMENT

PROJECT: Cross Beam Lifting Assy NAMES: Ramiz Ahmed INSTRUCTOR: Prof. Mark Jakiela

Nick Pusateri

Emel Saeidghafelpoor

The following teardown/cleanup tasks will be performed:

- No necessary teardown needed do to it being brought in on a wheel dolly
- Cleanup was required and fulfilled. The prototype was brought in on a dolly. After presenting the prototype we put the assembly back on the device and removed it from campus.
- The assembly is now in the possession of Ramiz Ahmed.

Instructor comments on completion of teardown/cleanup tasks:

OK. CLEAN UP A SMALL AREA OF ENGINEERING MACHINE SHOP

Instructor signature: ______________; Print instructor name: Mark Jakiela

Date: 8-12-19

(Group members should initial near their name above.)

NP

ES

RA

11 Appendix A - Parts List

Table 12 - Final Parts Listing

ITEM NO.	PART NUMBER	DESCRIPTION	MATERIAL
1	Main Beam Landing Pad	7" x 7" x 0.25" thk Steel Pad	AISI 1010 Steel, hot rolled bar
2	Main Cross Beam Tube	52" Long x 6" x 3" x 1/4" thk Rectangular Tubing	AISI 1010 Steel, hot rolled bar
3	Cross Beam Smaller Tubing_Opposite Side	5" x 2" x 1/4" thk Rectangular Tube	AISI 1010 Steel, hot rolled bar
4	Cross Beam Smaller Tubing	5" x 2" x 1/4" thk Rectangular Tube	AISI 1010 Steel, hot rolled bar
5	UHMW Board	1.5" x 5" x 0.25" thk UHMW Board	UHMW
6	UHMW Board Type 2	4.5" x 5" x 0.25" thk UHMW Board	UHMW
7	Cross Beam Smaller Tube Bar	1.5" Diam Cross Beam Smaller Tube Bar	ASTM A36 Steel
8	Smaller Beam Landing Pad	4" x 6" x 1/4" thk Steel Pad	AISI 1010 Steel, hot rolled bar
9	Main Beam Landing Pad Two	4" x 4" x 0.25" thk Landing Pad Two	AISI 1010 Steel, hot rolled bar
10	HNUT 0.5000-13-D-N	Hex Nut	Zinc
11	Loctite Epoxy	McMaster CARR Part No. 1813A234	Loctite Epoxy Glue
12	HBOLT 0.3750-16x1x1-N	Hex Bolt	Zinc
13	HBOLT 0.5000-20x4.25x1.25-N	Hex Bolt	Zinc
14	Preferred Wide FW 0.5	Wide Flat Washer	Zinc
15	92949A628	Button Head Hex Bolt	Zinc
16	HBOLT 0.3750-16x1.5x1-N	Hex Bolt	Zinc
17	Safety Chain	23" Long Chain (1/4" x 1")	Zinc
18	Regular FW 0.375	Flat Washer	Zinc
19	HNUT 0.3750-16-D-N	Hex Nut	Zinc

12 Appendix B - Bill of Materials

Table 13 - Final BOM with sourcing info

Type	Length (inches)	Width (inches)	Height (inches)	Diameter (inches)	Thickness (inches)	Material Type	Supplier	To Be Ordered By Wash U. (Y or N)	Quantity	Cost (each)	Total
Rectangular Tubing	52	6	3	-	0.25	1010 Hot Rolled Steel	Shapiro Metal Supply	Y	1	$80.00	$80.00
Rectangular Tubing	24	5	2	-	0.25	1010 Hot Rolled Steel	Shapiro Metal Supply	Y	2	$30.00	$60.00
Plate	6	4	-	-	0.25	1010 Hot Rolled Steel	Shapiro Metal Supply	Y	2	$5.00	$10.00
Plate	7	7	-	-	0.25	1010 Hot Rolled Steel	Shapiro Metal Supply	Y	1	$10.00	$10.00
Round Bar	3	-	-	1.5	-	A36 Hot Rolled Steel	Shapiro Metal Supply	Y	2	$12.50	$25.00
Plate	4	4	-	-	0.25	1010 Hot Rolled Steel	Shapiro Metal Supply	Y	1	$5.00	$5.00
UHMW Board (**Part No. 84765K113**)	12	12	-	-	0.25	Slippery, Abrasive Resistant, Glass Filled, UHMW	McMasterr CARR	Y	2	$22.12	$44.24
Epoxy (**Part No. 1813A234**)	-	-	-	-	-	Loctite 9460	McMasterr CARR	Y	1	$20.78	$20.78
Epoxy Gun (**Part No. 74695A71**)	-	-	-	-	-	-	McMasterr CARR	Y	1	$23.76	$23.76
Epoxy Gun Nozzle (**Part No. 74695A12**)	-	-	-	-	-	-	McMasterr CARR	Y	2	$1.30	$2.60
									Grand Total		**$281.38**

13 Appendix C – Complete List of Engineering Drawings

The link below leads to a zip file to download the SOLIDWORKS CAD files of the cross beam lifting assembly:

https://drive.google.com/file/d/17v13XL4DLG_YLJX1VmGvzZz81Zw09Te3/view?usp=sharing

14 Annotated Bibliography

1. Jacks, Industrial Rollers, Air Casters, & Hydraulic Gantries. ASME International, 2015, pp. 1–66, Safety Standards for Cableways, Cranes, Derricks, Hoists, Hooks, Jacks, and Slings

2.OSHA Standard 1926.959
"Department of Labor Logo UNITED STATESDEPARTMENT OF LABOR." 1926.959 - Mechanical Equipment. | Occupational Safety and Health Administration, www.osha.gov/laws-regs/regulations/standardnumber/1926/1926.959.

3."IBC Chapter 30: Automotive Lift Requirements." Automotive Lift Institute, www.autolift.org/ansi-standards-auto-lift-institute-knowledge-center/code-enforcement/ibc-chapter-30-automotive-lift-commentary/.

4."ANSI/ALI ALOIM Standard (R2013)." Automotive Lift Institute, www.autolift.org/ali-store/ansiali-aloim-standard-current-edition/.

5.AWS Bookstore. D1.3/D1.3M:2018 STRUCTURAL WELDING CODE-SHEET STEEL (AWS D1.3), pubs.aws.org/p/1763/d13d13m2018-structural-welding-code-sheet-steel.

6.AWS Bookstore. D1.4/D1.4M:2018 Structural Welding Code - Reinforcing Steel, pubs.aws.org/p/1852/d14d14m2018-structural-welding-code-steel-reinforcing-bars.

7."Fasteners for Use in Structural Applications." ASME, www.asme.org/codes-standards/find-codes-standards/b1826-2019-fasteners-use-structural-applications.

8."Y14.5 - Dimensioning and Tolerancing: ASME." ASME, www.asme.org/codes-standards/find-codes-standards/y14-5-dimensioning-tolerancing.

9."Verification of Allowable Stresses in ASME Section III, Subsection NH for Alloy 800H." ASME, www.asme.org/codes-standards/find-codes-standards/stp-nu-020-verification-allowable-stresses-asme-section-iii-subsection-nh-alloy-800h.