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Portable Snow-Bike

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Portable Snow Bike

By

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INTRODUCTION

Motivation:

This project was motivated by a need for a modification to allow a snow bike to become lightweight and portable.

Function Statement:

The portable snow bike will provide the strength and security of a rigid snow bike while providing the opportunity to be taken anywhere, which allows the bike to be used anywhere in the mountain.

Design Requirements:

- Weight between 20-30lbs.
- Fold down to fit into any backcountry backpack (30 litters min)
- Design to ride standing up
- It must not permanently deform during an impact landing onto snow
- Have a total manufacturing cost of less than $475.
- Have a total testing cost of less than $250.

Engineering Merit:

The engineering merit for this project comes from the application of engineering concepts and tools gained through the CWU MET program. This project requires research and analysis of material properties such as hardness and toughness to determine the appropriate material for the job. These concepts were used in Metallurgy. The designed bike will be required to withstand repetitive impacts. To ensure it does this, careful thought will be put into the structural shape of the bike using the tools gained in Statics, Strengths, and Dynamics. It will be necessary to analyze the forces the bike is expected to handle and determine the location and limits for bending stress, shear stress, and deformation. These values will also tie back into the tool material selection.

Scope of Effort:

The entirety of this project will be completed by myself individually. The scope of this project is to focus on the bike frame itself. This includes the material, shape, and structure of the frame. It is expected that the designed frame will see hard impact. Some analysis will be put in to calculate the failure limit of the frame. To cut down on time, and due to restrictions on resources, some parts, like the frame, may need to be reused or modified from a previous bicycle or scooter.

Success Criteria:

The success of the project is based on the performance of the final bike. The bike should be easy to carry, open, and use. Also, if it meets all the above requirements. The snowbike should be able to perform in any weather and snow conditions and be realistically (most adults should be able to carry it comfortably) portable.

Design and Analysis

Approach:

Aspects of the device such as portability, durability and weight are the major contributors to the design and are the primary objectives. Secondary objectives of the devise are to include safety, price and aesthetics. With the primary aspects in mind an approach to the problem can be started such as designing. And with a design one can analyze this device with standard statics, and strengths calculations

Design Description:

My snowbike will have an appearance like that of a scooter, the wheels of which are however replaced by runners or planks related to ski technologies, and which therefore includes a bearing rear runner and a directional front runner to which is connected a steering column.
The latter pivots in a sleeve firmly attached to the upper end of a stiff frame connecting said runners together. The lower end of the frame is fixed to a supporting base surmounting the bearing runner and which is provided for supporting the feet of the user. The latter is therefore standing upright on this support, his/her hands holding handlebars. surmounting the steering column and by means of which he/she steers the vehicle.

Benchmark:

The problem that is being solved is like the problem of the original snow bikes, and the design will be similar and serve a purpose that is similar as well. Except that the bike will be portable instead of being a fixed frame. Solution will consist of using similar materials and look to make it so that the two bikes will match. But the function and weight constraints will be different. Most importantly its portability!

Performance Predictions:

Some of the performance predictions that are given are the size and weight predictions. The weight of the snow bike itself needs to be so that an adult would be willing to carry it (no more than 40lbs). The snow bike will be able to withstand the weight of a 180lbs person while going fast down the mountain on a powder day.

Description of analysis:

A few things that need to be analyzed are the welding that will be used to make the frame. Some of the calculations done are listed as followed:

- Max Moment and Shear for each tubing
- Weld Width
- Force on each tube

- Frame Diameter
- Frame Deflection

Scope of Testing and Evaluation:

The testing will take place in a hill or at a ski resort such as Stevens Pass, somewhere with space so we don't run into other people in the testing phase. The testing will consist of folding the snow bike and placing in into a backpack and taken into the mountain top. Once there, the bike will be unfolded and ridden like a normal snow bike. The snowbike will be ridden at multiple speeds and for a certain amount of time to make sure that there are no problems with the frame breaking. It will also be tested against small drops and jumps.

Analysis:

The first analysis as shown in Figure ? Appendix A is the total amount of force provided by the rider onto the frame. First an impact at 35mph with a .5 second impulse was calculated, since in a real-life event unless hitting a solid concrete wall there would be a longer impulse time in which the force would be slightly dissipated through the softness of the snow, rider and shock absorbed by the frame. Since this device will be in conditions where it is critical it can take a harsh crash, miles and possibly days away from a repair shop the goal is to emphasize an impact in the worst-case scenario of a .5 second impulse. The impulse force is 733 lbs.

The second analysis as shown Figure ? is finding the impact force from a 7.5ft drop off a cliff into 2 feet of powder with an impulse of .5 seconds due to the velocity going forward and the board surface area on the snow spreading out the weight distribution as well as the human legs acting like a dampener much like a spring under pressure. The impact force is 1725 lbs.

I also analyzed all the welding components. How wide they should be between two frame pieces and critical parts.

The third analysis is that the fork positioned at the lower end of the steering column should damp impacts, vibrations, etc. in the axis of said steering column, the design should further be able to provide interaction between the horizontal movements of the steering column and the positioning of the bearing runner. In fact, to operate optimally, the latter would have to follow the movements of the directional runner by reproducing them just after it.

The fourth analysis will be the combined existence of the aforementioned base/runner mechanical connections and of the division of the supporting base into two portions notably allows complex displacements of the base supporting the feet of the user to be performed according to stresses imposed by the user and retransmitted through the handlebars, on the one hand, to forces individually exerted by the feet of the user on the other hand, either on the rear portion of the base or on its front portion, and even to reactions caused by the ground or the quality of the snow.

The fifth analysis is the turning arc, to turn, the user positions himself/herself on a lateral edge, the runner bends and describes a circular arc which defines the trajectory. The more the circular arc is pronounced, more the guiding and the bend are narrow. On very hard snow, edgings are very important, as they allow one to turn despite the very slipping nature of the ground.

Device: Parts, Shapes, and Conformation:

The look of this design will consist of being much like a normal bike frame with two snowboards instead of tires and the fact that the frame folds like a scoter. The hollow beams that will be used for assembly will be about 1.25" x 1.25" and welded together because that is preferred for the final look. Pins and nuts and bolts will be used when needed. The boards that the bike will be sitting on will be made of something that I still have not decided. If time is available, the frame maybe be painted.

Device:

The shape of the device is of functionality and meeting the requirements. Physical appearance has nothing to do with the design besides the color it will be painted to be. The device purpose will be to withstand a 180lbs person while riding in any snow and terrain condition. The bike will be easily folded from its original shape.

Device Assembly:

Tolerances:

Of primary issue when designing is stacking tolerances as the stacking of the tolerances, if the tolerances are too tight parts will not fit and if too loose parts will not function as intended.

Technical Risks Analysis:

Risks involved in the manufacturing of this device will be the machining of the part since more than likely it will be machined from aluminum which is financially risky since this material is expensive to purchase and machine. Machining is usually done with coated carbides since, however this can be minimized using HSS (high speed tool steel) for such a low run number of parts. The first batch of parts will be machined from steel to dial in the manufacturing since it is readily available and it is cheap compared to that of aluminum.

Safety factors:

The safety factors are by the component rather than that of the whole system. Pieces such as the frame will have a safety factor of 2 due to wear and spikes in pressures causing fatigue while the rest of the components will have a safety factor of 1.5 since they will experience less fatigue and wear. I chose 1.5 since if this design fails there is an increased risk of injury for the rider and increase risk the rider may not be able to get out of the mountains.

Operation Limits:

Limits of the device will be the size of the rider (0-180 lbs.). The type of impact the bike will experience will be limited to impacts of less than 1500 lbs. and to 15ft vertical of drop onto 2ft of soft snow. Temperature limitations are to -30 Celsius as at this point other factors such as the bikes construction will be compromised.

Methods and Construction

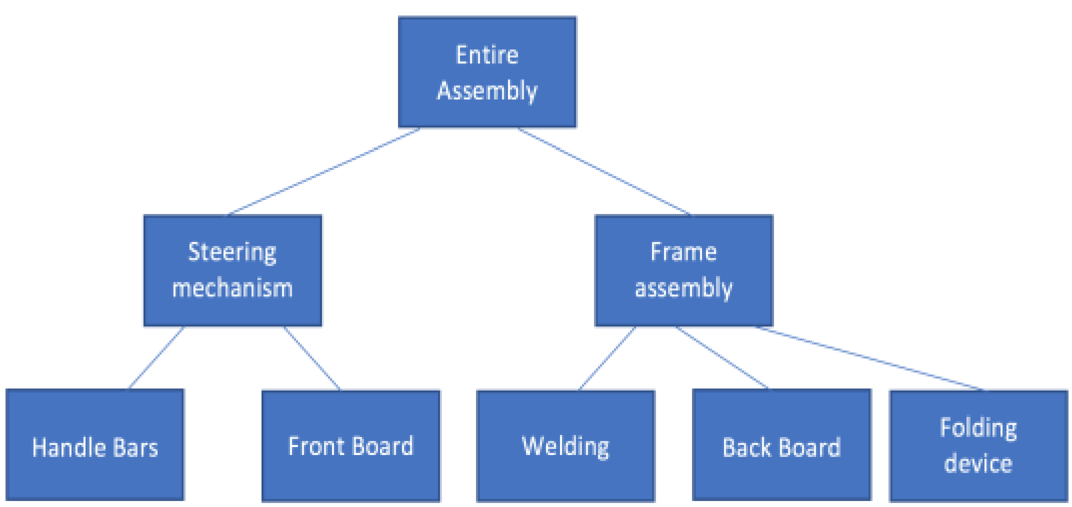
Construction:

The construction of this project will take place over the period of winter quarter. I will try to find as many as possible existing old bike frames I will modify. The final frame will be welded into place by hand. The frame will be measured, cut, and precision mitered to the appropriate dimensions. Frame size will run from 19-25 inches (48-63 cm). The assembled frame will be placed into jigs and checked for proper alignment. I am hoping that adjustments will be possible while the frame is still hot and malleable. The excess welded metal will be cleaned off by gridding until smooth. After the metals have cooled, further precision alignments will be made. The frame will be painted, not only to create a more finished appearance, but also to protect the frame. The frame is first primed with an undercoat and then painted by hand with the help of spray.

Description:

This project will consist of the main assembly that will be welding the frame beams together so that they have a nice uniform look and stability. The frame will then be attached to the boards underneath, and the handlebars will be the last piece.

Drawing Tree:



Manufacturing issues:

Some of the manufacturing issues that may be of concern are listed below:

- Welding spots need to be done correctly on all drawings, because one tube may get welded to the wrong location or wrong part.
- Cutting the tubes for the frames in the wrong angle and/or size

Testing Method

Test Design Guide

Introduction:

In this report, three tests on the Snow-Scooter were done. The first was a weight test to see how much heavier the product was than the original part. The next test was to test if the bike will work in real life in the snow and on the slopes of a ski run and if it will withstand a real-life jump, and if it can be assembled on the mountain easily. The last test was to see if there was permanent deformation done to the binding after a 650-lb. compressive force was loaded onto the frame through the simulating a 15ft drop onto 2ft of powder or 7.5 ft. onto compact snow. These tests were in line with real life functionality and a non-permanent deformation. All testing was done following the testing schedule shown in Figure 1 in the appendix.

Method/Approach:

Resources used for the testing of this product included personnel such as Matt Burvee to help run the tensile tester and Andrew Kastning and his resources to acquire data capture devises such as a data logger for the strain gauge values. Procedure of tests were done using a scientifically approach to testing for the three important physical requirements. However, these tests had operational limitations such as accuracy of the testing devises such as the straight edge having limited precision and the scale used to weigh the scale having limited precision to the thousandth of a pound and the strain gauges having precision to the hundredth of a pound. Data that was acquired was hand recorded for the weight requirement and was computer generated from the data logger recording max values from the strain gauges. Data values that were recorded were tabulated using excel spread sheets within the same day they were produced.

Test Procedure:

Weight Test

Equipment: Table scale accurate to the thousandth of a pound, certified 100-gram weight.
Procedure:

1) Calibrate scale using certified weights such as a 100-gram weight and convert it to pounds.
2) Disassemble frame from board so that the frame being weighed only includes the welding pieces and all its components mounted to it.
3) Place frame onto the scale.
4) Record this value and tabulate data.

Real Life Test Ride

Equipment: Machinist straight edge (Straight within .005" over a 1ft span), Measuring tape 15ft.)

Set of Pin Gauges

Procedure:

1) Inspect gear and check for cracks and any buckle issues at the welded parts of the frame and holes.
2) Use the Pin gauge set to check the pin hole sizes prior to assembly.
3) Once inspected disassemble the bike, put bike in back pack.
4) Hike up a ski resort slope that has a jump that one can reach at least 15ft vertical with 2 ft. of powder snow (dry snow) or 7.5ft vertical onto compact snow.
5) Once the rider has hike to where they want to ride from take the bike off the backpack.
6) Insert pins in each hole to retain the frame.
7) Clip bike together using correct coupling in the center tube.
8) Insert tube onto the mounting brackets and adjust the bike by sliding the two halves by each other to position the mounting plates in relation to the boards.
9) Lock bike in using the pins and inserting them into the mounting holes.
10) Ride the bike system down the mountain once and get use to the feel of the ride.
11) Repeat steps 1 through 10 until the rider feels comfortable enough to hit a jump of either the required 15ft onto 2 ft. of powder or 7.5 ft. onto compact snow.
12) When done jumping and riding the bike, disassemble frame from the board and check the coupling straightness with a straight edge such as a machinist ruler.
13) Use pin gauges to check for any deformation in hole sizes compared to previous recorded data.
14) Tabulate data.

Tensile Tester compressive test:
Equipment: 2 prewired strain gauges, data logger, laptop, 1 hour epoxy, polishing pad, rubbing alcohol, 2 ½"x ½" x 10" piece mild steel flat bar, 3 ½"x 3 ½"x 12" Wood post.
Procedure:

1) Polish surface of mounting spots directly on top of where the frame sits over the mounting plate.
2) Clean with rubbing alcohol and apply a strain gauge directly above the fastening pin hole parallel with connection hole with 1hr epoxy and allow to dry for one hour. (Make sure the strain gauge is centered over the mounting hole.)
3) On top of the main frame directly centered apply one strain gauge in the horizontal position running parallel to the bottom strain gauge.
4) Next wire terminal one to the bottom strain gauge, terminal 2 to the top strain gauge.
5) Connect to data logger and connect data logger to a computer with the data loggers running programs.
6) In the software that has been supplied with the data logger zero all the micro strain gauge readings.
7) Insert a 6inch long 3.5"x3.5" piece of wood post into the frame so that it lies perpendicular to the flat bar allowing the tensile tester to compress the frame as a foot would.
8) Put the entire setup into the tensile tester so that the tester can compress the 3.5"x3.5" wood post into the frame.
9) Run the tensile tester to 650 lbs. and record max values of each strain gauge in increments of 100 lbs. each time and record.
10) Unload the tensile tester and repeat process of loading and record max values again and check for extreme outliers.
11) Load data into an excel spread sheet.

Deliverables:

Weight test

Parameter values:

11.8 lbs. via weighting the original frame the same way
Calculated Values:
12.41 lbs. using scale
Success Criteria values:
Up to a 5% increase in weight would be acceptable
Conclusion: The frame exceeded the success criteria values by 1%.

Ride Test

Parameter values:
.000" of permanent deflection
.000" of hole deformation

Calculated Values: I am calculating
.000" of permanent deflection and
.000" of hole deformation

Success Criteria values:
0-.005" permanent deflection
0-.002" permanent hole deformation

Conclusion: The frame had no permanent deflection and/or deformation from the ride testing.

Compressive Test:

Parameter values:
I was willing to have it test up to -1800 strain so it wouldn't break the frame.
It got close to that value at 650 lbs., so I stopped there.

Calculated Values:

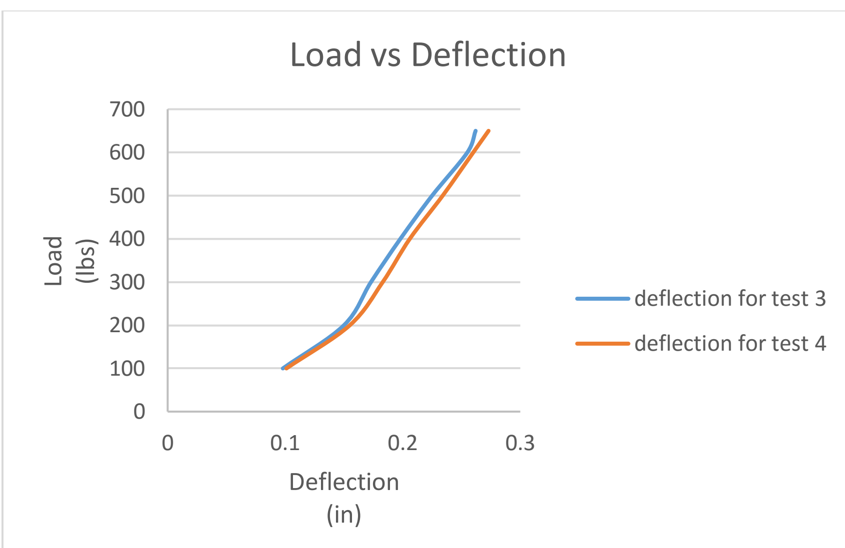
strain#1 - middle, compression

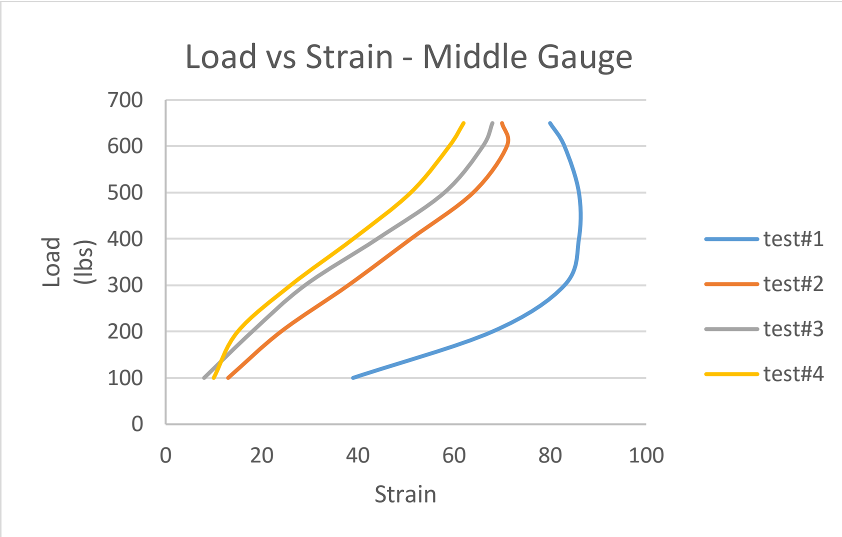
load	**test#1**	**test#2**	**test#3**	**test#4**
100	39	13	8	10
200	68	24	18	15
300	83	38	29	26
400	86	51	44	39
500	86	64	58	51
600	83	71	66	59
650	80	70	68	62

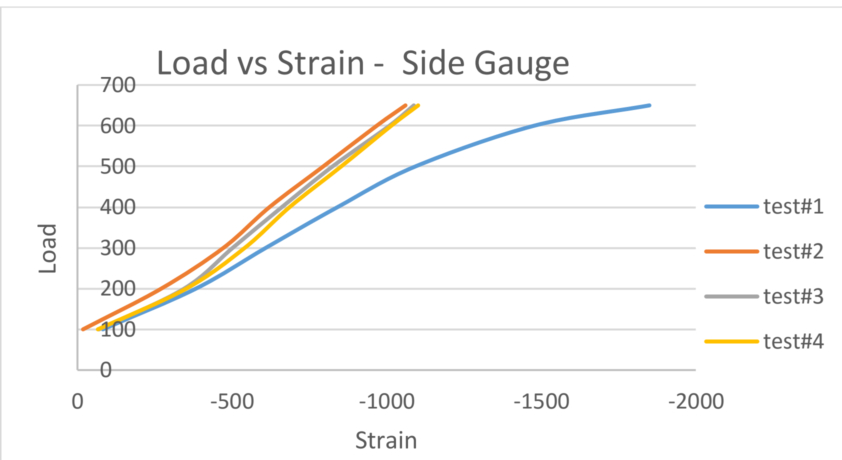
strain #2 - side -tension

load	test#1	test#2	test#3	test#4
100	-82	-18	-70	-66
200	-383	-271	-345	-352
300	-609	-472	-502	-541
400	-841	-621	-661	-686
500	-1093	-795	-825	-853
600	-1477	-968	-1009	-1015
650	-1850	-1061	-1088	-1102

deflection for test 3	deflection for test 4
0.098	0.101
0.15	0.155
0.173	0.183
0.198	0.206
0.225	0.234
0.255	0.260
0.262	0.273







Success Criteria values
Yield strength values of a36 steel at 245,000 psi
Conclusion: The only value that is conclusive and matters in this test with the inside gauge because it has the least amount of cross sectional area about the bending axis. The frame performed as expected and after 650 lbs. applied, there was no permeant damage.

Budget/Schedule/Project Management

The main parts for this assembly will be purchased through Haskins Steel so that the CWU discount can be received so that the project will cost less money. In doing research this can save a couple hundred dollars when receiving this discount. The other parts for this assembly will be purchased online through McMaster Carr. I will try and buy old used bikes and scooters at pawn shops or just asking around the school for used broken parts. I should be able to acquire most of the parts needed for this project basically free, but if all else fails I will purchase the material as mentioned above.

Labor:

This product will have $0 of labor involved as the designer is a machinist and fabricator and all work is in house, besides anodize rates.

Estimate of total project cost:

The estimated total cost of this project is in the ball park of $475.00.

Funding source:

The funding of this project will be from Tiago Sousa.

Proposed Schedule:

Out lined by the schedule in the Gantt chart is the primary source of scheduling for the project to management. The schedule shows project completeness and hours needed to complete the project's design, analysis, rendering, and projected manufacturing of parts. The Gantt chart also keeps track of timing issues conflicts and deadlines in which the project must meet to be on track with the progress of this product.

Human resources:

Primary human resources are those found at the CWU Mechanical Engineering dept. for student development through engineering practices.
Contributors to this project have been: Dr. Johnson, Ted Bramble, Matt Burvee, Charles Pringle.

Physical Resources:

Hogue Laboratories on Central Washington University campus in Ellensburg WA.

Project Management:

One big consideration in this project will be safety. This is because of multiple reasons. One because this project requires some welding to be done for the structure of the frame. Safety precautions must be made so that the person welding the structure will not get hurt of any sort while performing this task. One safety precaution will be masks and gloves to be worn while welding the steel. Also, two people in the room at all time to make sure the safety of the welder. The second safety caution for this project is when the final product is finished it must be tested perhaps on an actual hill with snow.

Conclusion:

This project is expected to be a successful due to design requirements such as weight, manufacturability of the components and experience of the machinist making the parts.

The weight will make this design successful due the weight reduction of this model of snowbike compared to that of the benchmark. Weight is of primary concern do to the user and today's snowboarder or skier wants the lightest gear on the market.

The manufacturability will also make this project a success due to the limited use of expensive and tough materials such as aluminum and stainless steel. Aluminum is the primary metal used in terms of volume of material being removed due to the high level of machinability and time to remove material from stock.

The experience of the machinist making the parts will make this project a success as he has years of CNC programming and manual machining experience using CNC mills, manual mills, CNC Lathes and manual lathes. The Machinist is also an experienced fixture fabricator as he has 6 years of welding and fabricating experience.

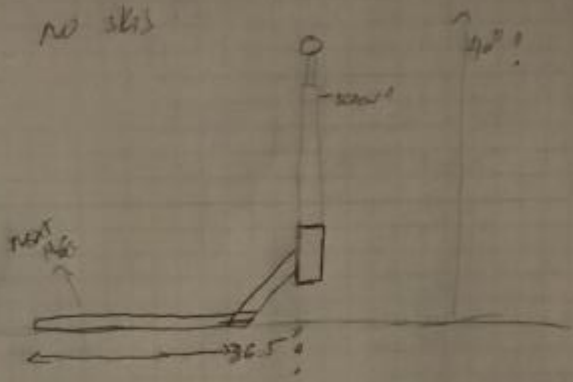
Because of the weight and machinability of the product and the experience of the manufacture, this project is projected to be a success when completed in spring of 2017.

Acknowledgements:
- Matt Burvee's support regarding manufacturing procedures and needs.
- Dr. Johnson's support regarding the metallurgy and senior project critique.
- Charles Pringle's support for project and design critique.
- Central Washington University.

Appendix A: Analysis

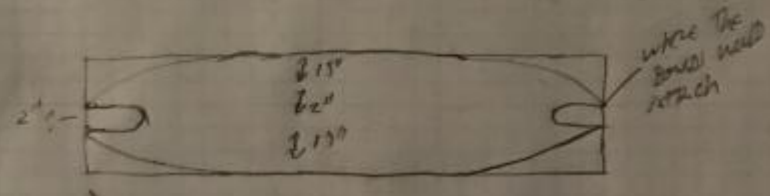
Snow bike | 10-18-16 | Team

no skis



37-40 tall!

30-40, narrow!



Acrylic deck?

SNOW BIKE | 10-18-16 | TSOUSA | 1/

IMPACT ANALYSIS #1

GIVEN: - RIDER WEIGHT 180 LBS
- BIKE 50 LBS
.5 SEC IMPACT
@ 35 MPH

FIND: IMPACT FORCE

ASSUME EQUAL LOADING BETWEEN FRONT AND BACK

MOMENTUM = $\vec{P} = m\vec{v}$

SOLUTION: $F = ma$

$230^{lbs} \left(\frac{1kg}{2.20462 lbs}\right) = 104.326 kg$

$F = 104.336\ kg \left(9.81 m/s^2\right) = 1023.44 N$

IMPULSE: 35 MPH TO 0 MPH IN .5 SEC

$F = m \frac{\Delta v}{t}$ $F = 104.326\ kg \left(\frac{15.64 m/s}{.5 sec}\right) = 3,263.31 N$

35 MPH ⇒ 15.64 m/s

3,263.31 N ~ TO LBS 733.62 LBS

IMPACT FORCE = 733.62 LBS

REFERENCE: PHYSICS FOR SCIENTISTS & ENGINEERS 3RD EDITION PG-225 EXAMPLE 9.1

3-0235 — 50 SHEETS — 5 SQUARES
3-0236 — 100 SHEETS — 5 SQUARES
3-0237 — 200 SHEETS — 5 SQUARES
3-0137 — 200 SHEETS — FILLER
COMET

IMPACT ANALYSIS #2 (SNOW PACK)

GIVEN: ·230 LBS
·2 FT FRESH SNOW (POWDER)
·.5 SEC OF IMPACT

7.5 FT DROP

SPRING
431.25 lb/in

FIND: IMPACT FORCE FROM 7.5 FT INTO 2 FT OF SNOW

SOLUTION $230^{lb}\left(\frac{7.5\ ft}{.5\ sec\ impulse}\right)-\left(431.25\ {}^{lb}/_{in}\ (4\ in)\right)$

$= 1725\ lbs$

REFERENCE: PHYSICS FOR SCIENTIST & ENGINEERS
3RD EDITION PG 256 HOOKS LAW
PG 225 IMPULSE

ANALYSIS #3 THE STRESS IN A ROUND BAR (DOWN TUBE) HAVING A DIAMETER OF 83 mm (STANDARD) AND SUBJECT TO A DIRECT FORCE OF 1725 LbS

SOLUTION: 1725 LbS about 7673.18 N

SO, $\sigma = \frac{F}{A}$

$$A = \frac{\pi (83\,mm)^2}{4} = 5410.6\ mm$$

$$\sigma = \frac{7673.18\,N}{5410.6\ mm} = \boxed{1.42\ MPa}$$

REFERENCE: MACHINE ELEMENTS IN MECH DESIGN 5th EDITION.

ANALYSIS #4: DEFORMATION

GIVEN: LOAD 180 LBS, SQUARE BAR (TOP TUBE) 12MM ON A SIDE (STANDARD) AND $L = 1.65\,m$ (ALSO STANDARD)

FIND: STRESS AND AXIAL DEFORMATION IF IT IS MADE FROM ALUMINUM 6061-T6 (THIS IS WHAT I WANT TO USE)

SOLUTION: - 1.65M INTO MM = 1650MM
- 180 LBS INTO KN = 0.800 KN

SO, $\sigma = \frac{P}{A} \Rightarrow A = (12mm)^2 = 144\,mm^2$

$\sigma = \frac{.800N}{144mm} = 0.0055\ MPa$

$\delta = \frac{PL}{EA} = \frac{(.800)(1650mm)}{(69)(144mm^2)} = \frac{57292\ mm}{69}$

$\delta = 0.0001328$,
SO BASICALLY NOTHING

ALUMINUM
6061-T6
$E = 69\ GPa$

SNOW BIKE | 12-02-16 | TSOUSA | 5

ANALYSIS # 5 : STRENGTH

SAE 301
STAINLESS STEEL ROD 1/2 AND

IF I USE A STEEL ROD WITH A DIAMETER OF .60 IN (ALSO STANDARD FOR BIKE FRAMES) IT IS GOING TO BE MACHINED. LETS USE A 99% RELIABILITY.

FIND: ACTUAL ENDURANCE STRENGTH

SOLUTION: $S_U = 150$ KSI ; $C_S = 1.0$ $C_{ST} = 0.80$

$S_n = 52$ KSI $C_m = 1.0$ $C_R = 0.75$

SO, $S_n' = (52 \text{ KSI})(1.0)(1.0)(.80)(0.75) = \boxed{31.2 \text{ KSI}}$

PRETTY STRONG IF I WANTED TO USE IT FOR THE FRAME

Tiago Sousa | MET 420 | 2/22/17 | 1/2

6-1-7 $\sigma = \frac{MC}{I}$ $I = \frac{BH^3}{12}$

$$\sigma = \frac{MC(12)}{BH^3}$$

400 lbs ↑

$$= \frac{(10)(400)(.5)(12)}{(2.5)(1)^3} = 9600 \text{ psi}$$

$$\sigma = \frac{MC(12)}{BH^3} = \frac{(10)(200)(1.25)(12)}{(1)(2.5)^3}$$

$$= 1920 \text{ psi}$$

→ 200 lbs

Tiago Sousa | MET 420 | 2/22/17 | 2/2

Deflection $\delta_{MAX} = \frac{PL^3}{3EI}$

P = LOAD

L = LENGTH

$E = 29 \times 10^6$

$I = \frac{BH^3}{12}$ or .2083

$$\theta_{max} = \frac{400(10)^3}{3(29\times10^6)(.2083)} = 0.02207 \rightarrow 400 \text{ lbs}$$

$$\theta_{max} = \frac{200(10)^3}{3(29\times10^6)(.2083)} = 0.011036 \rightarrow 200 \text{ lbs}$$

1" tube OD

Lest assume: wall thickness = 0.1"

STRESS

$A = \pi r^2 = 0.283\ in^2$

$\sigma = \frac{P}{A} = \frac{160}{0.283} = 45\ PSI$

Person weight = 160 lbs

STRAIN (DISPLACEMENT)

δ = Deflection

L = Length

ε = The strain

$\varepsilon = \frac{\delta}{L} =$

Material	Modulus of Elasticity (PSI)	Yield Strength (PSI)	Density (lb/in³)
Steel	30,000,000	60,000 - 150,000	0.285

TIAGO SOUSA | MET 4120 | 01/04/17 |

LET ASSUME 20" LONG TUBE; WALL THICKNESS OF 0.02"
1" OD;

WEIGHT OF MATERIAL = W = 0.285 × 0.062 × 20 = 0.35 lbs

ID = .96
OD = 1

$$A = A_0 - A_1$$

$$A = \frac{\pi D^2}{4} - \frac{\pi (ID)^2}{4}$$

$$= \frac{\pi (1)^2}{4} - \frac{\pi (.96)^2}{4}$$

$$= 0.062 \text{ in}$$

LET ASSUME P OF 2000 lbs (WE DON'T WANT TO BREAK THE FRAME)

$$\text{SO, } \sigma = \frac{P}{A} = \frac{2000}{0.062} = 32{,}300 \text{ PSI}$$

Axial Loading

$$D = \frac{(P*L)}{AE} = \frac{2000(10)}{(0.062)(30000000)} = .0021 \text{ in}$$

Tube Inertia

$$I = 0.049 * [OD(4) - ID(4)]$$
$$= 0.0074 \text{ in}$$

Bending of Tube

$$S = \frac{M(y)}{I}$$
$$= 135.223 \text{ psi}$$

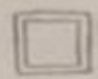
M = Applied moment
Y = Distance from center
I = Inertia

Deflection (Radius of Curvature)

$$R = \frac{E(I)}{M}$$
$$= 1.64 \text{ inches}$$

E = Elasticity
I = Inertia
M = Moment

Given:



1¼ x 1¼ x 1/8 Square Tubing
A-36 Steel

M_A = 3122.03 lb·in
M_B = 1851.84 lb·in
M_C =

Find: Weld width for each moment.

Solution

$$S_w = bd + \frac{d^2}{3}$$

$$= 1.25(1.25) + \frac{1.25^2}{3}$$

$$= 2.08 \text{ in}^2$$

Calc for M_A:

$$F = \frac{M}{S_w}$$

$$= \frac{3122.03 \text{ lb in}}{2.08 \text{ in}^2}$$

$$F = 1500.97 \text{ lb/in}$$

Width of Weld:

$$= \frac{1500.97 \text{ lb/in}}{9600}$$

$$\boxed{= 0.156 \text{ in Weld}}$$

Calc. For M_c:

M_c = 6000lb·in from methods of Section

$$F = \frac{M}{S_w}$$

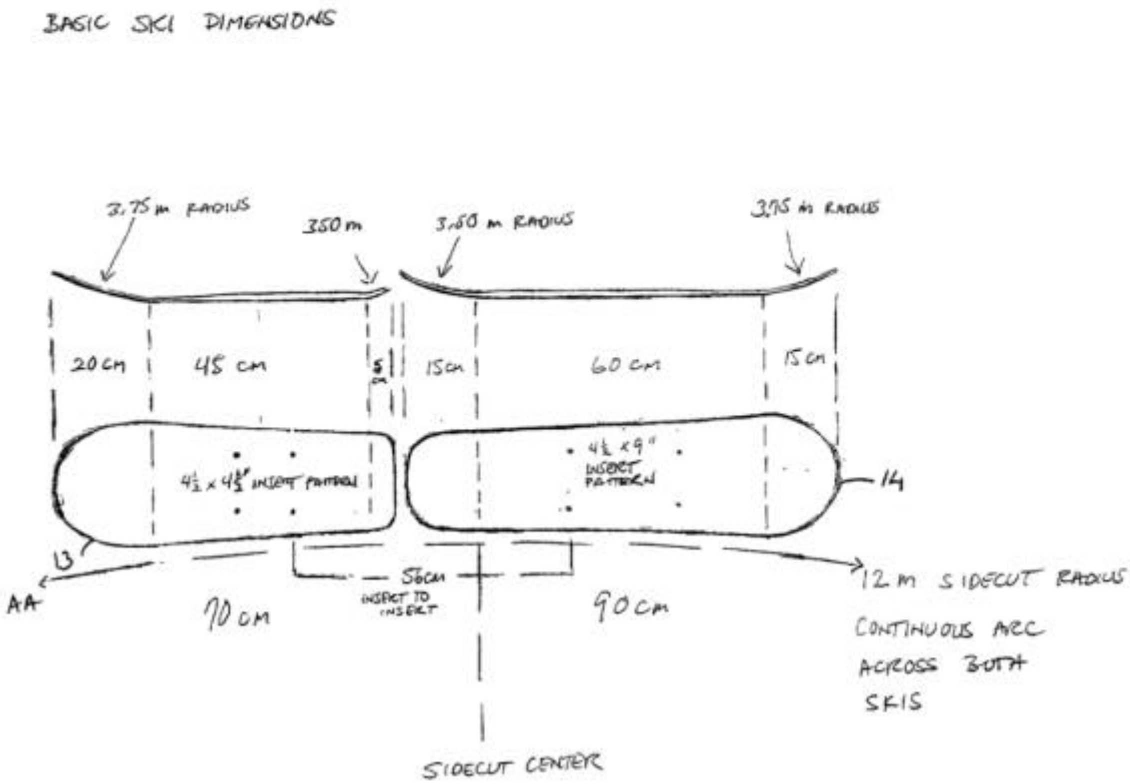
$$= \frac{6000\,lb\cdot in}{2.08\,in^2}$$

$$= 2884.6\,lb/in$$

Weld Width:

$$= \frac{2884.6\,lb/in}{9600}$$

Appendix B: Drawings



Handlebars

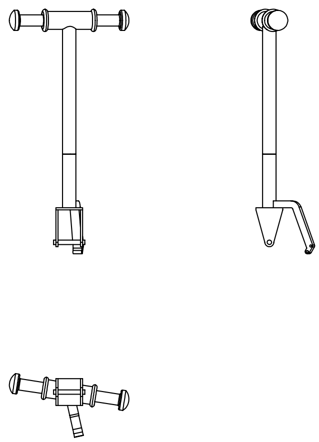
 they will collapse to make it even more portable


CRIGHTON
SNOWMOTO 28ST


CRIGHTON

2 1

B

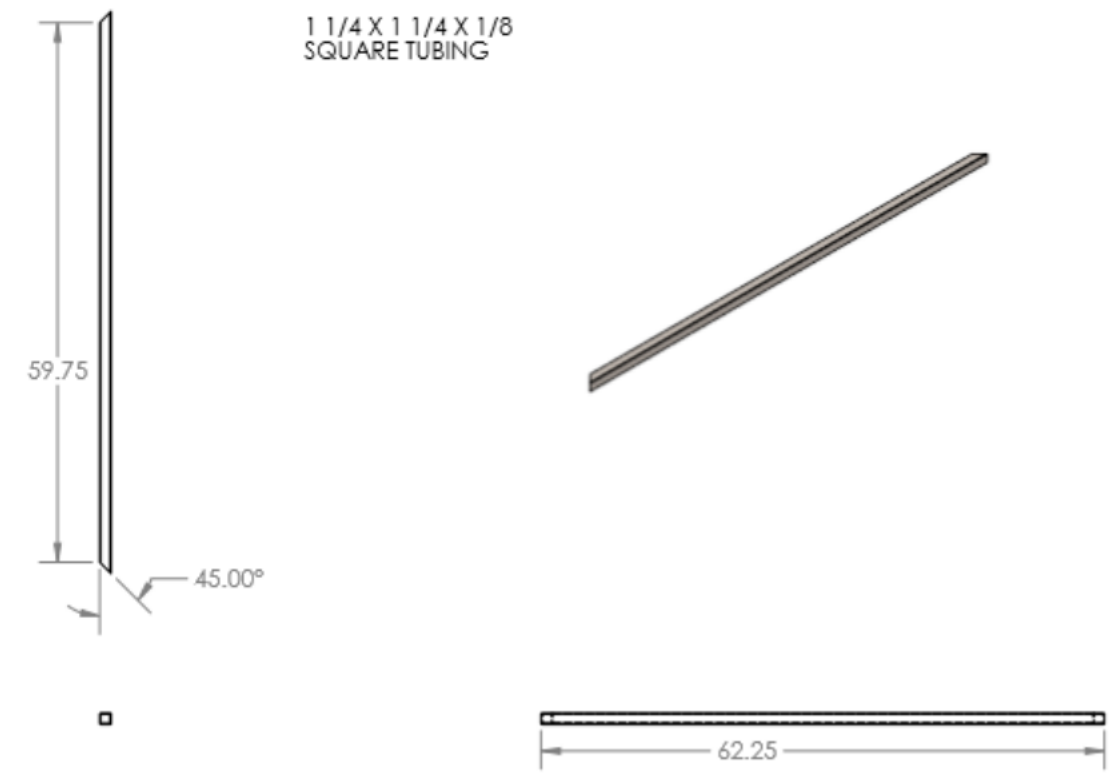


Handlebars and
from attachment

A

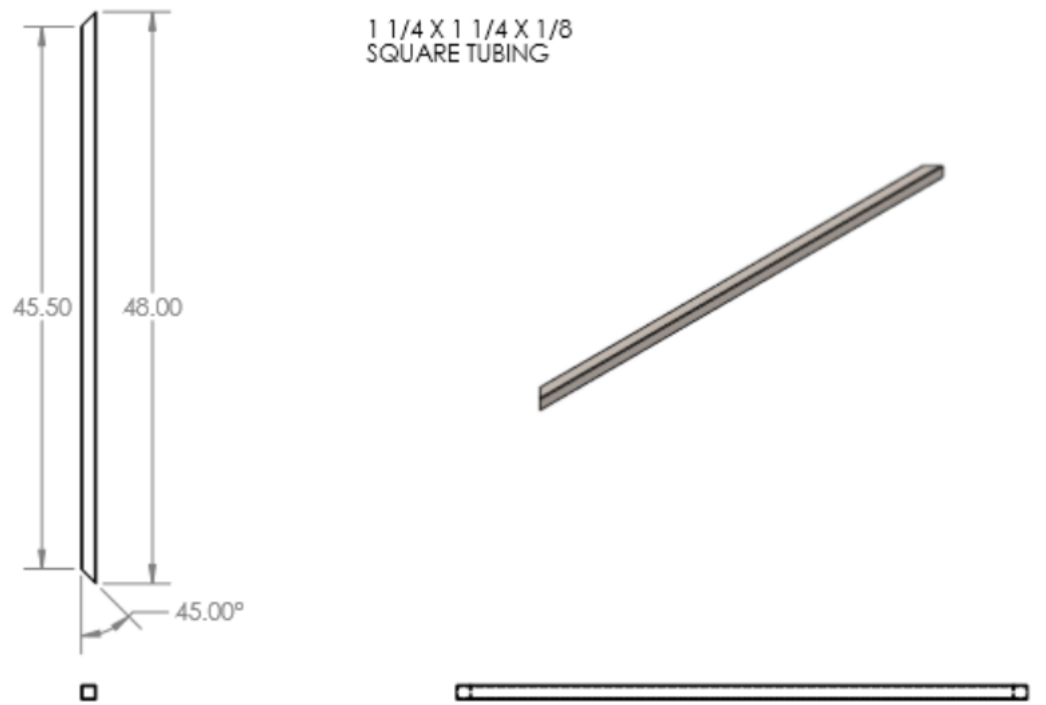
		UNLESS OTHERWISE SPECIFIED:		NAME	DATE	
		DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± ANGULAR: MACH ± BEND ± TWO PLACE DECIMAL ± THREE PLACE DECIMAL ±	DRAWN			TITLE:
			CHECKED			
			ENG APPR.			
			MFG APPR.			
		INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.			
		MATERIAL	COMMENTS:			SIZE A — DWG. NO. Assem2 — REV
NEXT ASSY	USED ON	FINISH				
APPLICATION		DO NOT SCALE DRAWING				SCALE: 1:2 — WEIGHT: — SHEET 1 OF 1

2 1



UNLESS OTHERWISE SPECIFIED:		NAME	DATE	2 X THIS PART
DIMENSIONS ARE IN INCHES TOLERANCES: ± 0.005 FRACTIONAL ± ANGULAR: MACH ± BEND ± TWO PLACE DECIMAL ± THREE PLACE DECIMAL ±	DRAWN	T.S.	11-22-15	TITLE: STEEL TUBING 1-1
	CHECKED			
	ENG APPR.			
	MFG APPR.			
INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.			
MATERIAL A-36 STEEL	COMMENTS:			SIZE A	DWG. NO. A-001	REV A
FINISH				
DO NOT SCALE DRAWING				SCALE: 1:16	WEIGHT:	SHEET 1 OF 1

NEXT ASSY	USED ON
APPLICATION	



UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES: ± 0.005
FRACTIONAL ±
ANGULAR: MACH ± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±
INTERPRET GEOMETRIC TOLERANCING PER:
MATERIAL A-36 STEEL
FINISH
DO NOT SCALE DRAWING

NEXT ASSY | USED ON
APPLICATION

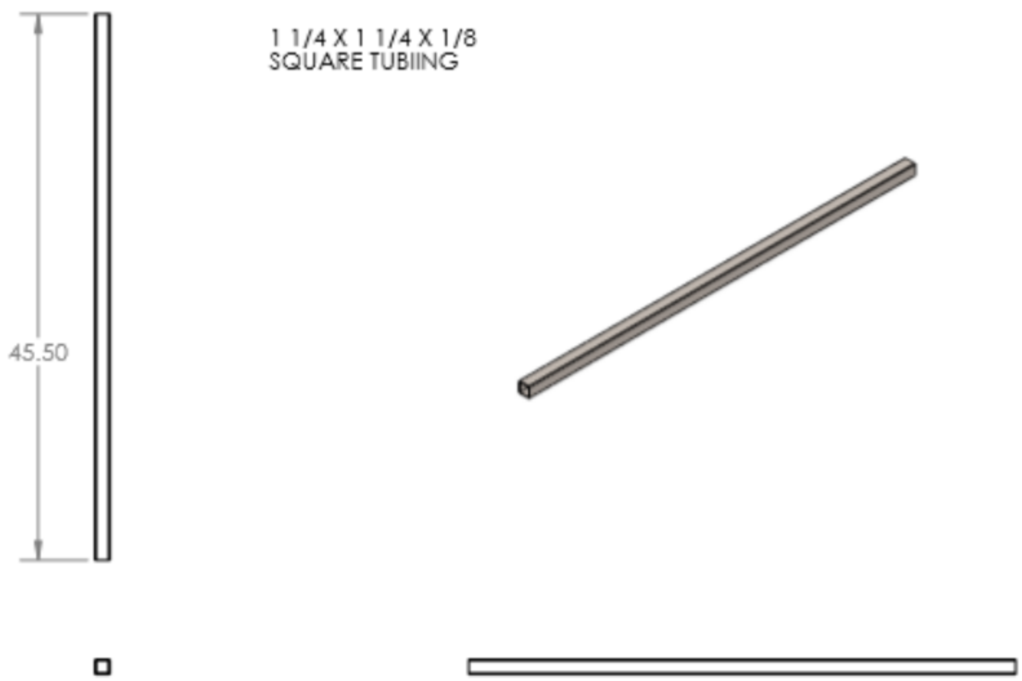
	NAME	DATE
DRAWN	T.S.	11-22-15
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		
COMMENTS:		

2 X THIS PART

TITLE: STEEL TUBING 1-2

SIZE A | DWG. NO. A-002 | REV A

SCALE: 1:12 | WEIGHT: | SHEET 1 OF 1



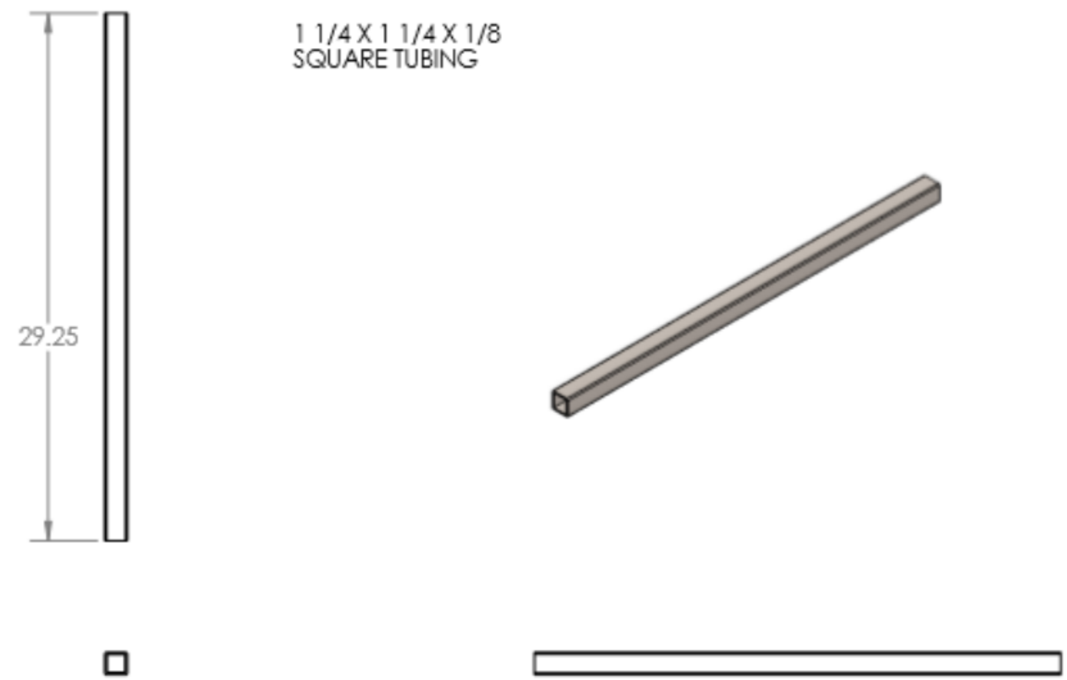
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES: ± 0.005
FRACTIONAL ±
ANGULAR: MACH ± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±
INTERPRET GEOMETRIC TOLERANCING PER:
MATERIAL A-36 STEEL
FINISH
NEXT ASSY | USED ON
APPLICATION
DO NOT SCALE DRAWING

	NAME	DATE
DRAWN	T.S.	11-22-15
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		
COMMENTS:		

TITLE: STEEL TUBING 1-3

SIZE A | DWG. NO. A-003 | REV A

SCALE: 1:12 | WEIGHT: | SHEET 1 OF 1



2 X THIS PART

TITLE:

STEEL TUBING 1-4

	NAME	DATE
DRAWN	T.S.	11-22-15
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		
COMMENTS:		

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES: ± 0.005
FRACTIONAL:
ANGULAR: MACH ± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±

INTERPRET GEOMETRIC TOLERANCING PER:

MATERIAL A-36 STEEL

FINISH

DO NOT SCALE DRAWING

NEXT ASSY | USED ON

APPLICATION

SIZE A | DWG. NO. A-004 | REV A

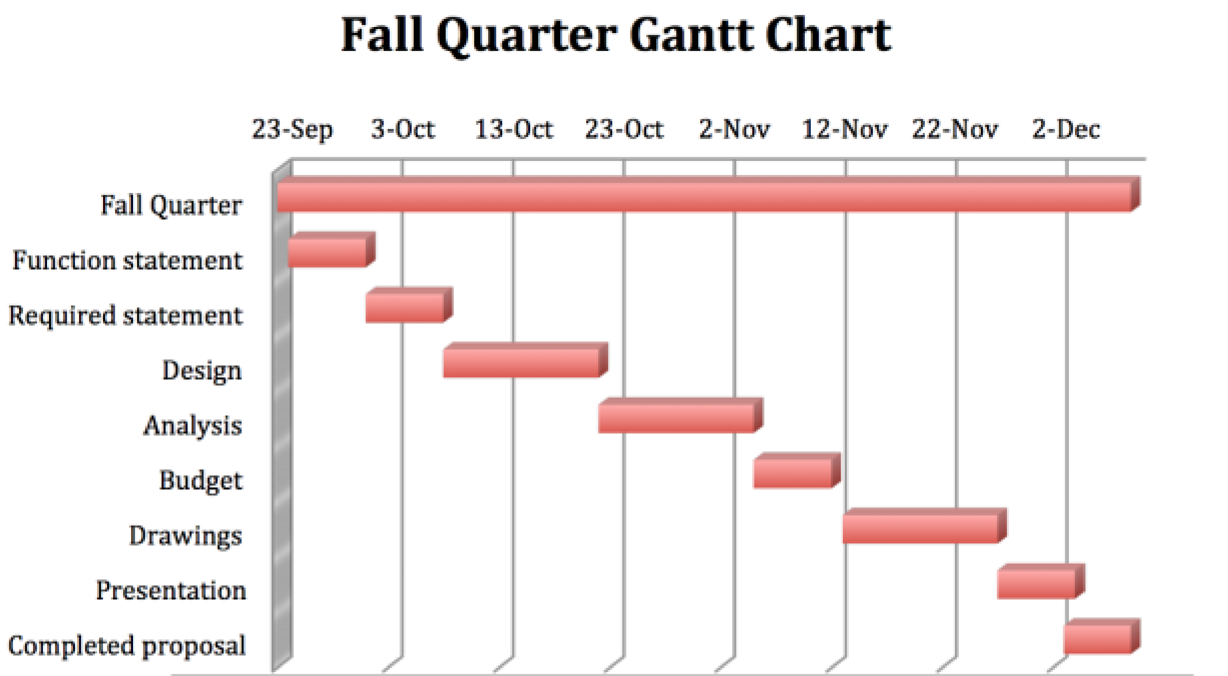
SCALE: 1:8 | WEIGHT: | SHEET 1 OF 1

Appendix C/D - Parts list and Budget

Aluminum Material Source: WWW.Thomasnet.Com	$300
Hardware Source: Fastenal	$30
Stainless Steel Rod Source: Harvestco Fabricators	$10
Aluminum (Demo Model) Source: Harvestco Fabricators	$40
Steel Angle Iron Source: Harvestco Fabricators	$20
Total-	$400

Appendix E – Schedule

Fall Quarter (Design and analysis proposal)					
Task	Start date	Duration	End date	Hours projected	Hours Spent
Fall Quarter	23-Sep	78	9-Dec	-	-
Function statement	24-Sep	7	30-Sep	2 hours	2.5 hours
Required statement	1-Oct	7	7-Oct	2 hours	2 hours
Design	8-Oct	14	21-Oct	10 hours	12 hours
Analysis	22-Oct	14	4-Nov	4 hours	3 hours
Budget	5-Nov	7	12-Nov	2 hours	1 hour
Drawings	13-Nov	14	26-Nov	10 hours	15 hours
Presentation	27-Nov	7	2-Dec	2 hours	-
Completed proposal	3-Dec	7	9-Dec	-	-



	Completed proposal	Presentation	Drawings	Budget	Analysis	Design	Required statement	Function statement	Fall Quarter
Start date	3-Dec	27-Nov	13-Nov	5-Nov	22-Oct	8-Oct	1-Oct	24-Sep	23-Sep
duration	7	7	14	7	14	14	7	7	78

Gantt Chart:

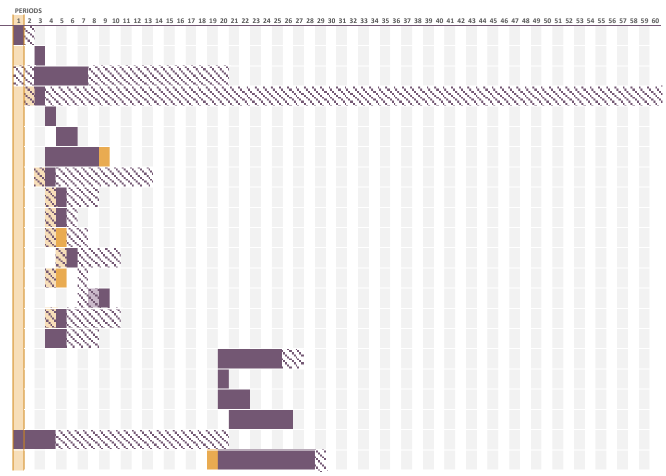
Snow Bike/ Scooter Snow

Select a period to highlight at right. A legend describing the charting follows.

Period Highlight: 1

Plan Duration | Actual Start | % Complete | Actual (beyond plan) | % Complete (beyond plan)

ACTIVITY	#	START WEEK	PLAN DURATION IN HOURS	ACTUAL START WEEK	ACTUAL DURATION IN HOURS	PERCENT COMPLETE
Email Companies	1	1	2.5	1	1	100%
Receive Parts	2	3	1	3	1	100%
Drawings	3	1	20	3	5	100%
Start Manufactoring	4	3	80	3	0	100%
email bike frame companies	4	4	1	4	1	100%
Steering System Assembly	5	5	2	5	2	100%
Cutting the Stearing wheel	6	4	5	4	6	100%
Cutting Frame	7	4	10	4	0	100%
Board Mounting	8	5	4	5	0	100%
Lifter Kit Mounting	9	5	2	5	0	100%
Folding mechanism	10	6	2	5	0	100%
Leash Mounting	11	6	5	6	0	100%
Drill holes	12	7	1	5	0	100%
Welding	13	7	3	9	0	100%
Installing Boards	14	5	6	5	0	100%
cutting boards to right size	15	4	5	4	2	100%
Test ride	17	20	8	20	6	100%
Rebuild Bike (after crash)	18	20	1	20	1	100%
Analyse Data	19	20	3	20	3	100%
Test Strain	20	21	6	21	6	100%
Update written report	16	1	20	1	4	100%
Update web site	21	20	10	19	10	100%



Appendix F: Acknowledgments: (for now)

I received some help from Matt Burvee with deciding materials and how to approach the manufacturing and using the press. Andrew Kastning and his resources to acquire data capture devises such as a data logger for the strain gauge values
The mechanical design book was also very helpful with analysis and design to this project. As well as Charles Pringle for calculation questions.

Appendix J: Resume

TIAGO SOUSA

6410 Campbell Road, Peshastin WA 98847 • (801) 921-3187 • shippa@gmail.com

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EDUCATION

Central Washington University Anticipated May 2017
Senior
B.S., Mechanical Engineering Technology

- *Completed Coursework*: Thermodynamics, Fluids Dynamics, Machining, Advanced Machining, Solidworks, Industrial Electronics, Statics, Instrumentation, Strength of Materials, Applied Heat Transfer, Production Technology, Technical Dynamics

Utah Valley University, Orem, UT December 2008
B.S., Business Management

EMPLOYMENT

General Services Administration, Auburn, WA, Summer 2016
Engineering Intern

- Worked with project managers, estimators, architects, fire protection engineers, structural engineers and mechanical engineers to design and implement large construction project in a federal building.
  - Worked to design and implement HVAC system.
  - Worked with seismic related structural standards (RP8).
- Drafted and distributed Lessons Learned reports in regards to seismic events.

Vulcraft, Brigham City, UT, Summer 2015
Engineering Intern

- Designed the automation of the welding line.
  - Drafted the automated system, as a whole, in Solidworks.
  - Created individual part specifications for machining.
  - Worked with technicians to implement the design, including design editing in Solidworks to troubleshoot and to improve processes based on technician feedback.
- Updated maintenance catalogs.

Excel Mortgage, Salt Lake City, UT, 2013-2014
Junior Underwriter

- Managed loan documentation, searched for discrepancies and ensured client compliance with conditions for loan approval. Communicated with loan processor, broker and account executive on sufficiency of loan documentation. Expert with DataTrac software.

CERTIFICATIONS & SKILLS

- A+ Certified
- HVAC 1, 2, and 3 Certified
- Advanced knowledge of Microsoft Suite products