Ski Haus Tow Rope

Hallie Eha- CAD Engineer, Financial Engineer

Kailey Lewis- Project Manager, Test Engineer

Jesse Wells – Logistics Manager, Manufacturing Engineer

Project description

The Ski Haus tow rope is a compact motorized transportation device for ski resort use to pull riders back up the mountain. The design will solve the problem of alleviating riders from fatigue and potential injury from hiking. The tow rope will be used in rail jam competitions hosted by Ski Haus at Arizona Snowbowl. The design will cost about $2000, weighing less than 300lbs.

<u>Updates:</u>

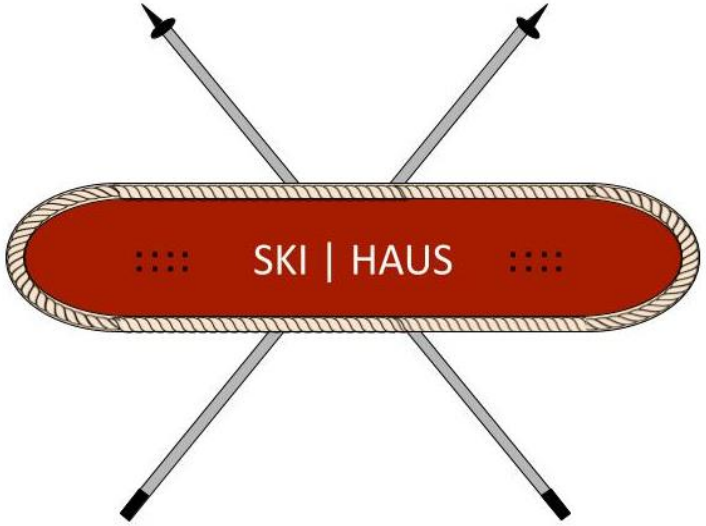
Prototype

Analysis

Sweatshirts

<u>Sponsor:</u>
Ski Haus

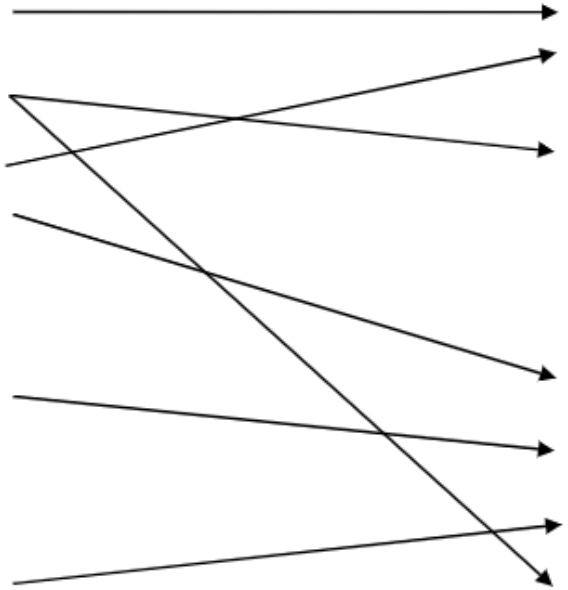
<u>Client:</u>
Davis Bedient



Design Requirements

Customer Requirements

- Quickly Transports riders
- Safe for all riders
- Minimum towability of 5 people
- Portable (easy set up/take down)
- Maintains speed with varying loads of riders
- Easy to operate
- Covers the ground of a typical rail jam competition
- Durable for all weather conditions



Engineering Requirements

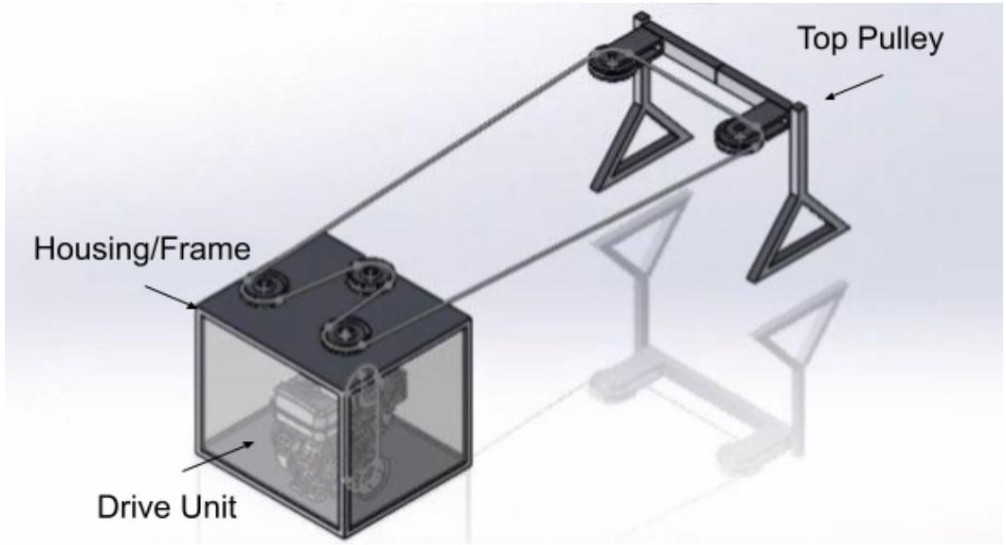
- Motor capable of towing 60 people/hour
- Safety features include, throttle, emergency stop switch, encased drive unit, stop gate
- Less than 200lbs
- Less than 5 operating parts
- Aluminum and steel framing
- Factor of safety of 3-4

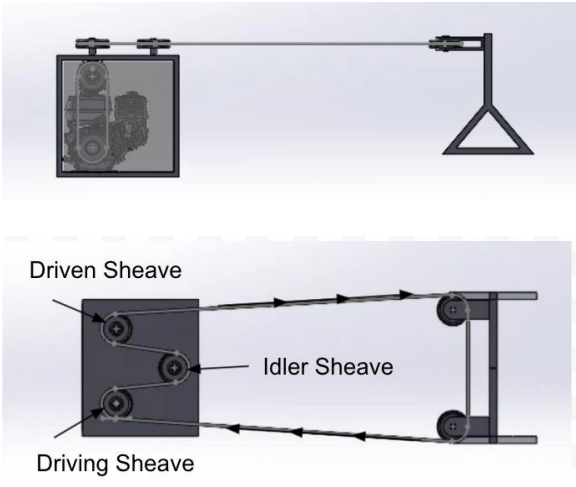
1.5 m/s velocity transports riders nearly 300ft/min
16 HP motor more than capable (see analysis)
Gear box with large factor of safety

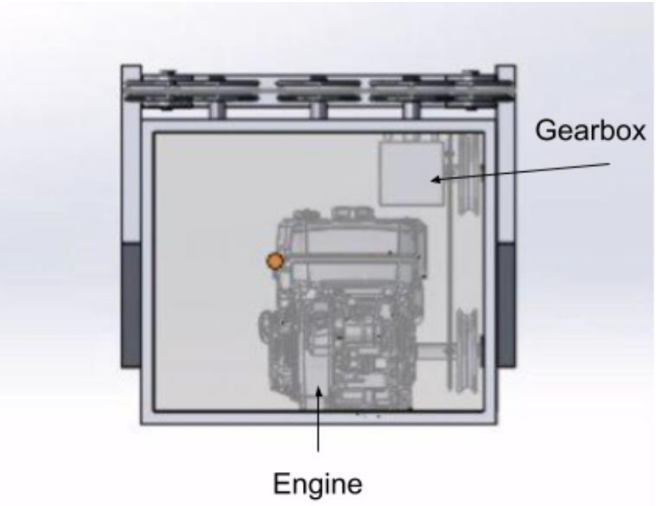
Design Description

-Drive Unit: Contains horizontal shaft motor, axis changing gearbox, sheave wheels with idler wheel.
-Housing/Frame: Aluminum frame with internal supports and mounting crosspieces, plexiglass housing.
-Top Pulley: Significant width to separate ropes, two pulley system to reduce stress, waist height for rider comfort while grabbing rope.

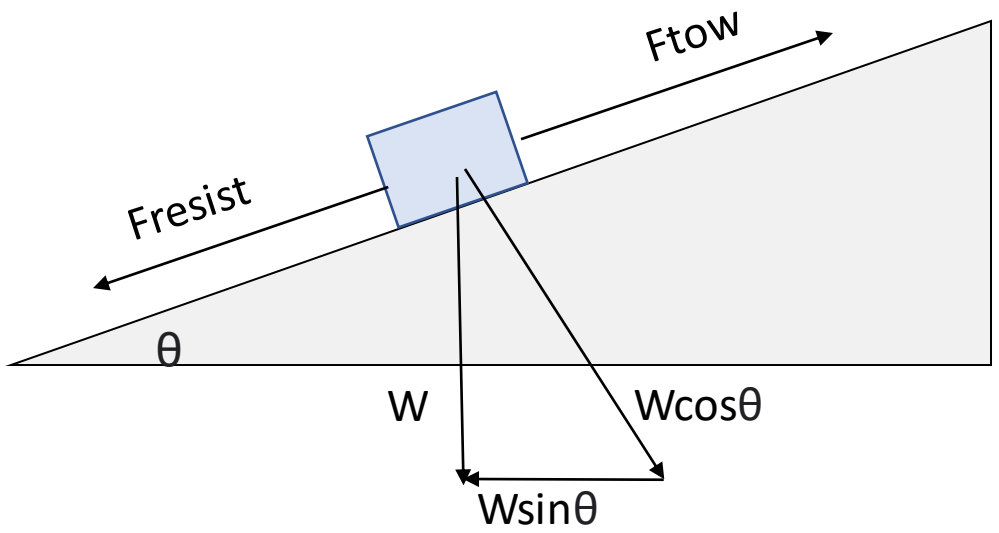
Next Updates: Additions to frame to enclose the sheave wheel system, hooks on top pulley for anchoring, trailer wheels, feet, and hitch for ease of transportation, FEA simulations.







Analytical Analysis



Assuming worst conditions

- 10 people at 200lbs
- Θ = 16 degrees
- Kinetic friction = 0.1
- Velocity of 1.5 m/s
- 16 HP motor with max torque of 28.5 Nm and max speed of 3600 rpm
- Sheave wheel of a 6-inch diameter (0.1524m)

Calculations

N = mgcosθ = 8554.73N
Ftow = Uk*N+mgsinθ = **3308.5N**
Fresist = **855.47N**
Ftow>>Fresist

T = F*r = **252.12 Nm**
Velocity of 1.5 m/s
Speed = Velocity/Circumference = 187.98 RPM
Power = T*Speed = **6.7 HP needed**

Yes, our motor of 16HP will be more than capable of towing 10 people at a constant velocity of 1.5 m/s. A 10:1 gear box will be necessary to increase torque and decrease speed.

Design validation-FMEA

Process or Product Name:	Ski Haus Tow Rope	Prepared by:	Hallie Eha		
Responsible:	Hallie Eha, Kailey Lewis and Jesse Wells	FMEA Date:	(Orig.) 11/2/2021	(Rev.)	Page 1 of 1

Process Step/Input	Potential Failure Mode	Potential Failure Effects	SEV	Potential Causes	OCC	Current Controls		DET	RPN	Actions Recommended	Responsible	SEV	OCC	DET	RPN
						Prevent	Detect								
What is the process step/input under investigation?	In what ways does the input go wrong?	What is the impact on the Output Variables (Customer Requirements) or internal requirements?	How sever is the effect to the customer?	What causes the input to go wrong?	How often does cause of FM occur?	What are the existing controls and procedures (inspection and test) that prevent/detect either the Cause or Failure Mode? Should include an SOP number.		How well can you detect cause or FM?		What are the actions for reducing the occurrence of the Cause, or improving detection? Should have actions only on high RPN's or easy fixes.	Who is responsible for the recommended action?				
Drive Shaft	Unsafe amount of shear stress applied on shaft	Impacts safety of Riders	8	Too many people loaded on tow rope	2	Include maximum number of poeple allowed to load in owners manual	Include FEA design testing under varying loads and include a high FOS	3	48	Reinforced drive shaft and proper gear ratios to reduce stress on drive shaft	CAD Engineer and Test engineer	8	2	3	48
	unable to operate with high flucuating loads	Towablility of 5 people and maintains speed with varying loads	6	Inefficicent gear ratios and power output	5	Calculate the optimal operating torque from torque speed graph from motor	Maximum load testing versus speed	4	120	Inclusion of owners manual that sets the amount of riders able to tow with the current snow conditions	Logistics Manager and Test Engineer	6	5	4	120
Motor and Pulley Belts	Slipping in belts	Effects power transfer to the other pulleys and sheaves	7	Not enough tension between belt pulleys, too high of RPM that would cause belt slipping	4	Create high tension in belt in assembly, use timing belt or chain to eliminate slipping	Power loss due to friction	6	168	Using appropriate timing belts or chains to prevent slipping	CAD Engineer and manufacturing engineer	7	4	6	168
Stop Gate sensor	Failed sensor to stop motor	Impacts safety of Riders and effects emergency procedures	8	Stop sensor disconnected or disengaged	6	Manditory Stop checks of stop gate and stop button on motor	detected by the tow rope stopping function	8	384	Daily stop checks as outlined in ski lift operations safety standards	Logistics Manager, Test Engineer and tow rope operator	8	6	8	384
Gear box	Reversed motion of tow rope	Maintaining speed in uphill direction and effects safety of riders	5	too many people loaded on tow rope	2	Using a worm gear box to prevent reversed motion	Visually seeing if row travels in the correct direction	6	60	Using a worm gear for the gear box or using a gear box with manual reverse and forward gears	Logistics manager and test Engineer	5	2	6	60
Rope	Slipping in the rope around the sheave wheels	maintaining speed and towability and effects amount of riders to tow	7	too many people loaded on tow rope and not enough tension in the rope during setup	5	Use idler sheave to tension rope around the drive unit, high tensioning in the top pulley with ratchet straps and anchor	Visually see any slipping in the rope as riders load the tow rope	5	175	using effective anchoring systems and tensioning methods such as ratchet straps for top terminal	CAD engineer and test engineer	7	5	5	175

Design validation

Testing Procedures:

- Stresses and buckling in the Frame: material analysis, load testing
- Belt slipping: observe belt behavior in various weather conditions and speeds
- Actual Torque applied to motor and gear box
- Stop button speed: Measuring the response time of the stop button/gate to shut off motor
- Speed versus load testing: Measure changes in speed with various loads

Equipment/Resources needed:

- Completed Tow rope
- Snowy conditions
- Dynameter for Load testing
- Volunteers or weights
- AZ Snowbowl
- Spare parts/pulleys
- Scale
- Stopwatch
- Measuring tape

Schedule

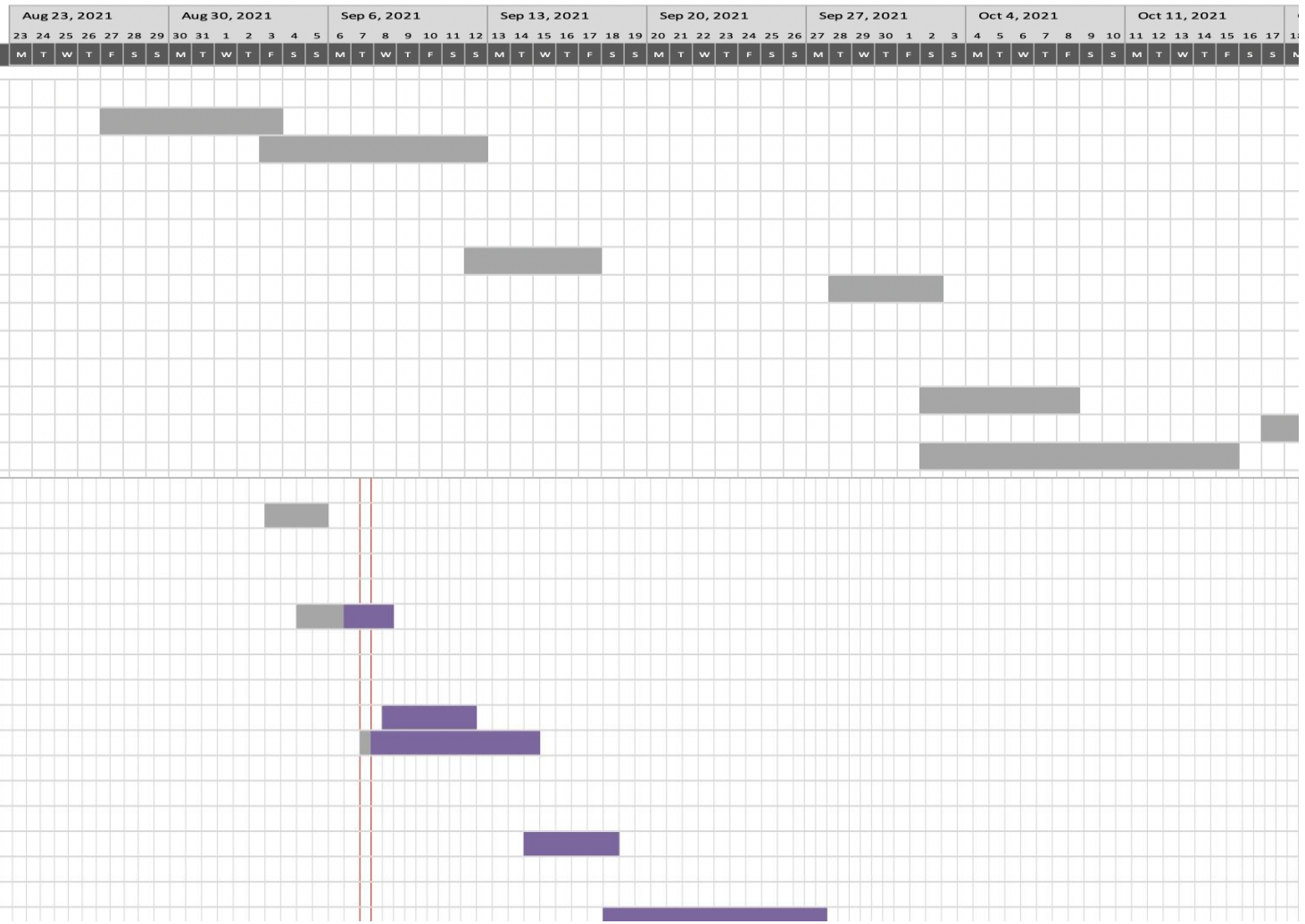
SKI HAUS TOW ROPE

Shredderz Co.

Project Start: Fri, 8/27/2021

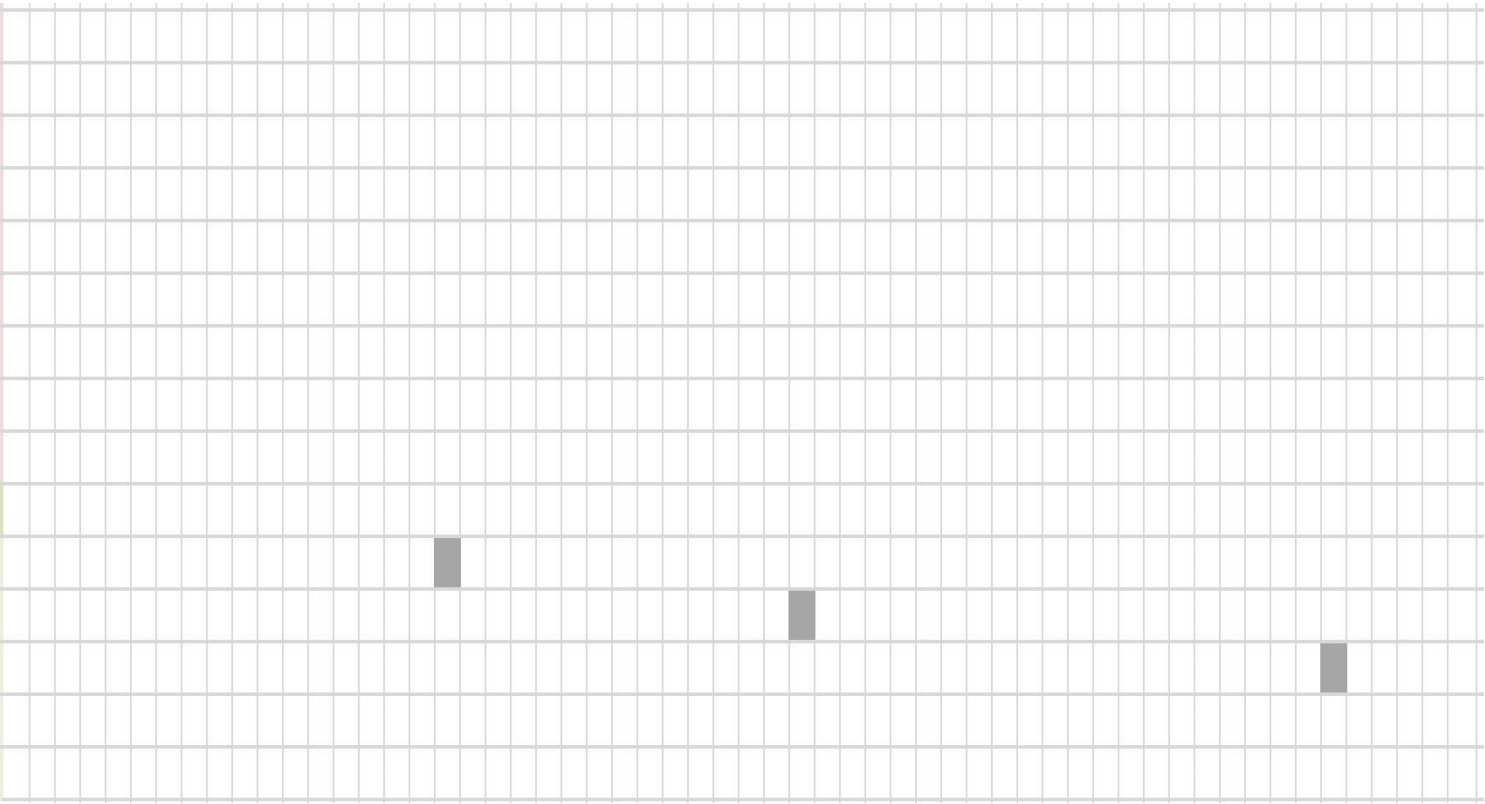
Display Week: 1

TASK	ASSIGNED TO	PROGRESS	START	END
Preliminary Assignments				
Team Charter	All	100%	8/27/21	9/3/21
Presentation 1	All	100%	9/3/21	9/12/21
lit review/CR&ER/QFD/schedule	Kailey			
project description/lit review	Hallie			
budget/lit review/benchmarking	Jesse			
Peer Eval 1	All	100%	9/12/21	9/17/21
Presentation 2	All	100%	9/28/21	10/2/21
project descrip/decomp model/CV/pugh/	Kailey			
CV/CAD/Decision matrix/weight analysis	Hallie			
decomp model/CV/chosen design	Jesse			
Peer Eval 2	All	100%	10/2/21	10/8/21
Website Check 1	Kailey	100%	10/17/21	10/24/21
Preliminary Report	All	100%	10/2/21	10/15/21
Final Assignments				
Team memo	All	100%	10/26/21	10/29/21
topic 1	Kailey			
topic 2	Hallie			
topic 3	Jesse			
Final Presentation	All	50%	10/28/21	11/3/21
Design Requirements/schedule	Kailey			
Design validation/budget	Hallie			
Design/project descriotion	Jesse			
Peer Eval 3	All	0%	11/3/21	11/10/21
Final Proposal Report	All	10%	11/1/21	11/14/21
QFD/TPs/filling in old	Kailey			
Risk analysis/TPs	Hallie			
standards/design selected	Jesse			
Final Bill of Materials and CAD	All	0%	11/14/21	11/19/21
CAD	Kailey/Hallie			
Bill of materials	Kailey/Jesse			
Final Prototype	All	0%	11/19/21	12/3/21



Schedule

Risk analysis/TPs	Hallie			
standards/design selected	Jesse			
Final Bill of Materials and CAD	All	0%	11/14/21	11/19/21
CAD	Kailey/Hallie			
Bill of materials	Kailey/Jesse			
Final Prototype	All	0%	11/19/21	12/3/21
manufacturing and testing	All			
Peer Eval 4	All	0%	11/19/21	11/23/21
Website Check 2	Kailey Lewis	0%	12/1/21	12/7/21
Customer Meetings				
Customer Meeting 1	All	100%	9/8/21	9/8/21
Customer Meeting 2	All	100%	9/22/21	9/22/21
Customer Meeting 3	All	100%	10/13/21	10/13/21
Customer Meeting 4	All	100%	10/27/21	10/27/21
Customer Meeting 5	All	0%	11/10/21	11/10/21



Ski Haus Tow Rope

Projected Budget: $3000

Project Info

Budget Liaison: Jesse Wells
Start Date: 8/23/21

Budget Summary

Budget	Actual	Under(Over)
$ 2,010	$ 2,226	$ (216)

	Labor		Materials		Fixed Costs					
Expenses	Hrs	Rate	Units	$/Unit	Material	Travel	Other	Budget	Actual	Under(Over)
Part								$ 1,855	$ 1,975	$ (120)
Filament			1	$20.00				20.00	20.00	-
DC motor kit			1	$14.18				15.00	$15.18	(0.18)
duromax motor 16hp			1	$379.00				300.00	379.00	(79.00)
emergency button			1	$0.00				-	-	-
rope			400	$1.72				500.00	688.00	(188.00)
snow stakes			8	$2.95				50.00	23.60	26.40
gear box			1	$150.00				100.00	150.00	(50.00)
housing unit									-	-
aluminum sheets			6	$25.54				200.00	153.24	46.76
aluminum frame			50	$4.80				250.00	240.00	10.00
pulleys			5	$26.48				200.00	132.40	67.60
belt pulley			2	$23.11				50.00	46.22	3.78
4L V belt			1	$6.78				20.00	6.78	13.22
screws			50	$0.18				10.00	8.98	1.02
top pully										
frame stands (steel)			2	$18.40				50.00	36.80	13.20
frame (steel)			2	$5.57				15.00	11.14	3.86
pulleys			2	$21.49				50.00	42.98	7.02
ratchet straps			4	$14.00				60.00	56.00	4.00
gasoline (for testing)			5	$3.09				20.00	15.45	4.55
labor								$ 100	$ 200	$ (100)
Welding	10	$20.00						100.00	200.00	(100.00)
prototyping	25	$0.00						-	-	-

Budget

$1728 to be available (t-shirt money)

Anticipated expenses: $2226

Expenses to date: $34.18

Balance: $2191.82

Questions?