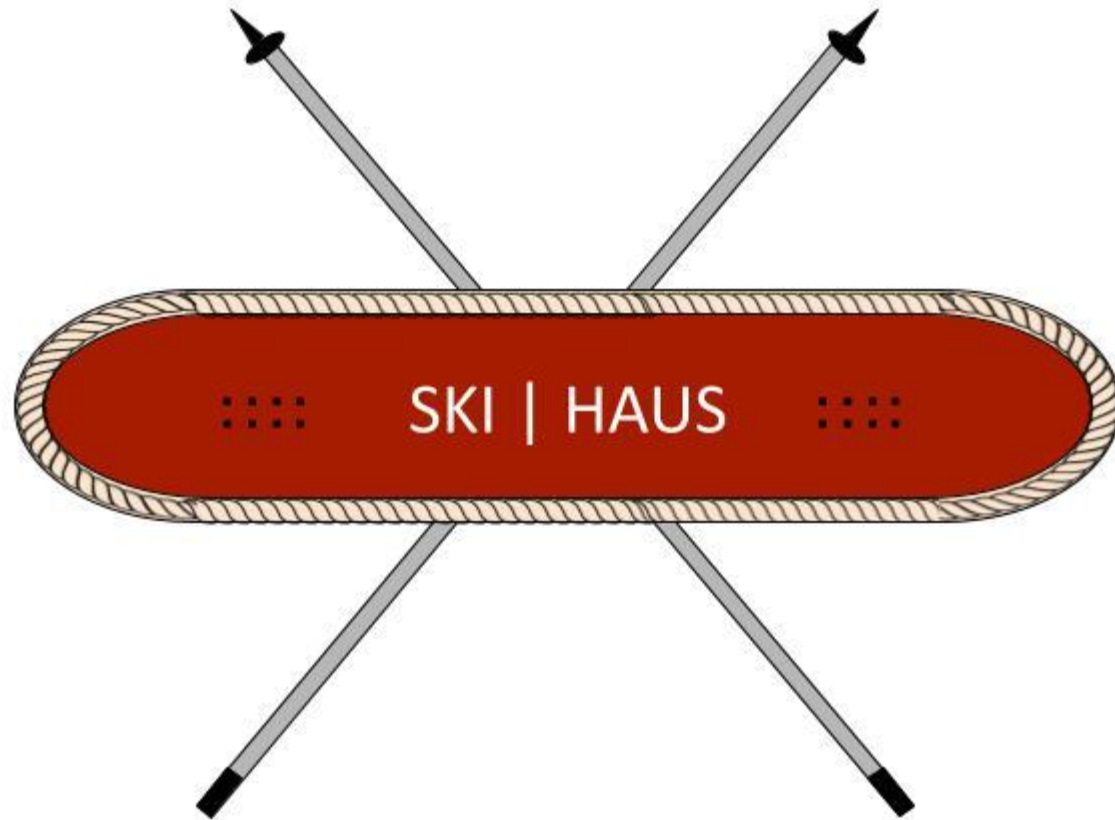


# SKI HAUS TOW ROPE



## Team Members:

Hallie Eha

*CAD Engineer and Financial  
Manager*

Kailey Lewis

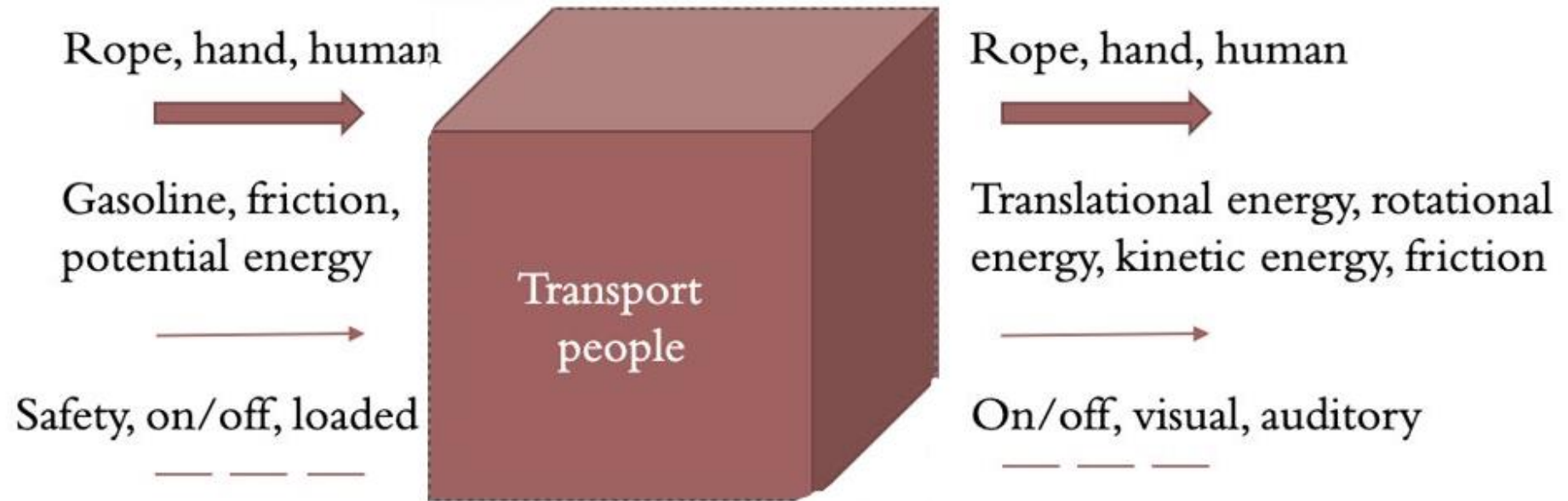
*Project Manager and Test  
Engineer*

Jesse Wells

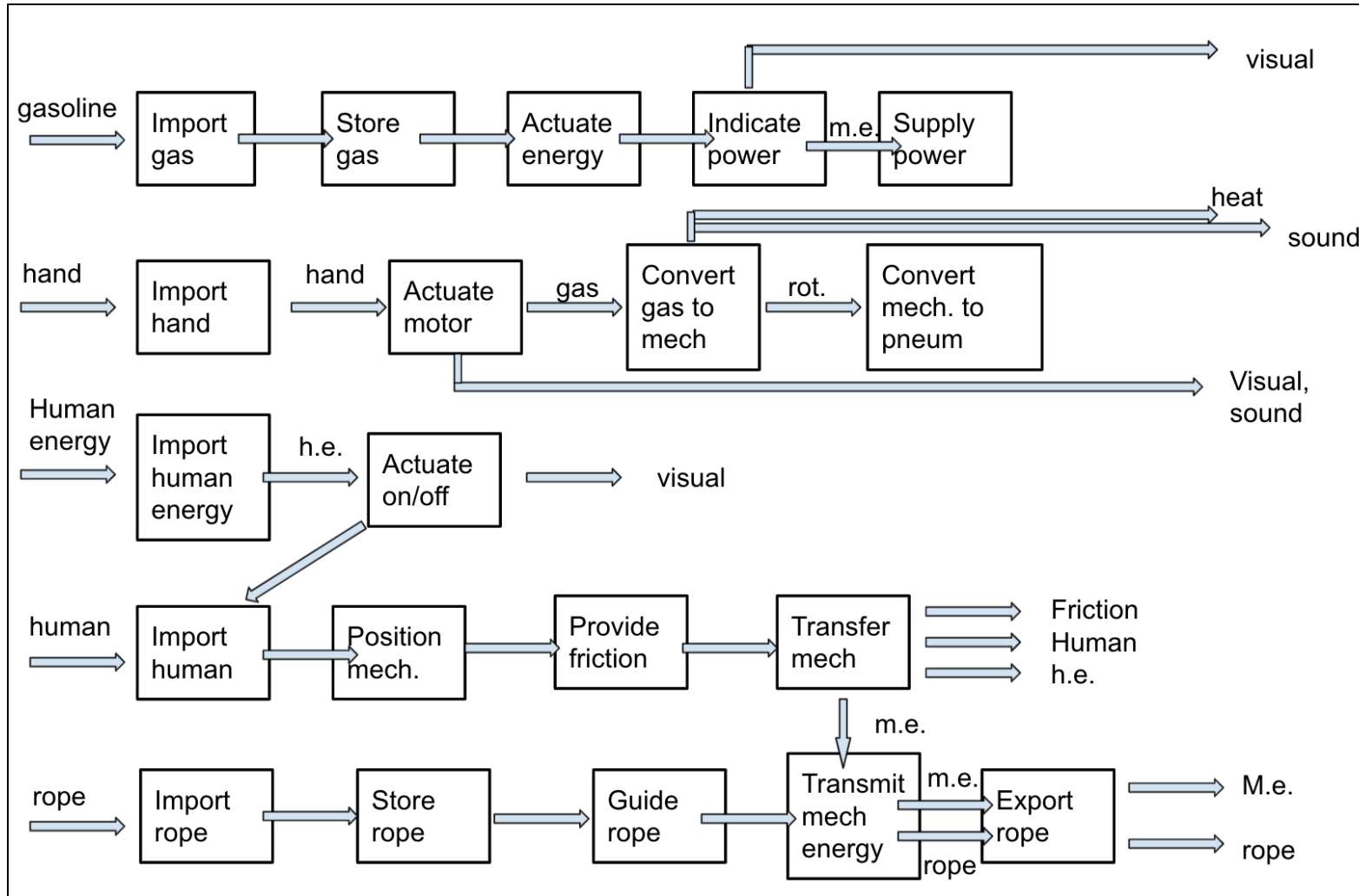
*Manufacturing Engineer and  
Logistics Manager*

# PROJECT DESCRIPTION

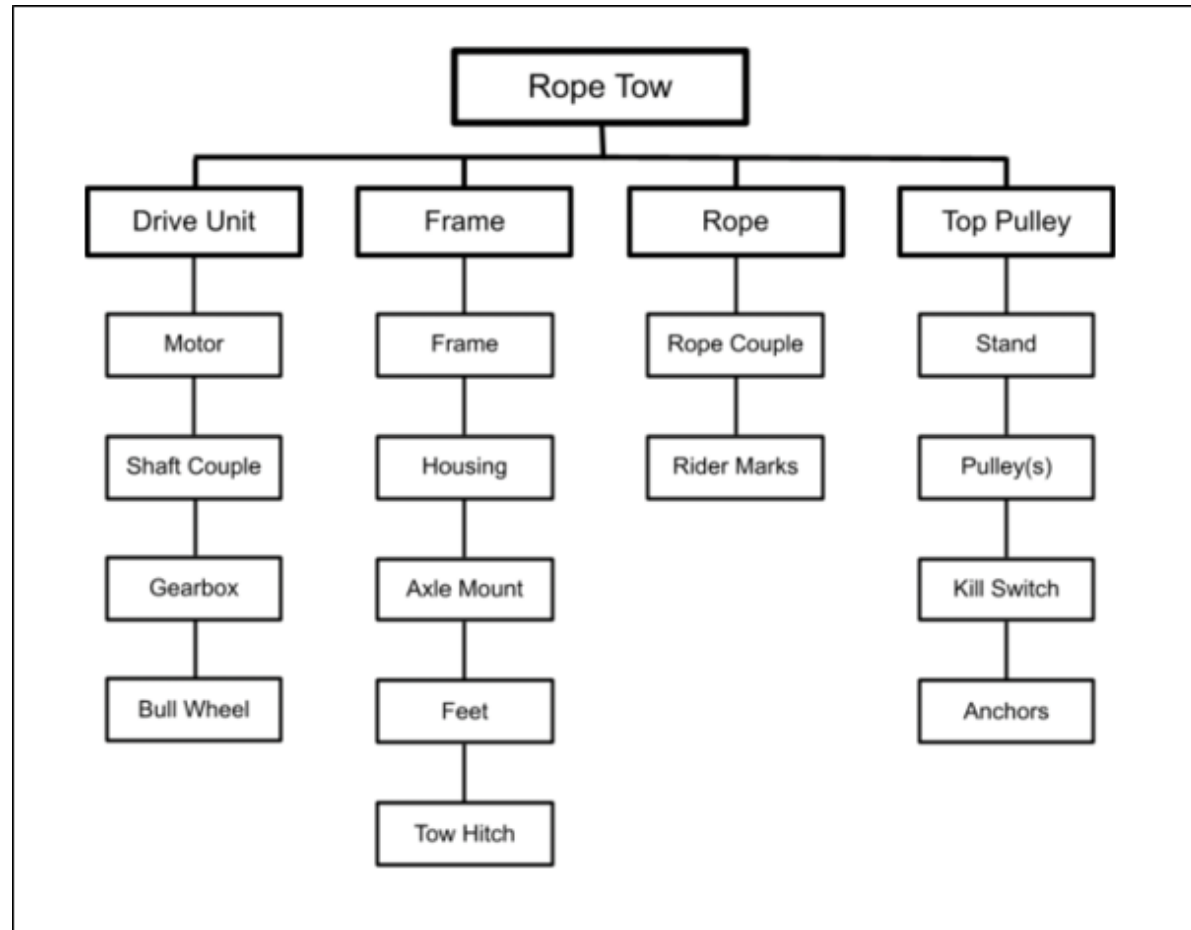
The Ski Haus tow rope is a portable motorized transportation device for ski resort use to pull riders back up the mountain. Its use in rail jam competitions hosted by Ski Haus at Arizona Snowbowl will ensure the safety of riders, reducing the fatigue caused by hiking. The design will cost about \$2000, weighing less than 300lbs.



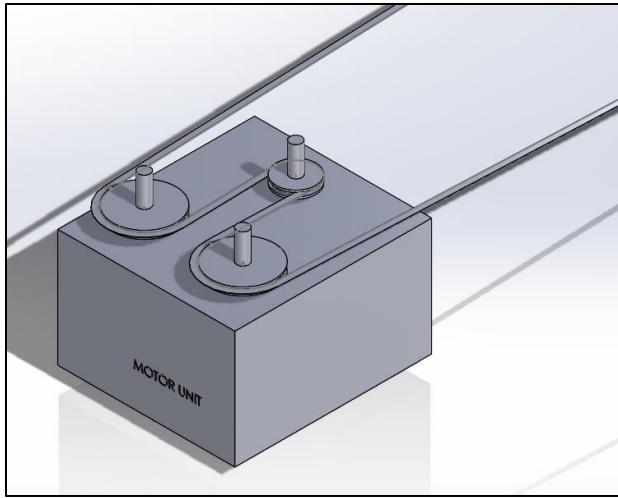
# DECOMPOSITION MODEL



# DECOMPOSITION MODEL



# CONCEPT GENERATION - SUBASSEMBLY 1 (DRIVE UNIT)

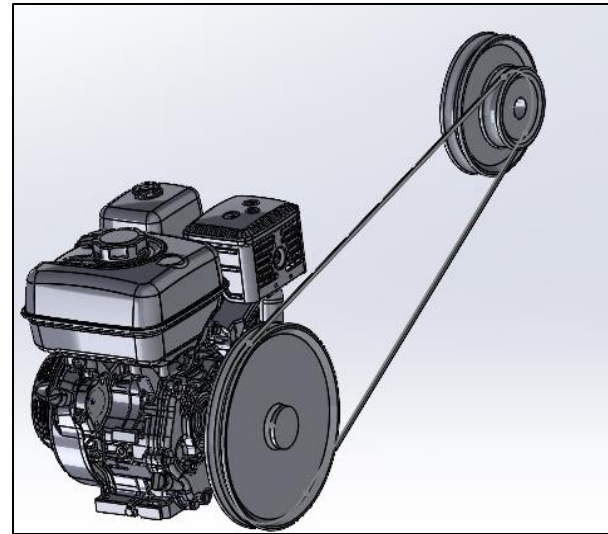


## Advantages

- Compact pulley design
- Horizontal rope position
- Moderate amount of parts/sheave wheels

## Disadvantages

- Attaching rope during use is difficult
- Difficult to create tension on rope during use

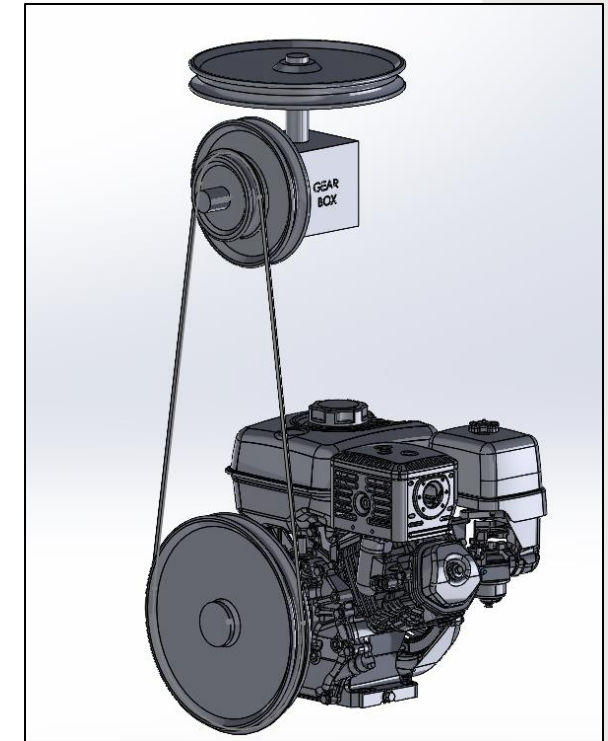


## Advantages

- Easy setup when used
- Compatible with horizontal drive shaft (no need for gear box)
- Easy/simple repair

## Disadvantages

- Larger frame required
- Less torque produced
- Vertical rope placement



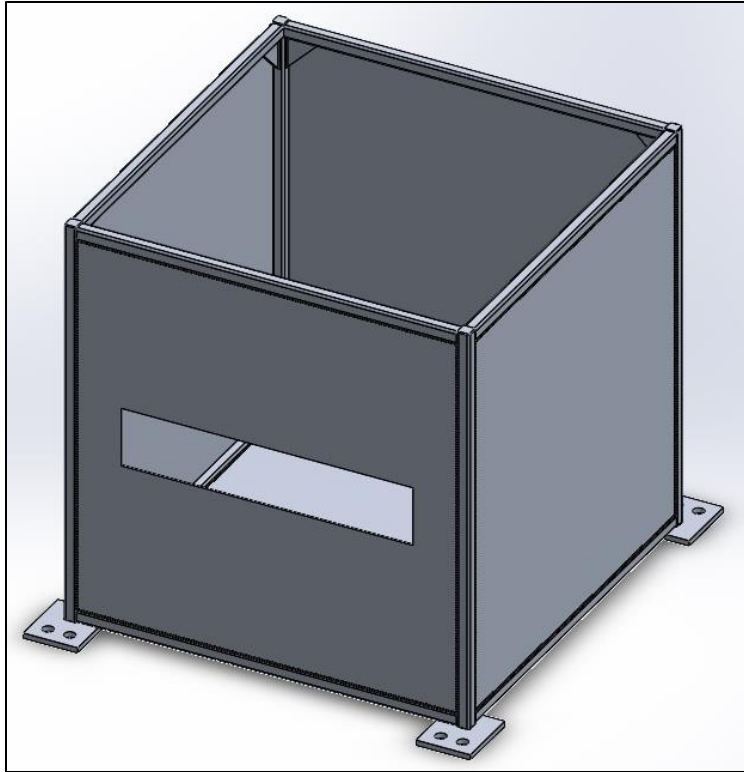
## Advantages

- Horizontal rope placement
- Compatible with horizontal drive shaft
- Easy setup when used

## Disadvantages

- More complex frame needed (2-stage frame)
- Gear box required (increase cost)

# CONCEPT GENERATION- SUBASSEMBLY 2 (FRAME)

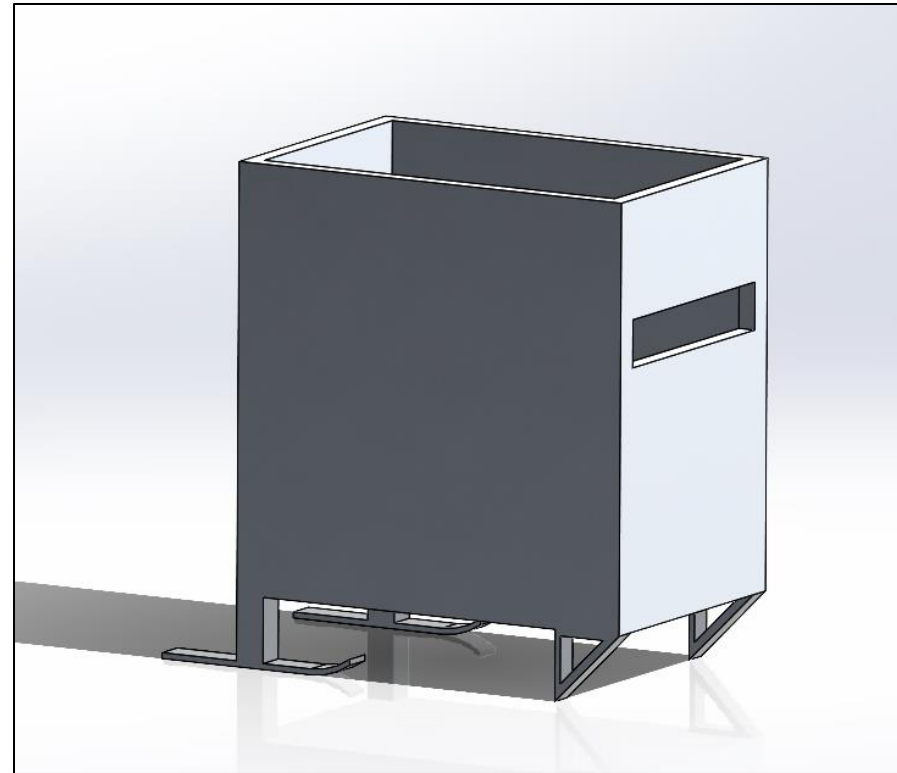


## Advantages

- Sturdy
- Secure tie downs
- Fits all motorized equipment
- Easy access for repair

## Disadvantages

- Bulky
- Expensive
- Not as maneuverable



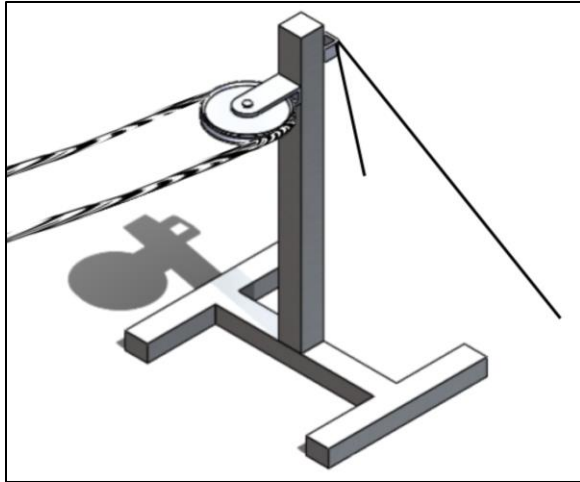
## Advantages

- Maneuverable
- Light
- Access for repair

## Disadvantages

- Expensive
- Harder to keep from moving on slope
- Equipment may need to be stacked

# CONCEPT GENERATION- SUBASSEMBLY 3 (TOP PULLEY)

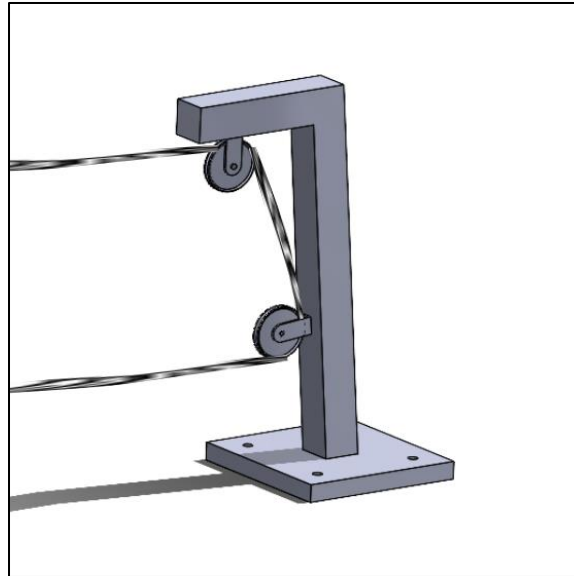


## Advantages

- Affordable
- Compact/collapsible
- Simple installation

## Disadvantages

- Small wheel diameter
- Not as durable
- Safety concerns



## Advantages

- Keeps rope out of the way
- Durable
- Heavy for anchoring

## Disadvantages

- Expensive
- Difficult transportation/installation
- Safety concerns of tipping



## Advantages

- Affordable
- Compact/collapsible
- Simple installation
- Keeps ropes separate

## Disadvantages

- Lightweight difficult to anchor
- More difficult to fabricate
- Center connection could be flimsy

# CONCEPT EVALUATION-PUGH CHART

Criteria	drive unit	Design Alternative #1	Design Alternative #2	Design Alternative #3	housing	Design Alternative #1	Design Alternative #2	Design Alternative #3	top pully	Design Alternative #1	Design Alternative #2	Design Alternative #3
Compactness		+	D	+		-	D	+		S	D	-
Cost		-		-		+		S		+		S
weight		S	A	S		S	A	S		S	A	S
ease of operation		S		S		S		S		S		+
safety		+	T	-		S	T	S		S	T	+
$\Sigma+$		2		1		1		1		1		2
$\Sigma-$		1	U	2		1	U	0		0	U	1
$\Sigma S$		2		2		3		4		4		2
Score		1	M	-1		0	M	1		1	M	1

## Drive unit - 1st design

- Application of multiple sheave wheels increases safety

## Housing - 3rd design

- Smaller housing decreases weight and skis increase maneuverability

## Top Pully - 3rd design

- Two sheave wheels at the top separate input from output rope, increasing safety. Also has more tie down points



# CONCEPT EVALUATION: DECISION MATRIX

Score: 1-5																			
Design Criteria	Weight	Drive unit	Design Alternative #1	Design Alternative #2	Design Alternative #3	Housing	Design Alternative #1	Design Alternative #2	Design Alternative #3	Top Pulley	Design Alternative #1	Design Alternative #2	Design Alternative #3	Design Alternative #1	Design Alternative #2	Design Alternative #3	Design Alternative #1	Design Alternative #2	Design Alternative #3
			Rating	Weight Score	Rating	Weight Score	Rating	Weight Score	Rating	Weight Score	Rating	Weight Score	Rating	Weight Score	Rating	Weight Score	Rating	Weight Score	Rating
Compactness	15%		4	0.6	4	0.6	3	0.45		2	0.3	4	0.6	5	0.75		3	0.45	
Cost	20%		3	0.6	3	0.6	2	0.4		3	0.6	2	0.4	3	0.6		3	0.6	
Weight	20%		3	0.6	3	0.6	3	0.6		3	0.6	3	0.6	4	0.8		2	0.4	
Ease of Operation	15%		3	0.45	3	0.45	3	0.45		3	0.45	3	0.45	3	0.45		3	0.45	
Safety	30%		5	1.5	2	0.6	2	0.6		3	0.9	2	0.6	3	0.9		2	0.6	
SUM				3.75		2.85		2.5			2.85		2.65		3.5			2.5	

Drive unit: Design #1  
Housing: Design #3  
Top Pulley: Design #3

# CONCEPT EVALUATION: WEIGHT ANALYSIS FOR DRIVE UNIT

Override Mass Properties... Recalculate

Include hidden bodies/components  
 Create Center of Mass feature  
 Show weld bead mass

Report coordinate values relative to: -- default --

Mass properties of CG2  
Configuration: Default  
Coordinate system: -- default --

Mass = 14.36 pounds

Volume = 397.42 cubic inches

Surface area = 1192.85 square inches

Center of mass: ( inches )  
X = 0.08  
Y = -4.76  
Z = 20.47

Principal axes of inertia and principal moments of inertia: ( pounds \* square  
Taken at the center of mass.  
I<sub>x</sub> = ( 0.00, 0.16, 0.99) Px = 157.56  
I<sub>y</sub> = ( 1.00, -0.01, 0.00) Py = 2209.29  
I<sub>z</sub> = ( 0.01, 0.99, -0.16) Pz = 2216.08

Moments of inertia: ( pounds \* square inches )  
Taken at the center of mass and aligned with the output coordinate system.  
L<sub>xx</sub> = 2209.26 L<sub>xy</sub> = 1.11 L<sub>xz</sub> = 7.12  
L<sub>yx</sub> = 1.11 L<sub>yy</sub> = 2162.35 L<sub>yz</sub> = 328.18

Concept#1: 14.36lbs

Override Mass Properties... Recalculate

Include hidden bodies/components  
 Create Center of Mass feature  
 Show weld bead mass

Report coordinate values relative to: -- default --

Mass properties of CG3  
Configuration: Default  
Coordinate system: -- default --

Mass = 6.04 pounds

Volume = 167.10 cubic inches

Surface area = 669.10 square inches

Center of mass: ( inches )  
X = 0.04  
Y = -7.49  
Z = 10.52

Principal axes of inertia and principal moments of inertia: ( pounds \* square  
Taken at the center of mass.  
I<sub>x</sub> = ( 0.00, 0.04, 1.00) Px = 43.73  
I<sub>y</sub> = ( 1.00, 0.00, 0.00) Py = 961.57  
I<sub>z</sub> = ( 0.00, 1.00, -0.04) Pz = 1000.45

Moments of inertia: ( pounds \* square inches )  
Taken at the center of mass and aligned with the output coordinate system.  
L<sub>xx</sub> = 961.56 L<sub>xy</sub> = 0.17 L<sub>xz</sub> = 3.66

Concept#2: 6.04lbs

Override Mass Properties... Recalculate

Include hidden bodies/components  
 Create Center of Mass feature  
 Show weld bead mass

Report coordinate values relative to: -- default --

Mass properties of Assem1  
Configuration: Default  
Coordinate system: -- default --

Mass = 32.70 pounds

Volume = 905.06 cubic inches

Surface area = 2062.24 square inches

Center of mass: ( inches )  
X = 0.06  
Y = 12.03  
Z = 4.33

Principal axes of inertia and principal moments of inertia: ( pounds \* square  
Taken at the center of mass.  
I<sub>x</sub> = ( 0.13, 0.00, 0.99) Px = 4761.65  
I<sub>y</sub> = ( 0.99, 0.00, -0.13) Py = 30880.98  
I<sub>z</sub> = ( 0.00, 1.00, 0.00) Pz = 35619.97

Moments of inertia: ( pounds \* square inches )  
Taken at the center of mass and aligned with the output coordinate system.  
L<sub>xx</sub> = 30444.87 L<sub>xy</sub> = -17.53 L<sub>xz</sub> = 3346.71  
L<sub>yx</sub> = -17.53 L<sub>yy</sub> = 35619.30 L<sub>yz</sub> = -142.78

Concept#3: 32.7lbs

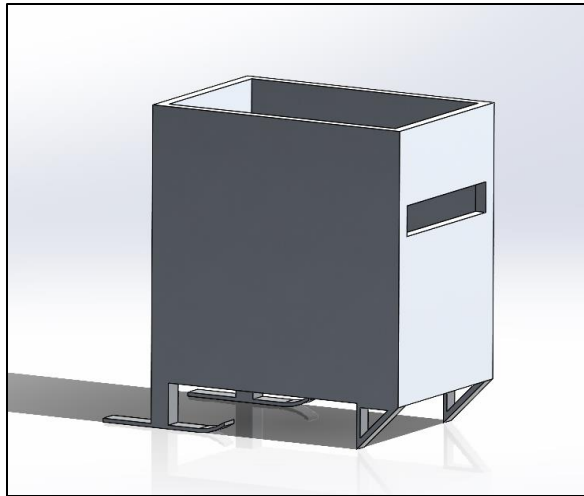
# CHOSEN DESIGN

## Customer Needs

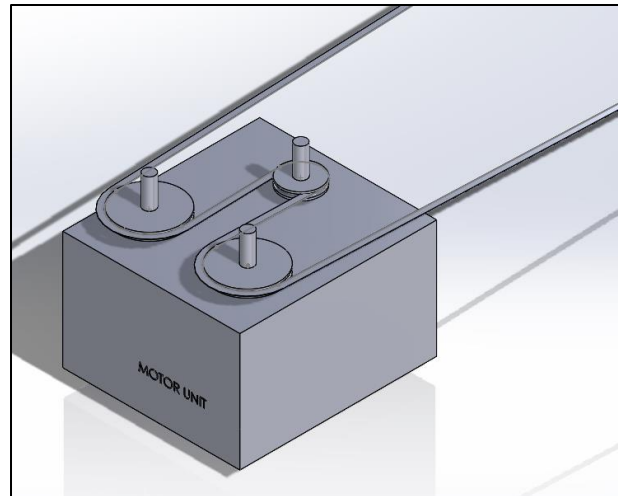
- Affordable
- Compact
- Lightweight
- Easy maintenance
- Easy transportation
- Safe
- Efficient

## Engineering Requirements

- 5-10 Riders
- 15 Horsepower
- Under 300 lbs
- 60 people/hour
- Encased mechanical parts
- Separation of input and output rope
- Steady anchorable frame



Design and 3



Design 1



Design 3

# BUDGET PLANNING

## Budget Summary

Budget	Actual	Under(Over)
\$ 1,785	\$ 1,888	\$ (103)

Projected budget of \$3000

Estimated amount based on bill of materials: \$1888

Assuming total \$3000 is fundraised - **excess of \$1000**

Manufacture costs would be minimal as most would be done by the team. Welding may be done by sponsor: **\$100-\$200** max

Excess money would be used for:

- More material for framing and top pully based on redesign
- Emergency and safety features
- Wheels and transportation devices
- Additional tie downs and mounting hardware

Kailey Lewis - 10/5/21 - 21F09\_SkiHaus

Expenses	Labor		Materials		Fixed Costs			Budget	Actual	Under(Over)
	Hrs	Rate	Units	\$/Unit	Material	Travel	Other			
Part								\$ 1,635	\$ 1,642	\$ (7)
motor			1	\$300.00				300.00	300.00	-
rope			400	\$1.72				500.00	688.00	(188.00)
snow stakes			8	\$2.95				50.00	23.60	26.40
gear box			1	\$60.00				100.00	60.00	40.00
housing unit									-	-
aluminum sheets			6	\$25.54				200.00	153.24	46.76
aluminum frame			50	\$4.80				250.00	240.00	10.00
pully			1	\$21.49				50.00	21.49	28.51
screws			50	\$0.18				10.00	8.98	1.02
top pully			2	\$21.49				50.00	42.98	7.02
frame stands			2	\$18.40				50.00	36.80	13.20
frame			2	\$5.57				15.00	11.14	3.86
ratchet straps			4	\$14.00				60.00	56.00	4.00
come along			1	\$30.00				30.00	30.00	-
gasoline			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						-	-	-

QUESTIONS???

