TRAP BAR BUDDY
FINAL PRESENTATION

Group 2

PROBLEM STATEMENT

Gym-goers using trap bars to conduct their deadlift workouts **alone** run the **risk of straining their backs** while putting on the weight plates.

POTENTIAL USER & MARKET

01 Users of Trap Bar: >7.2 Million

- **8.5 MILLION HS & COLLEGIATE LEVEL ATHLETES**
- **85% PENETRATION RATE**
- **AGES 13-25**

02 Potential Purchasers

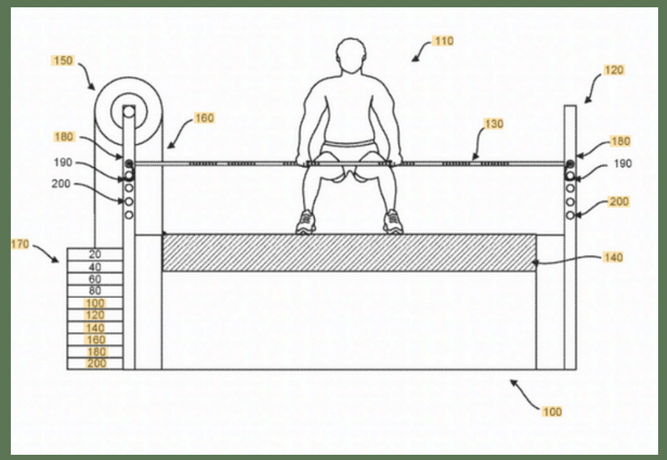
- **COMMERCIAL GYMS**
- **ATHLETIC TEAMS**
- **WEIGHTLIFTERS**

STATE-OF-THE-ART LIMITATIONS

patents that currently exsist

Alternative Deadlift Apparatus

FUNDAMENTALLY CHANGES THE EXERCISE



Trap Bar Redesign

NOTABLY THE STANDING TRAP BAR

Barbell Jacks

JACKS FOR BARBELL EXIST, THEY DO NOT WORK FOR THE TRAP BAR

BENCHMARK TESTING & SOA LIMITATIONS

DIY Methods & "Hacks" Used by Athletes

DIY Jack

VARIOUS LIMITATIONS AROUND INTUITIVENESS & DIMENSIONS

Standing Trap Bar

REQUIRES AT LEAST TWO PEOPLE TO PROP THE BAR UP

KEY SPECIFICATIONS

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- **Ease of Use**

KEY SPECIFICATIONS

- **Ease of Use**
- **Efficacy**

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- **Ease of Use**
- **Efficacy**

KEY SPECIFICATIONS

- **Ease of Use**
- **Efficacy**
- **Weight**

KEY SPECIFICATIONS

- Ease of Use
- Efficacy
- Weight
- Durability

KEY SPECIFICATIONS

- Ease of Use
- Efficacy
- Weight
- Durability
- Strength

KEY SPECIFICATIONS

- **Ease of Use**
- **Efficacy**
- **Weight**
- **Durability**
- **Strength**
- Adoptability

KEY SPECIFICATIONS

- **Ease of Use**
- **Efficacy**
- **Weight**
- **Durability**
- **Strength**
- Adoptability
- Cost

KEY SPECIFICATIONS

- **Ease of Use**
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- Safety

KEY SPECIFICATIONS

- **Ease of Use**
- **Efficacy**
- **Weight**
- **Durability**
- **Strength**
- Adoptability
- Cost
- Safety
- Aesthetics

KEY SPECIFICATIONS

- **Ease of Use**
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- **Weight**
- **Durability**
- **Strength**
- Adoptability
- Cost
- Safety
- Aesthetics
- Feasibility

SPECIFICATION	JUSTIFICATION	QUANTIFICATION
Ease of Use	Intuitive and easy to unload/load weight plates comfortably	**User Feedback on intuitveness and ease of use (scale of 1-10)**
Efficacy	How effective is the solution in preventing back strain	**User Feedback, Torque Equation, Friction Force Equation**
Weight	The solution should not cause strain to carry and move around in the gym	**Weighs under 20 pounds**
Durability	Long-lasting and reliable	**Can withstand daily use for 5+ years**
Strength	Must support the heavy weights used on a trap bar	**Able to withstand 405lbs**
Adoptability	Able to integrate into existing lift systems and settings, portable	**User Feedback**
Cost	Affortable to make it more accessible to everyone	**Less than $75**
Safety	Provide no additional safety hazards for users	**User Feedback**
Aesthetics	Aesthetically pleasing	**User Feedback - score rated on scale of 1-10**
Feasibility	Designed, built, iterated & tested within the ENGS 21 timeframe	**Fufills specifications**

RATIONALE FOR SELECTED ALTERNATIVE

IMPLEMENTATION MATRIX

	Ease of Use	Durability	Adoptability	Strength	Weight	Aesthetics	Feasibility	Cost	Safety to Use	Efficacy	Total
Weigh (1-3)	3	2	3	3	2	1	3	2	3	3	250
angle jack	6	8	5	7	6	7	9	8	6	6	168
arm jack	**9**	**9**	**7**	**7**	**7**	**8**	**9**	**8**	**8**	**9**	**203**
step-on jack	7	8	5	7	6	8	9	8	7	8	181
tilt cart	8	9	5	8	6	8	8	7	8	8	187
lever jack & hydraulic pump	8	8	5	9	4	7	7	6	8	8	178
DIY jack copy	7	7	7	6	7	7	9	8	7	6	177

MATERIALS MATRIX

	Ease of Man.	Durability	Strength	Weight	Aesthetics	Feasibility	Cost	Efficacy	recyclability	Total
Weigh (1-3)	3	2	3	2	1	3	2	3	2	270
3/4" plywood	8	6	6	6	8	9	7	8	6	151
1/8" steel	**9**	**9**	**9**	**6**	**8**	**9**	**7**	**9**	**9**	**178**
Hardwood	7	7	5	4	8	7	6	7	5	130
Plastic	5	8	7	9	5	5	5	6	3	124
Rubber	4	7	6	7	4	3	3	2	5	93

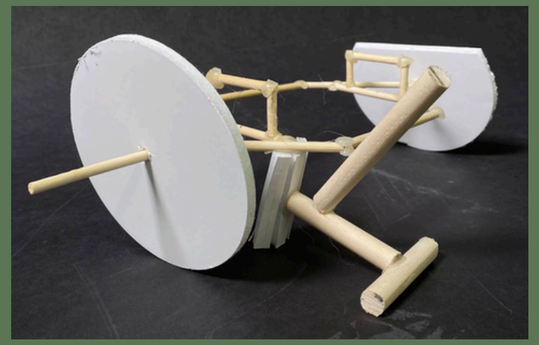
PROTOTYPE PROGRESSION

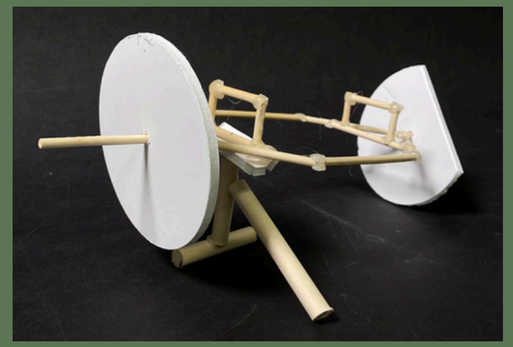
DIY JACK COPY

TILT CART

HYDRAULIC PUMP & LEVER JACK

ANGLE JACK





STEP-ON JACK

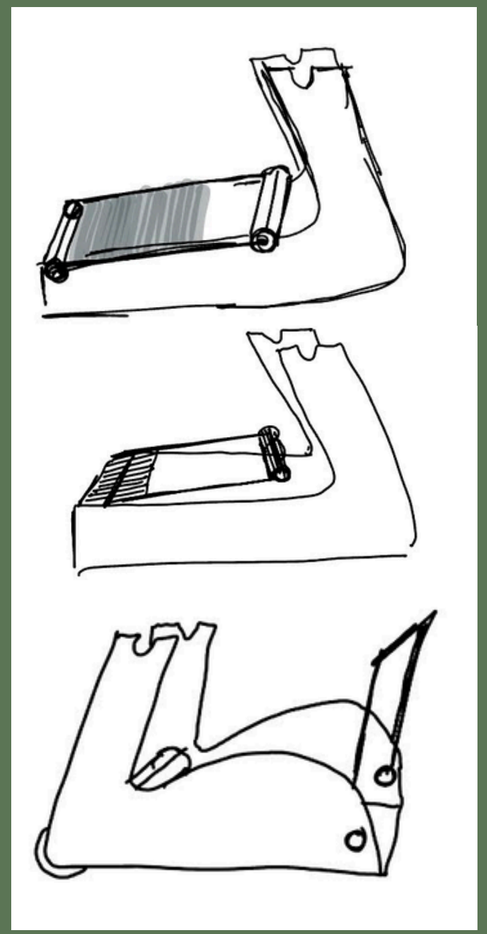
ANGLED (SINGLE) ARM JACK #1

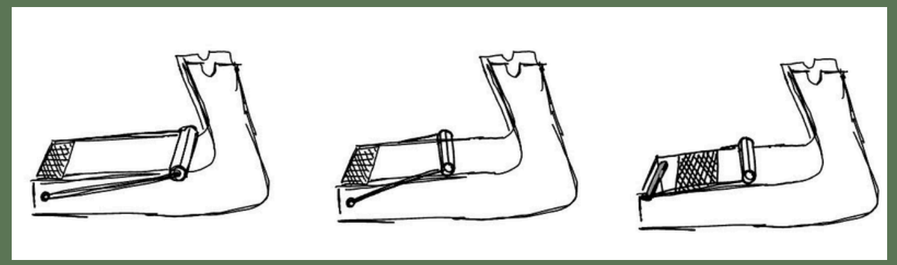
ANGLED ARM JACK #2 (WHEELS)

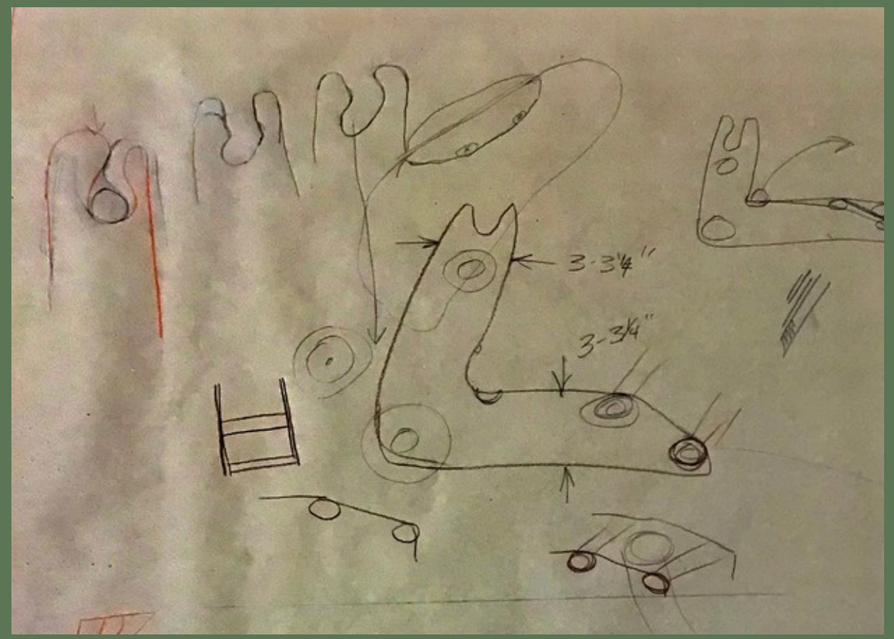
ANGLED ARM JACK #2 (ALUMINUM ROD)

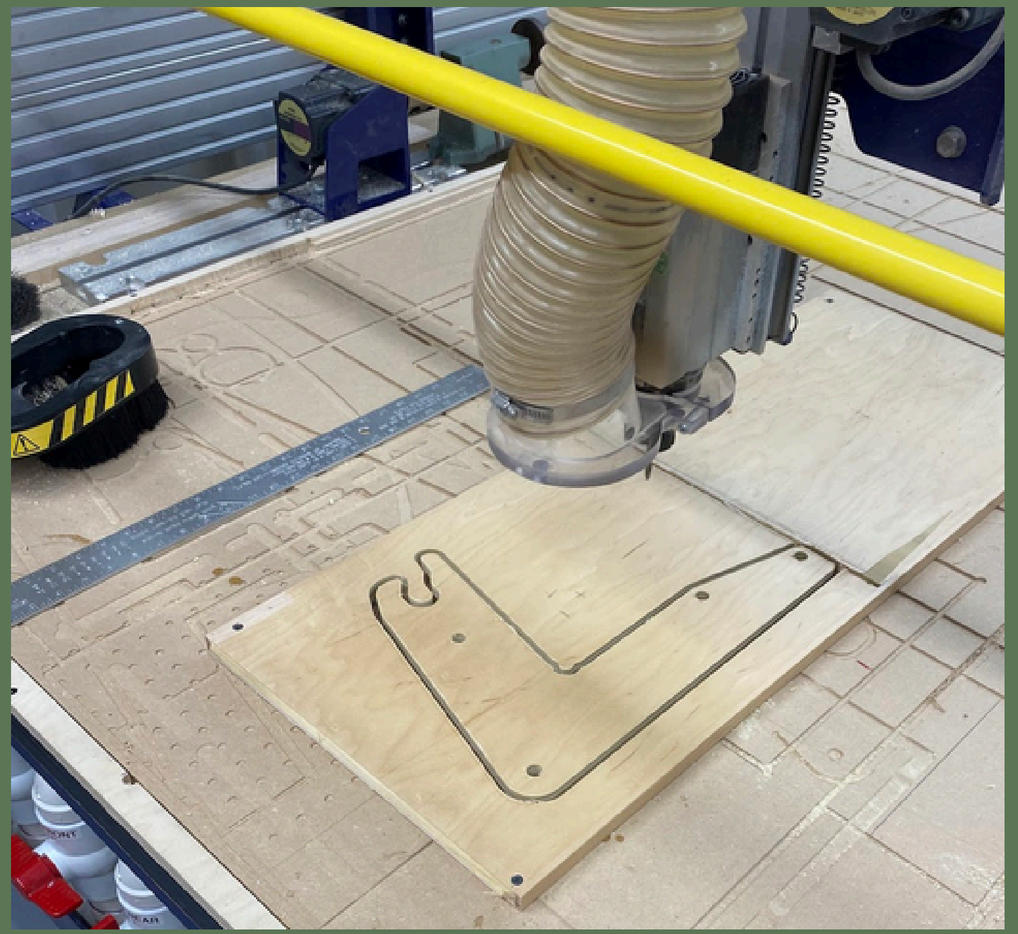
TESTING 405 LBS

USER FEEDBACK BRAINSTORMING





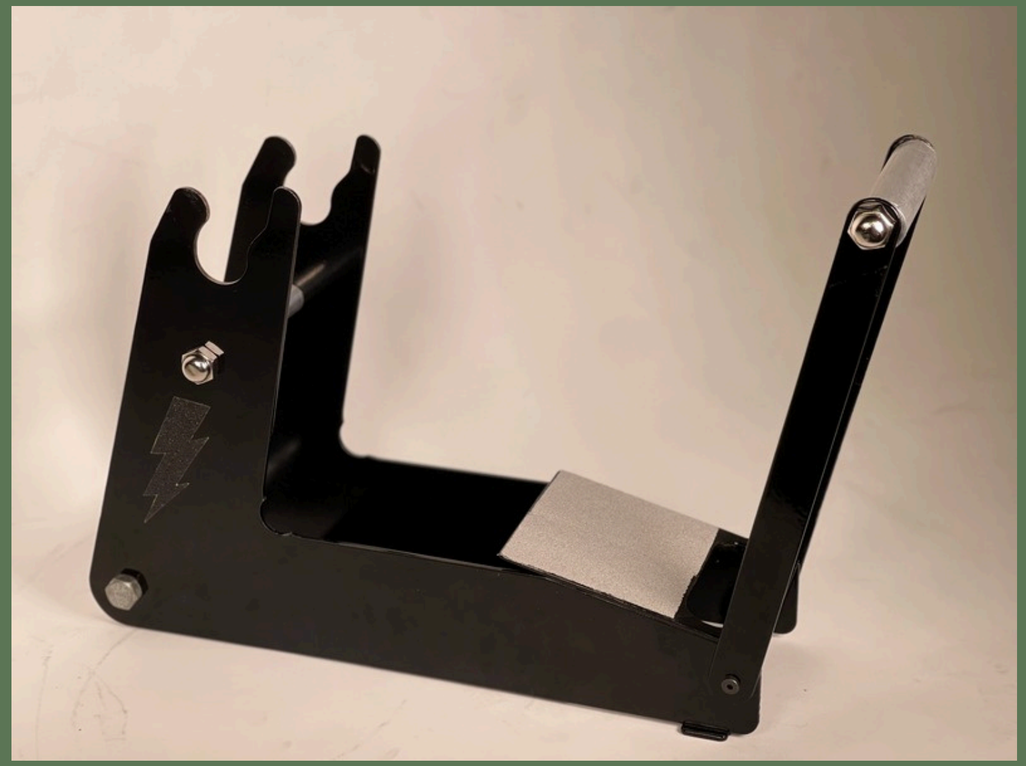




ANGLED ARM JACK #3

OUR PROTOTYPE

VS



FINAL PROTOTYPE PROCESS

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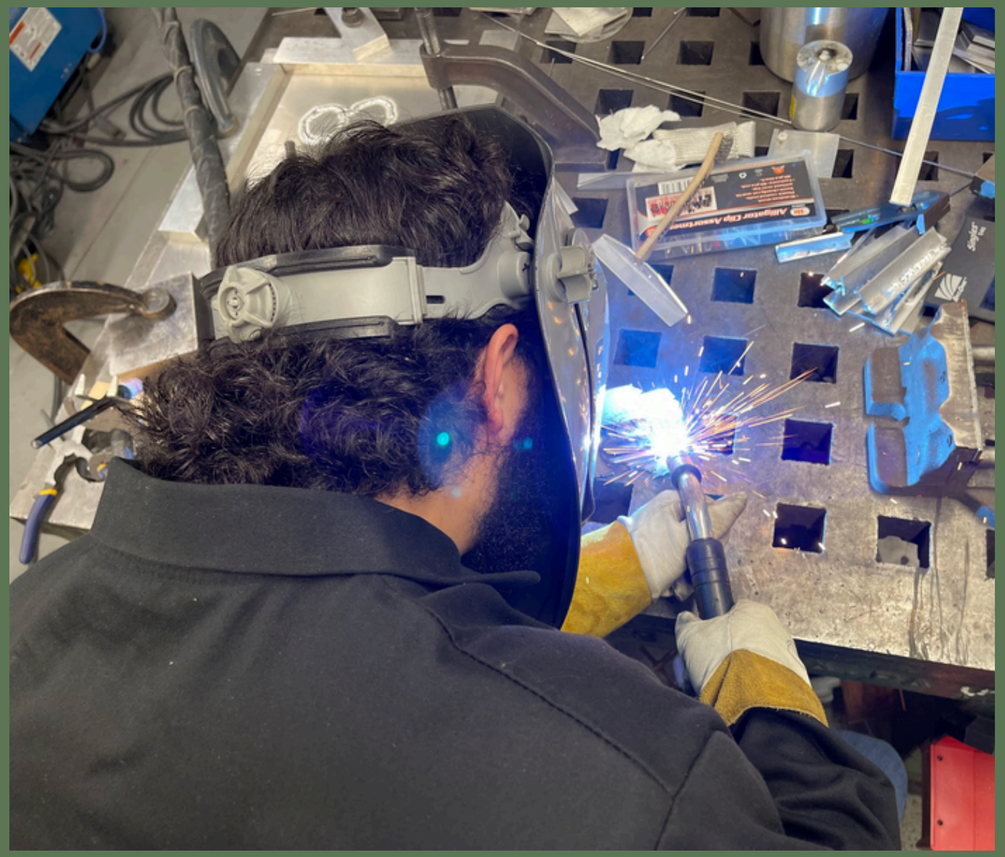
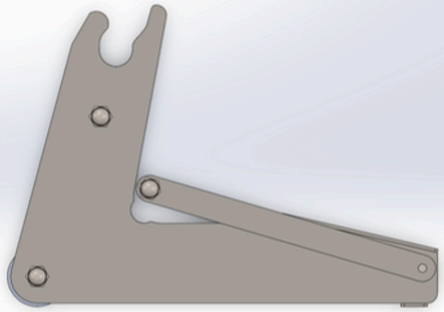
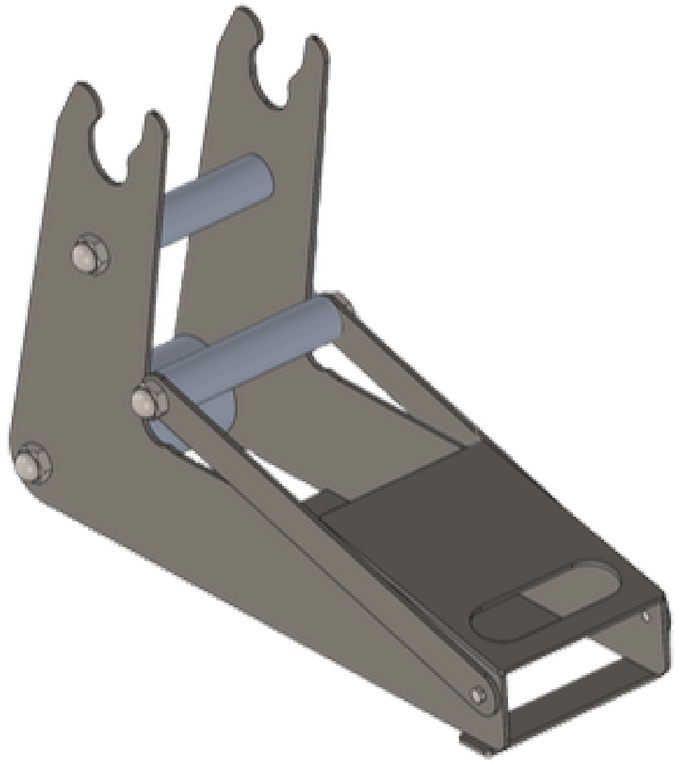
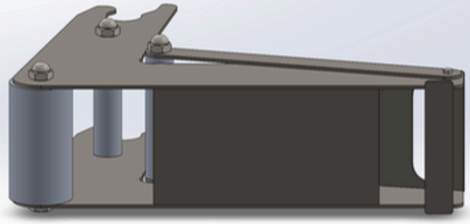
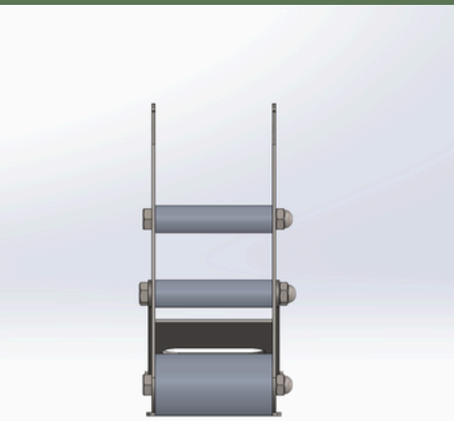


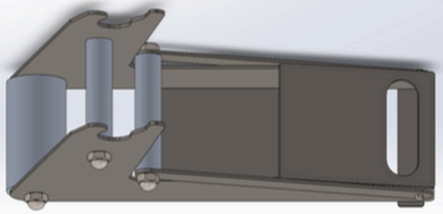
CAD MODEL











1.1.1 *Displacement*

Displacement, characterizes vibrations, is distance of a particle from its position of equilibrium:

$$\mathbf{u}(\mathbf{x},t) = \begin{pmatrix} u_1(\mathbf{x},t) \\ u_2(\mathbf{x},t) \\ u_3(\mathbf{x},t) \end{pmatrix}. \tag{1.1}$$

1.1.2 *Stress*

Stress characterizes forces applied to a material:

$$\sigma_{ij} = \underline{\boldsymbol{\sigma}} = \begin{pmatrix} \sigma_{11} & \sigma_{12} & \sigma_{13} \\ \sigma_{21} & \sigma_{22} & \sigma_{23} \\ \sigma_{31} & \sigma_{32} & \sigma_{33} \end{pmatrix}, \tag{1.2}$$

which is a tensor, and the first subscript indicates the surface applied and the second the direction (Figure 1.2).

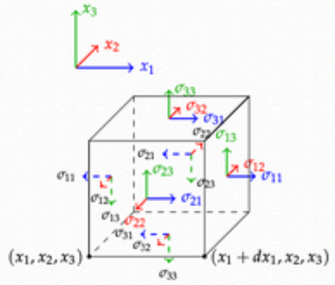


Figure 1.2: Stresses.

1.1.3 *Strain*

Strain characterizes deformations under stress. If stresses are applied to a material that is not perfectly rigid, points within it move with respect to each other, and deformation results.

Let us consider an elastic material which moves $\mathbf{u}(\mathbf{x})$ (Figure 1.3). When the original location of the material is $\mathbf{x}$, the displacement of a nearby point originally at $\mathbf{x}+\delta\mathbf{x}$ can be written as

$$u_i(\mathbf{x}+\delta\mathbf{x}) \approx u_i(\mathbf{x}) + \frac{\partial u_i(\mathbf{x})}{\partial x_j}\delta x_j = \underbrace{u_i(\mathbf{x})}_{\textit{parallel translation}} + \underbrace{\delta u_i}_{\textit{rotation+deformation}}, \tag{1.3}$$

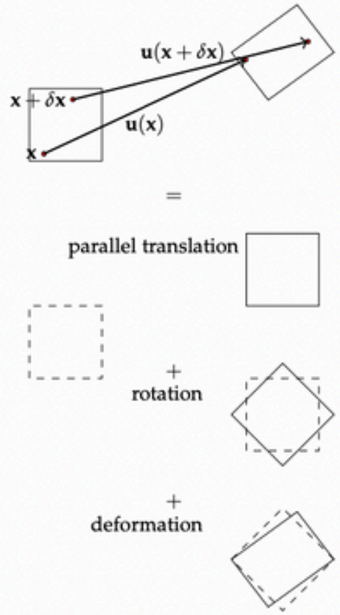
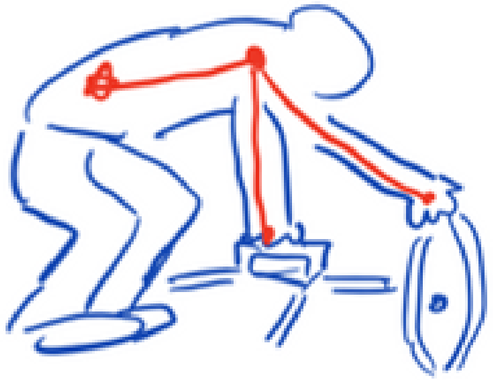


Figure 1.3: Displacement includes parallel translation, rotation, and deformation (strain).

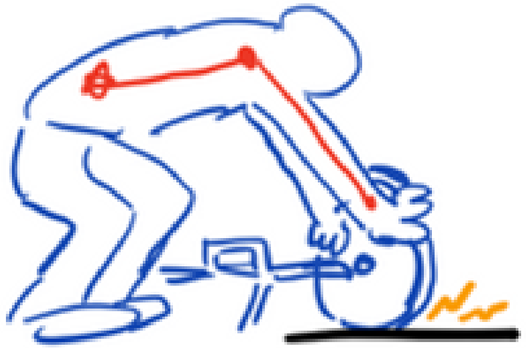
STRESS, DISPLACEMENT, STRAIN INTEPRETATIONS FROM MIT

QUANTITATIVE MEASUREMENT

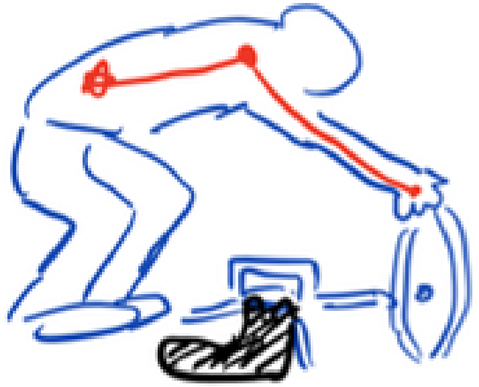
WITHOUT PROTOTYPE #1



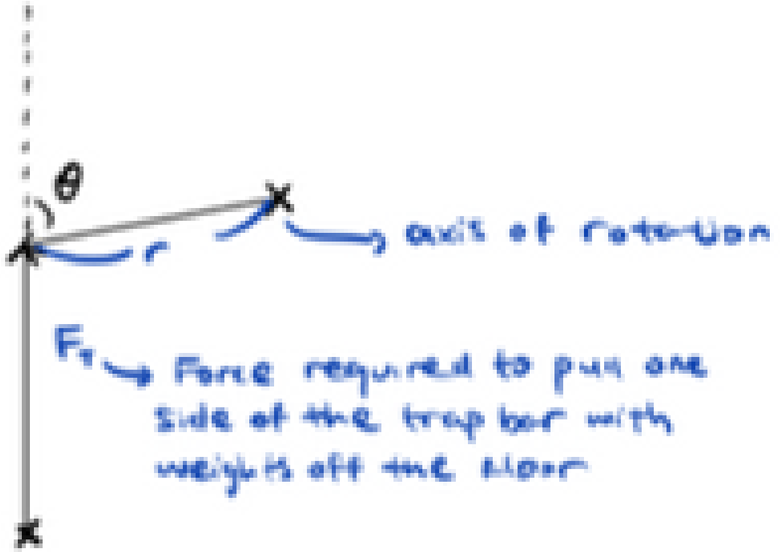
WITHOUT PROTOTYPE #2



WITH PROTOTYPE



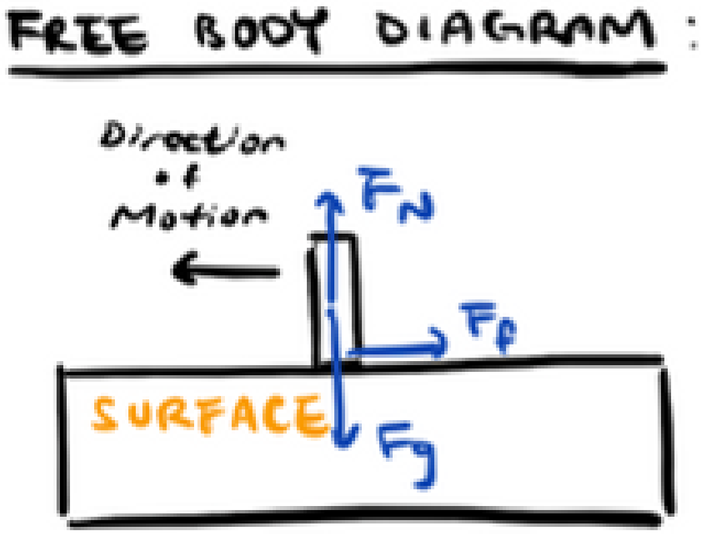
QUANTITATIVE MEASUREMENT



Average from users:
1. $\theta = 77°$
2. $r = 21.625$ inches
=0.549 meters
3. $F_{T_1} = 28.5kg$ (1 plate),
$F_{T_2} = 48.5kg$ (2 plates),
$F_{T_3} = 68.5kg$ (3 plates)

$\mathcal{T} = rFsin\theta = rmgsin\theta$
$\mathcal{T}_{T_1} = (0.549m)(28.5kg)(9.8N/kg)sin(77\,\text{deg})$
$=153.262N \cdot m$(1 plate)
$\mathcal{T}_{T_2} = (0.549m)(48.5kg)(9.8N/kg)sin(77\,\text{deg})$
$=260.814N \cdot m$(2 plates)
$\mathcal{T}_{T_3} = (0.549m)(68.5kg)(9.8N/kg)sin(77\,\text{deg})$
$=368.367N \cdot m$(3 plates)

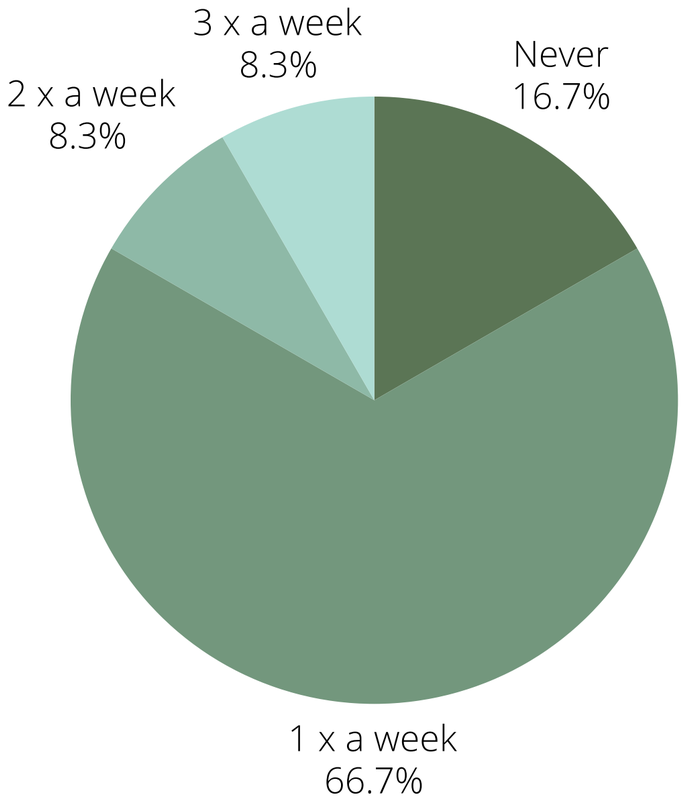
QUANTITATIVE MEASUREMENT



$\mu_s = 0.6$ (between rubber plate and concrete)
$F_g = (20kg)(0.8N/kg) = 196.2N$ (1 plate)
$F_g = F_N, F_f = \mu_s F_g \Rightarrow F_f = (0.6)(196.2N) = 177.72N$

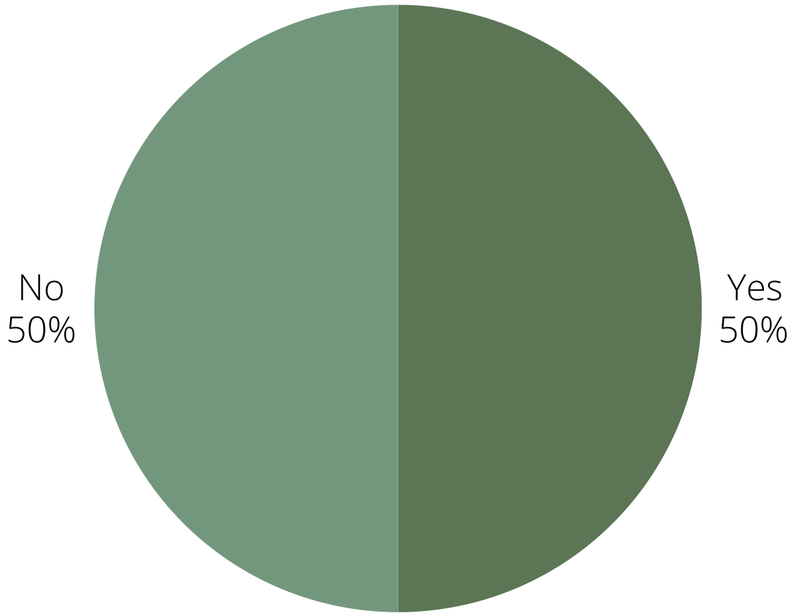
USER TESTING

How often do you trap bar deadlift?



12 USER TESTING SESSIONS

Do you have pre-existing back pain?



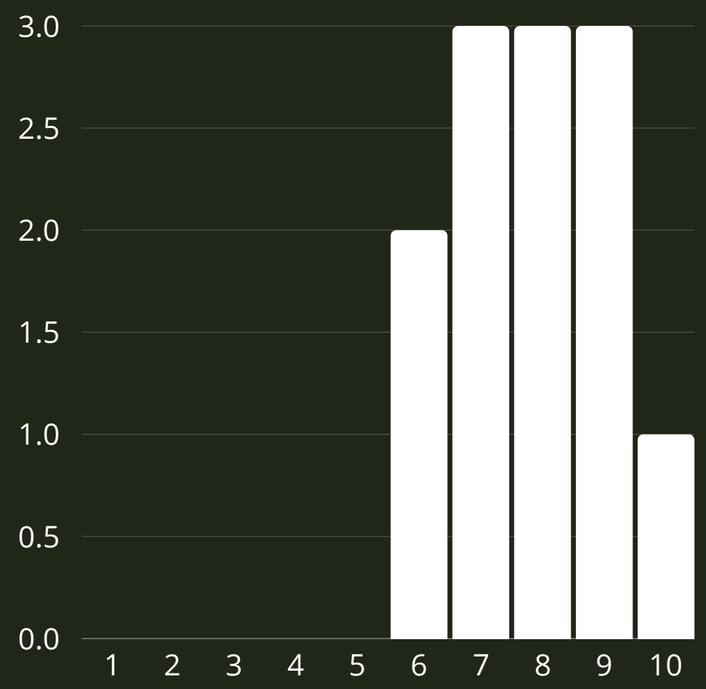
Do you feel this relieved backstrain?

Efficacy

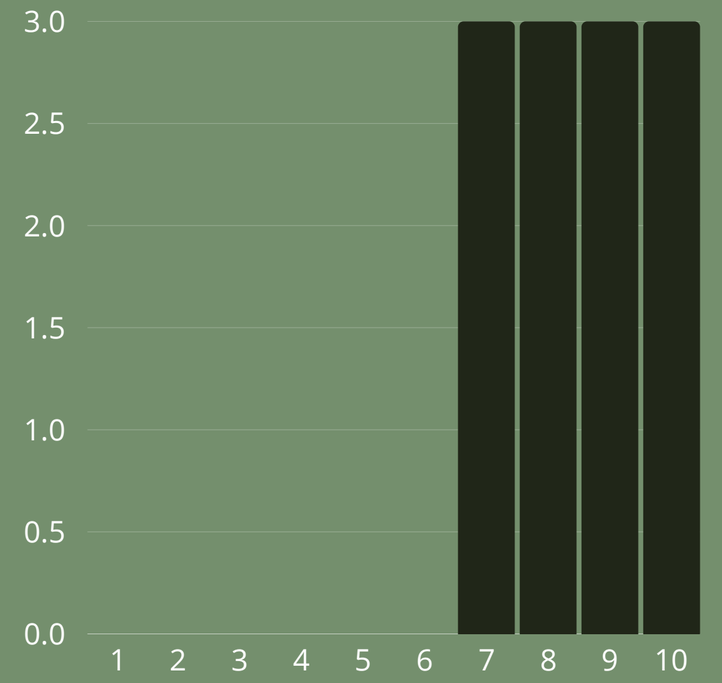

SAMSON
SAMSON

Ease of Use

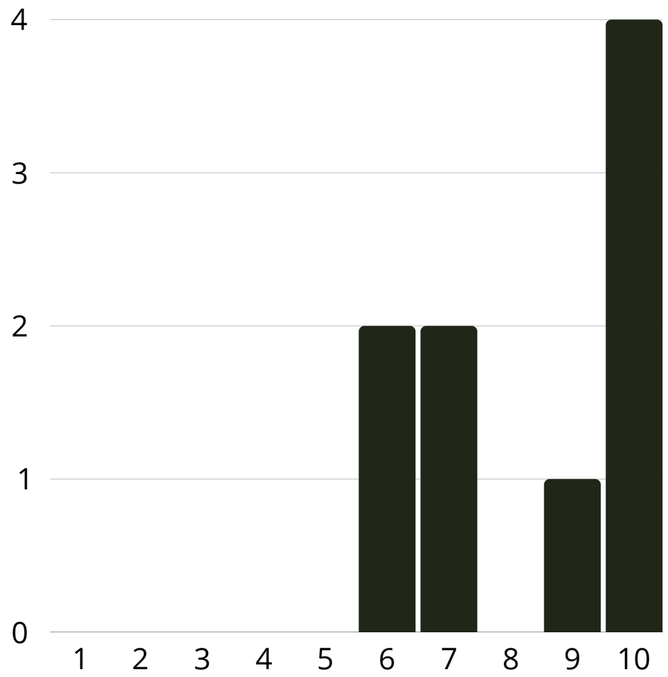
Is it intuitive?
(On a scale of 1-10)



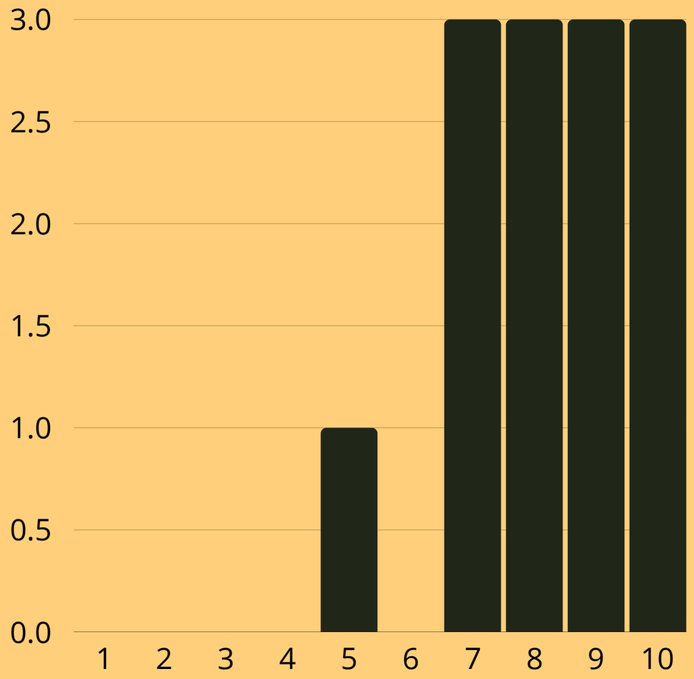
How easy is it to use?
(On a scale of 1-10)



How aesthetic is the product?
(On a scale of 1-10)

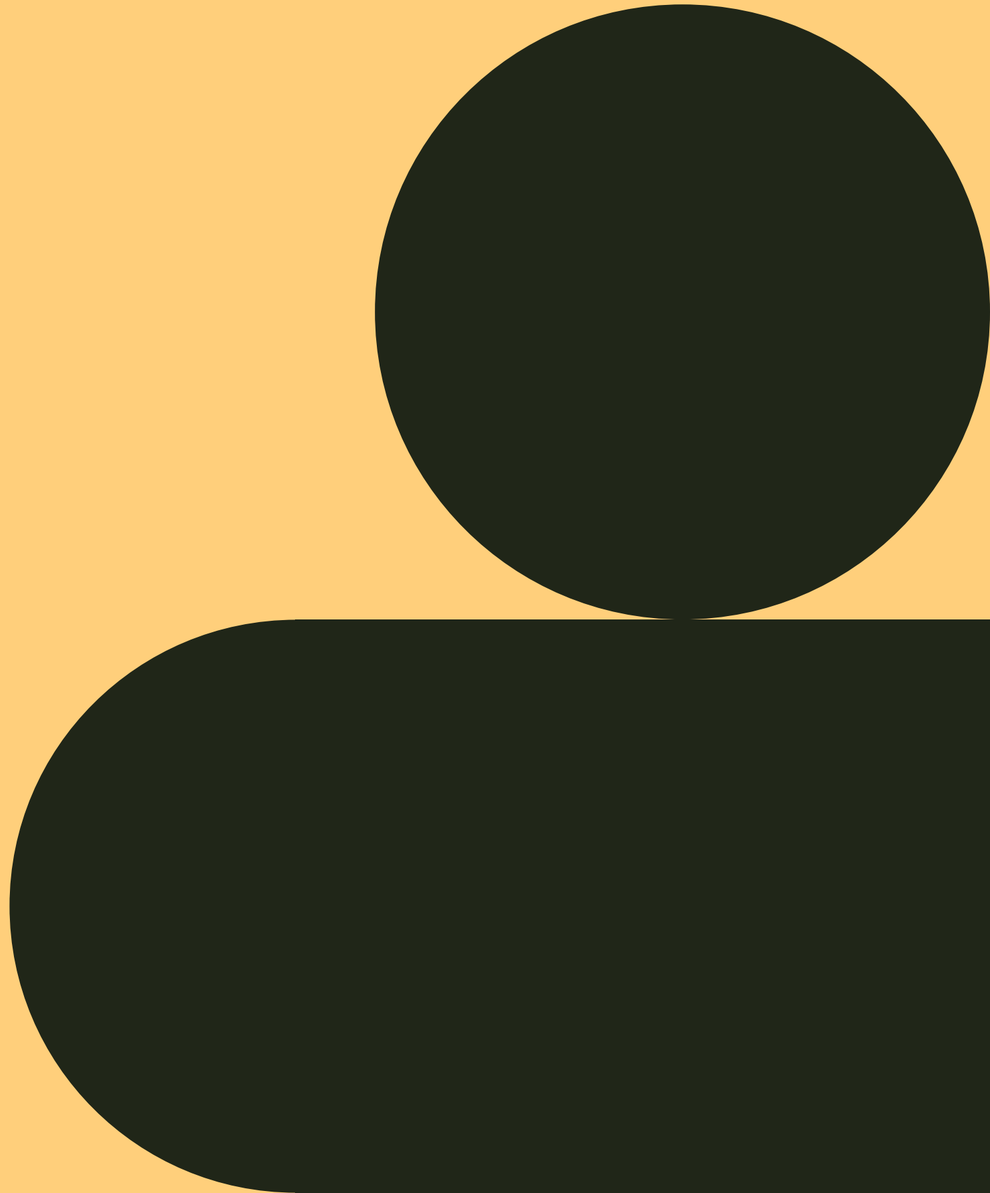


Would you implement this into your lifting regime?
(On a scale of 1-10)



Aesthetics

BUSINESS PLAN



FIXED COSTS

FIXED COSTS & CAPTIAL EQUIPMENT: JOUNRAL ENTRIES FOR JAN 1 2023					
1	Purchasing of the plasma cutter				* Assumption of a 10 year life cycle for captial equipment
					* Assuming no salvage cost of the captial equipment
		Account	DR	CR	
	Cash		$4,500		
		Equipment		$4,500	
2	Purchasing of the Hypertherm Table				
		Account	DR	CR	
	Cash		$18,000		
		Equipment		$18,000	
3	Yearly payment of rent paid upfront				
		Account	DR	CR	
	Cash		$60,000		
		Pre-paid rent		$60,000	
4	Upfront payment of yearly electiricty				
		Account	DR	CR	
	Cash		$2,364		
		Pre-paid utilites		$2,364	
5	Retainer for in-house council and insurance expense				
		Account	DR	CR	
	Cash		$15,000		
		Pre-paid legal expense		$15,000	
6	Advertising and marketing agency				
		Account	DR	CR	
	Cash		$20,000		
		Pre-paid Marketing Expense		$20,000	
7	Yearly administrative expense of staff				
		Account	DR	CR	
	Cash		$230,000		
		Salary expense		$230,000	
8	Pre-paid monthly consumables for capital equipment				* assuming $150 per month
		Account	DR	CR	
	Cash		$1,800		
		Pre-paid consumables		$1,800	

VARIABLE COSTS

STEEL	Tons	Sheets	Cost $	$/sheet	$/unit
	1	13.5	2362.50	175.00	14.583333
	5	67.5	11221.88	166.25	13.854167
	10	135	21321.56	157.94	13.161458
	15	202.5	30383.23	150.04	12.503385
	20	270	38485.42	142.54	11.878216
	25	337.5	45701.44	135.41	11.284305
	30	405	52099.64	128.64	10.72009
	35	472.5	57743.77	122.21	10.184086
	40	540	62693.23	116.10	9.6748813
	45	607.5	67003.39	110.29	9.1911372
	50	675	70725.80	104.78	8.7315804
	55	742.5	73908.46	99.54	8.2950013
	60	810	76596.04	94.56	7.8802513
	65	877.5	78830.09	89.83	7.4862387
	70	945	80649.25	85.34	7.1119268
	75	1012.5	82089.41	81.08	6.7563304
	80	1080	83183.94	77.02	6.4185139
	85	1147.5	83963.79	73.17	6.0975882
	90	1215	84457.69	69.51	5.7927088
	95	1282.5	84692.30	66.04	5.5030734

ALUMINIUM	Units	Tubes	Cost $	$/Unit	
	32	1	61.7	1.928125	
	64	2	123.4	1.928125	
	96	3	185.1	1.928125	
	128	4	246.8	1.928125	
	160	5	308.5	1.928125	
	192	6	370.2	1.928125	
	224	7	431.9	1.928125	
	256	8	493.6	1.928125	
	288	9	555.3	1.928125	
	320	10	586.2	1.831875	discount 5%
	352	11	644.82	1.831875	
	384	12	703.44	1.831875	
	416	13	762.06	1.831875	
	448	14	820.68	1.831875	
	480	15	832.95	1.7353125	discount 10%
	512	16	888.48	1.7353125	
	544	17	944.01	1.7353125	
	576	18	999.54	1.7353125	
	608	19	1055.07	1.7353125	
	640	20	1048.9	1.6389063	discount 15%

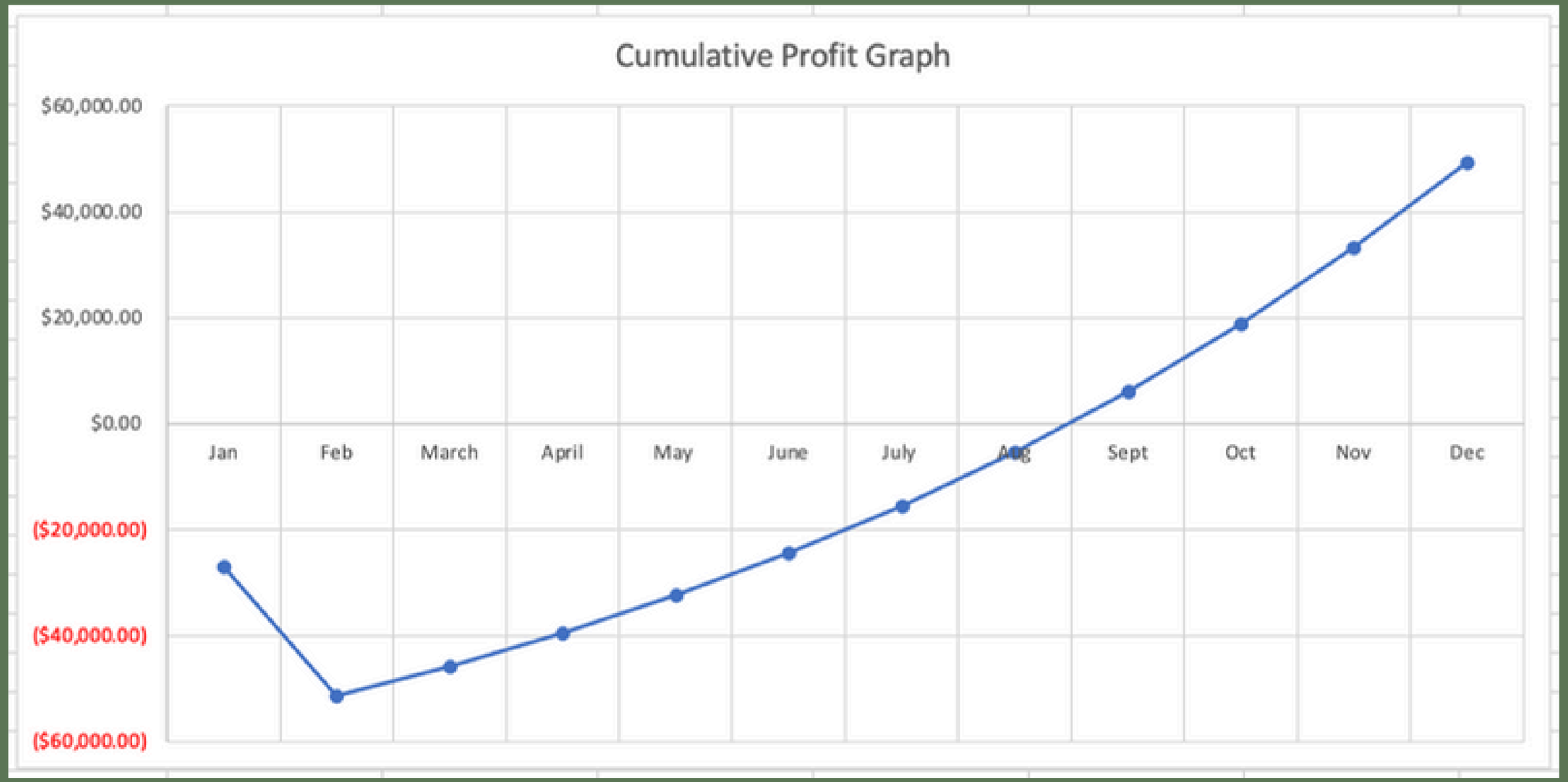
HEX	Cost $	$/unit		WASHER	Cost $	$/unit
100	$30	$0.30		9700	510.68	0.0526474
200	$60	$0.30		19400	1021.36	0.0526474
300	$90	$0.30		29100	1532.04	0.0526474
400	$120	$0.30		38800	2042.72	0.0526474
500	$150	$0.30		48500	2298.06	0.0473827
600	$180	$0.30		58200	2757.672	0.0473827
700	$210	$0.30		67900	3217.284	0.0473827
800	$240	$0.30		77600	3676.896	0.0473827
900	$270	$0.30		87300	4136.508	0.0473827
1000	270	$0.27	10% discount	97000	4340.78	0.0447503
1100	297	$0.27		106700	4774.858	0.0447503
1200	324	$0.27		116400	5208.936	0.0447503
1300	351	$0.27		126100	5643.014	0.0447503
1400	378	$0.27		135800	6077.092	0.0447503
1500	405	$0.27				
1600	432	$0.27				
1700	459	$0.27				
1800	486	$0.27				
1900	513	$0.27				

	YEAR 1			YEAR 2			YEAR 3
	12.5% growth/month			7.5% growth/month			5% growth/month
2023			2024			2025	
January	500		January	1964		January	4569
Feb	550		Feb	2111		Feb	4798
March	605		March	2270		March	5037
April	666		April	2440		April	5289
May	732		May	2623		May	5554
June	805		June	2820		June	5831
July	886		July	3031		July	6123
August	974		August	3258		August	6429
September	1072		September	3503		September	6751
October	1179		October	3766		October	7088
November	1297		November	4048		November	7443
December	1427		December	4352		December	7815
23YE	10692	units	24YE	36185		25YE	72727

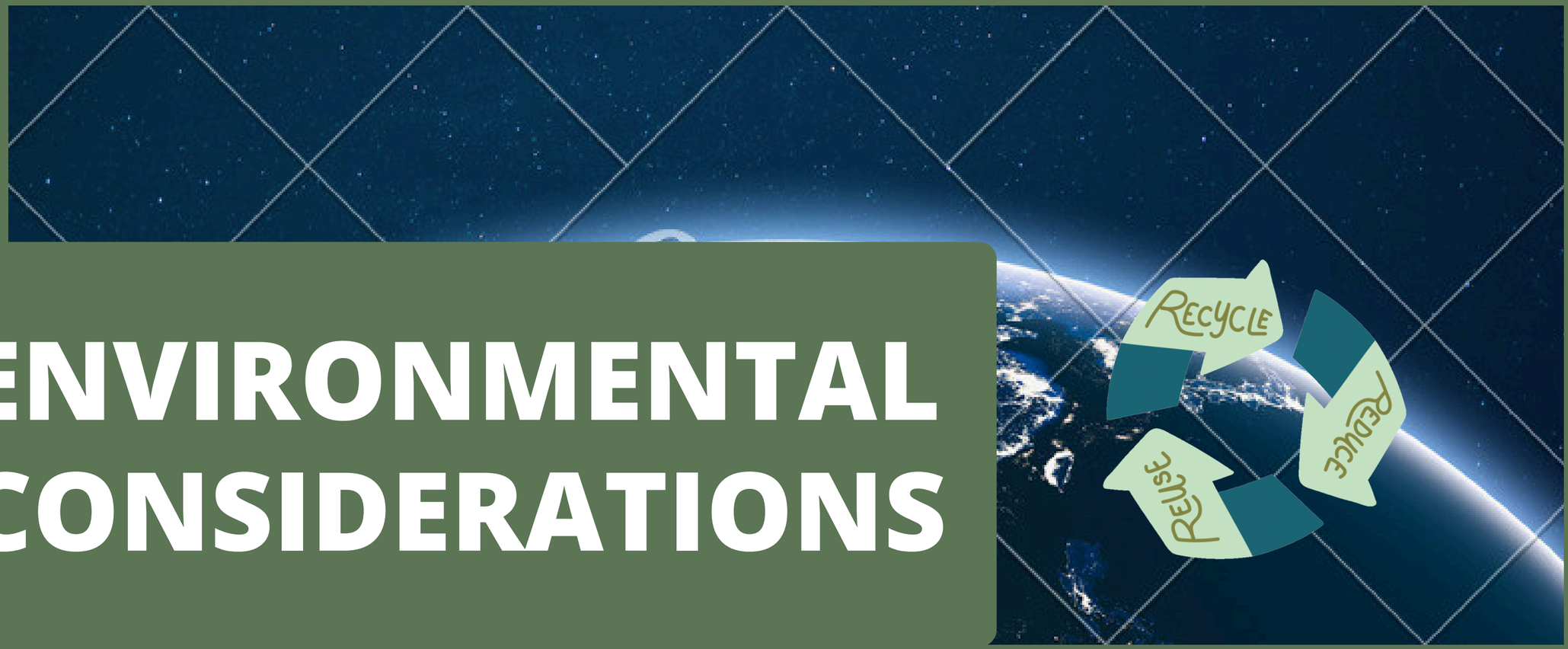
		Monthly Payment
LOAN	$205,457.31	
TOTAL LOAN PAYMENT with 10% ir (c.a.)	$226,003.04	$18,833.59
Loan Assumptions		
Took 6 months of Y1 Revenue		
Assumed 10% interest rate per annum (not compounded monthly)		
Paid off over 1 business year		

Price per Unit		$50											
Variable Cost		$7.78	<<< Y1										
Year		2023											
Month		Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Sales Volume		500	562.50	632.81	711.91	800.90	901.02	1013.64	1140.35	1282.89	1443.25	1623.66	1826.62
Revenue		$25,000	$28,125	$31,641	$35,596	$40,045	$45,051	$50,682	$57,017	$64,145	$72,163	$81,183	$91,331
Variable Cost		$3,891.05	$4,377.43	$4,924.61	$5,540.18	$6,232.70	$7,011.79	$7,888.27	$8,874.30	$9,983.59	$11,231.53	$12,635.48	$14,214.91
Contribution		$21,108.95	$23,747.57	$26,716.02	$30,055.52	$33,812.46	$38,039.02	$42,793.90	$48,143.14	$54,161.03	$60,931.16	$68,547.55	$77,115.99
Fixed Cost													
Rent													
$60,000		$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000
Captial Cost													
$24,300		$2,025	$2,025	$2,025	$2,025	$2,025	$2,025	$2,025	$2,025	$2,025	$2,025	$2,025	$2,025
Utilities													
$2,364		$197	$197	$197	$197	$197	$197	$197	$197	$197	$197	$197	$197
Marketing													
$20,000		$1,666.67	$1,666.67	$1,666.67	$1,666.67	$1,666.67	$1,666.67	$1,666.67	$1,666.67	$1,666.67	$1,666.67	$1,666.67	$1,666.67
Legal & Insurance													
$15,000		$1,250	$1,250	$1,250	$1,250	$1,250	$1,250	$1,250	$1,250	$1,250	$1,250	$1,250	$1,250
Admin Staff													
$230,000		$19,166.67	$19,166.67	$19,166.67	$19,166.67	$19,166.67	$19,166.67	$19,166.67	$19,166.67	$19,166.67	$19,166.67	$19,166.67	$19,166.67
Total Fixed Cost		$29,305	$29,305	$29,305	$29,305	$29,305	$29,305	$29,305	$29,305	$29,305	$29,305	$29,305	$29,305
Loan Payments		$18,833.59	$18,833.59	$18,833.59	$18,833.59	$18,833.59	$18,833.59	$18,833.59	$18,833.59	$18,833.59	$18,833.59	$18,833.59	$18,833.59
Profit		($27,029.97)	($24,391.35)	($21,422.90)	($18,083.40)	($14,326.46)	($10,099.90)	($5,345.02)	$4.22	$6,022.11	$12,792.24	$20,408.63	$28,977.07
Cumulative Profit		($27,029.97)	($51,421.31)	($45,814.25)	($39,506.30)	($32,409.85)	($24,426.36)	($15,444.92)	($5,340.81)	$6,026.32	$18,814.34	$33,200.87	$49,385.70

YE2023 Analysis	Price/Unit	COGS/Unit	Variable $/Unit	Cost/Unit	Profit/Unit
	$50	$7.78	$28.27	$36.05	$13.95


Cumulative Profit Graph
$60,000.00
$40,000.00
$20,000.00
$0.00
($20,000.00)
($40,000.00)
($60,000.00)
Jan
Feb
March
April
May
June
July
Aug
Sept
Oct
Nov
Dec

ENVIRONMENTAL CONSIDERATIONS



1

PLYWOOD

can only be recycled when untreated, unpainted, and unstained

2

STEEL

100% recyclable

maintain quality

3

ALUMINUM

recycling rate exceeds 90%

recycling energy = 5% producing energy

NEXT STEPS

+ RUBBER PADDING

Decrease Noise

Protect the Floor

FATTER GRIP

Adapt to New Trap Bars

Adapt to Barbells

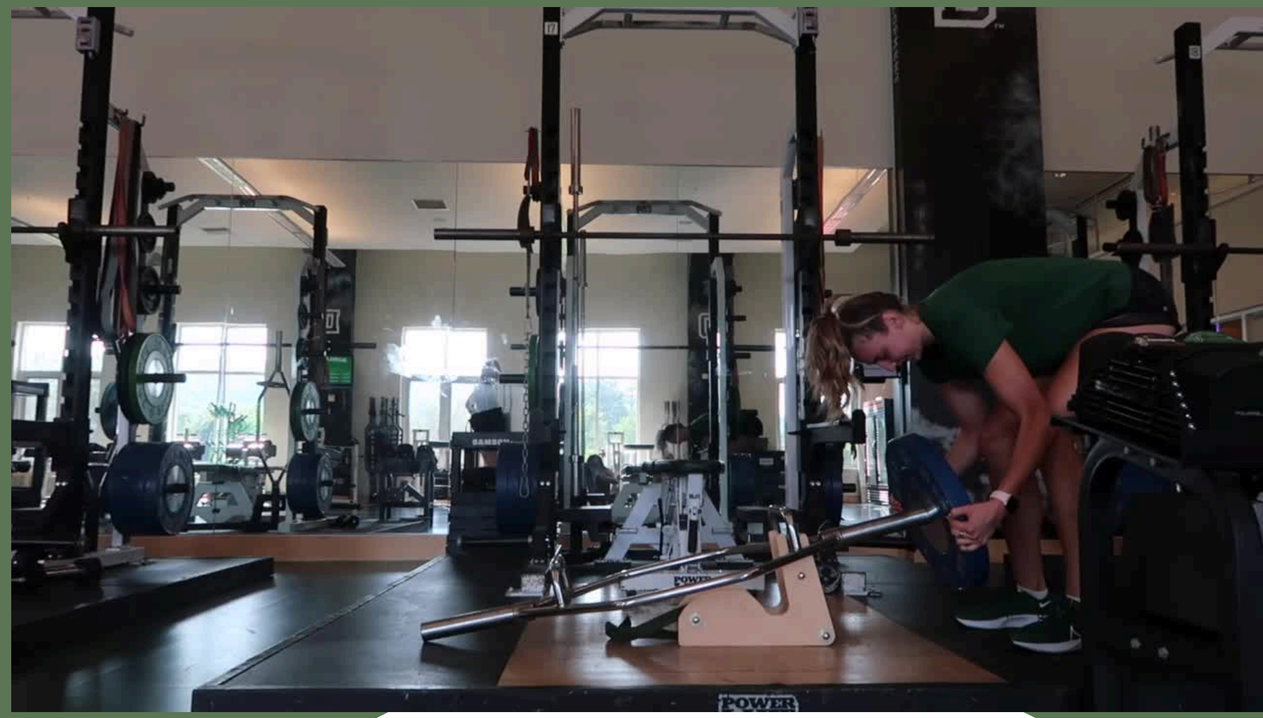
PATENT

Cheryl Junker & Dartmouth TTO

Invention Disclosure Form


WERK SAN
TÜRKEI
45
LBS
DEVELOPMENT


SAMSON
WERK SAN
TÜRKEI
45
LBS



USER TESTING WITH VOLLEYBALL

USER TESTING WITH RUGBY

TALKING TO S&C COACHES

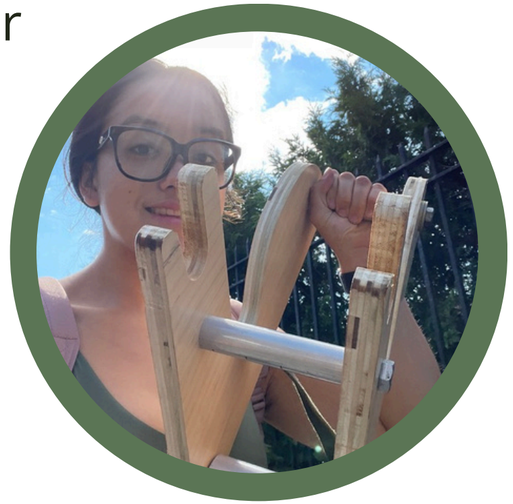
SEPTEMBER 2021

GROUP MEMBERS

Natalie Grover

Jihwan Choi

Selena Han



Hannah Sheehy

Frederico Goudie

QUESTIONS?