IRA A. FULTON SCHOOLS OF engineering
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Rollyn Royce

Propulsion driven wheelchair attachment enabling lever and gear integrated suite for current wheelchair

Problem Statement

Modern wheelchair lack multiple modes of propulsion, which mostly focus only on moving wheels using your wrist. This can cause repetitive stress injuries and suboptimal propulsion modes

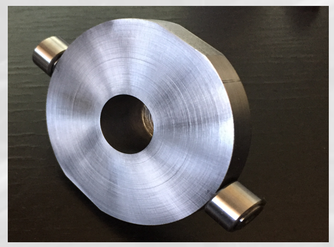
Requirements

Requirements were derived from VOC needs from various personal accounts, research and media

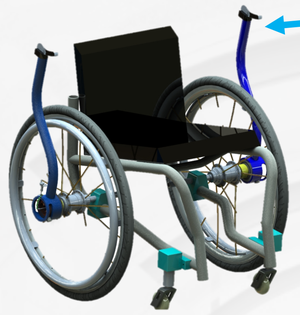
Voice of the Customer Needs	Measurable Requirement
Better propulsion efficiency	Drive mechanism required less work
Gear Reduction	Increased torque per stroke
Compactable	Must fit within a 10 cubic meter space
Lighter weight	Must be less than 30kg
Durable	Must withstand fatigue and not fail
Less complex	More standard parts in wheelchair

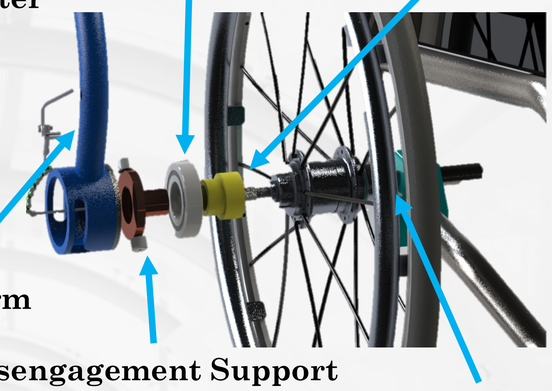
Development

Trains & Cheesecake encountered numerous challenges that threatened the success of Rollyn Royce. Despite setbacks, our main goals were satisfied and a final design was established. Using our engineering knowledge we looked for ideal designs to decrease manufacturing lead times and develop our prototype.



Final Design

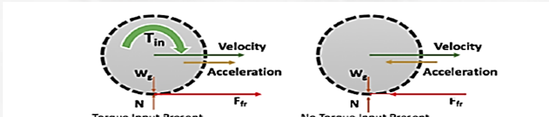




Spec Sheet			
Gearing Ratio	1:1	3:4	1:2
Dimensions	7.84” x 3.228” x 24.5”		
Lever Length	23.5 in		
Weight	6.3 lbs		
Wheel Size	26’’ Spoked Wheels		

Validation

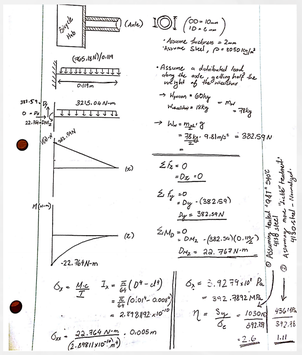
- Hand Calculations (Propulsion efficiency, transportation effectiveness, stresses)
- ANSYS (stress and fatigue simulations)
- Physics involved (FBD, Energy, Static and Kinematics)

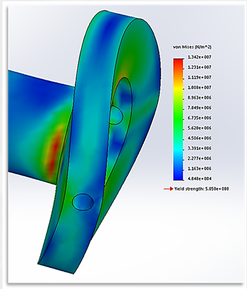


**When Input Torque is present opposing torque from friction counteracts the moment. When no torque is present, the friction changes direction to prevent motion

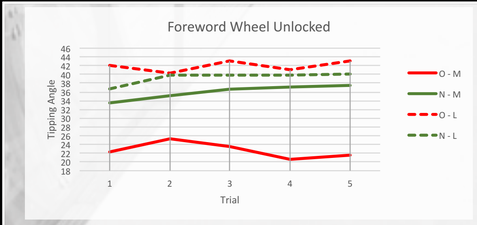
Figure 5.14: Defining Physics for Rolling with ‘No-Slip’

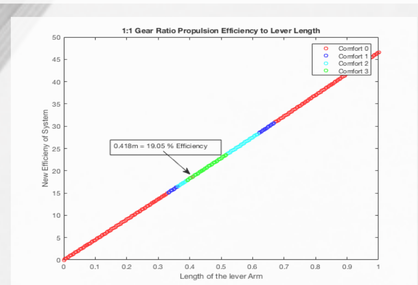
Axle equations





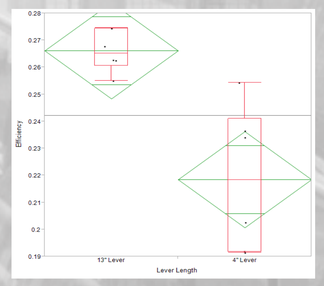
Von Mises stress of the disengagement support

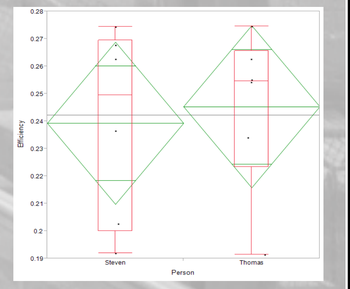




Testing

- Lever length effect on caloric output and wattage generation.
- Tilt-Testing to identify tipping angles
- Maneuverability testing to validate ISO 7176-1 requirement
- User centered optimum lever length testing
- Propulsion Efficiency comparing traditional and new Design





Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Lever Length	1	0.00682481	0.006825	17.8416	0.0018*
Error	10	0.00382522	0.000383		
C. Total	11	0.01065004			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
13" Lever	6	0.266161	0.00798	0.24837	0.28395
4" Lever	6	0.218465	0.00798	0.20057	0.23626

Std Error uses a pooled estimate of error variance

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Person	1	0.00010924	0.000109	0.1036	0.7541
Error	10	0.01054080	0.001054		
C. Total	11	0.01065004			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Steven	6	0.239296	0.01325	0.20976	0.26883
Thomas	6	0.245330	0.01325	0.21580	0.27486

Std Error uses a pooled estimate of error variance