National Science Foundation
WHERE DISCOVERIES BEGIN

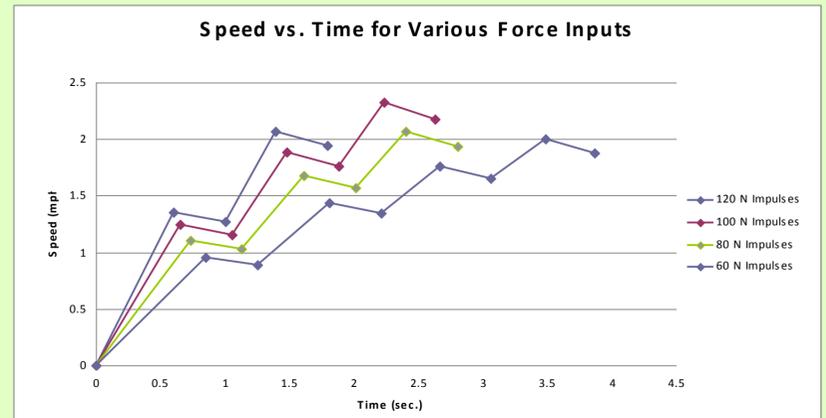# One- Arm Manual Powered Wheelchair

Project Background: Typical wheelchairs are difficult to operate for individuals who lack full use of both upper extremities. The desired wheel chair will enable stroke patients to independently power and steer the manual chair. While there is a specific customer in mind for this project, it is expected that successful development of such a wheelchair will benefit a wide variety of patients with one arm function.

Mission Statement: The purpose of this project is to develop a manual-powered wheelchair that can be operated by stroke patients or any other individual who has a reduced capacity to perform bilateral operation of a standard manual wheelchair.

Key Customer Needs

-Must be useable by persons with one-arm function

-Must be foldable for transport

-Should be able to traverse common terrain (tile, carpet, concrete, etc.)

-Range of motion of arm should be within acceptable boundaries

-Must be able to be maneuvered through a standard wheelchair accessible doorway

-Forces applied to propel wheelchair must be safe for users

-Must be able to handle a maximum of 250 lbs. weight limit (95th percentile male)

-Weight of wheelchair should be minimal.

-Must be able to remain stationary on a 1:12 ADA standard ramp grade

Force Analysis

Speed vs. Time for Various Force Inputs

- 120 N Impulses
- 100 N Impulses
- 80 N Impulses
- 60 N Impulses

The chart above displays the time required to achieve a speed of just under 2 mph for various inputs of force. Each peak denotes a power pulse or a round-trip movement of the lever. The chart shows that the lower the amount of force applied the longer it takes to achieve a desired speed.

Final Design
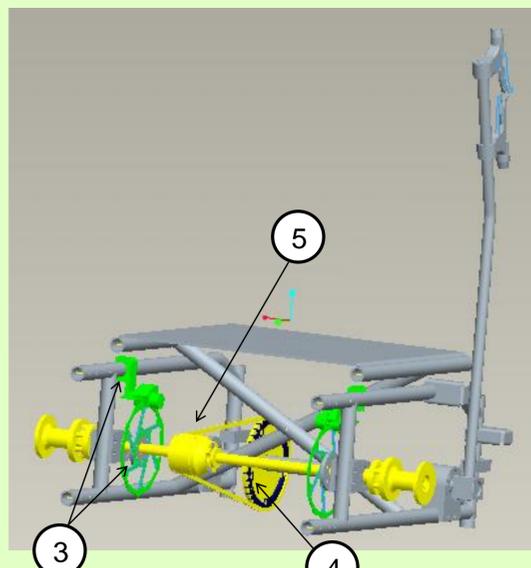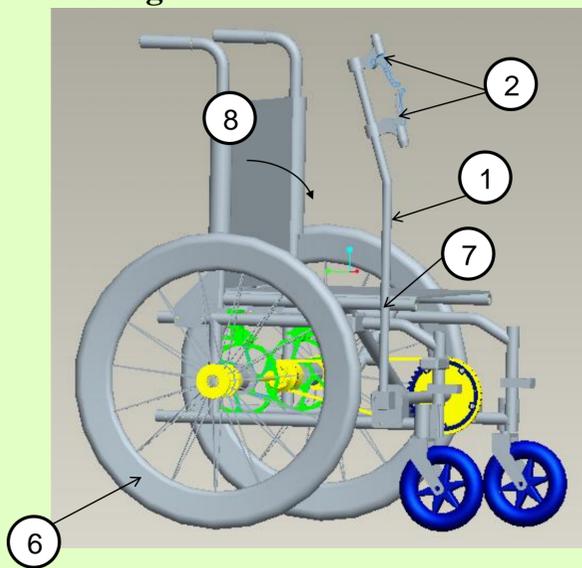
1- Lever Propulsion System

2- Brake Levers

3- Brake System

4- Gear System

5- Open Differential

6- Removable Wheels

7- Foldable Lever

8- Fold down back

The propulsion lever (1) is connected to the front axle. The gear on the front axle is chained to the gear on the back axle (4), transferring power to the rear axle. An open differential (5) on the back axle controls power to the wheels. The braking system (3) is controlled by the brake levers (2). To turn, the user depresses one brake lever and the open differential (5) transfers all power to the wheel that is not braking, turning the wheelchair around the braking wheel. To fold, the wheels remove (6), the lever folds over the seat (7), and the back folds down (8).
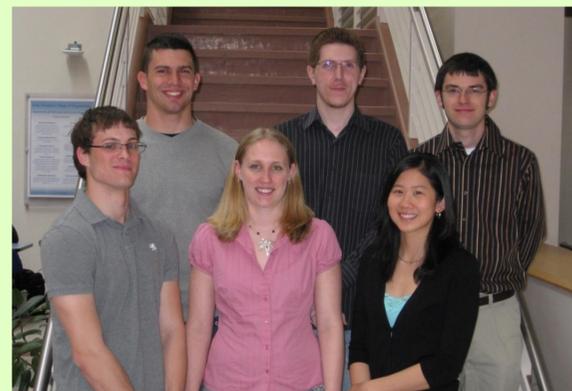
NIOSH Lifting Analysis

Figure 1 Graphic Representation of Hand Location
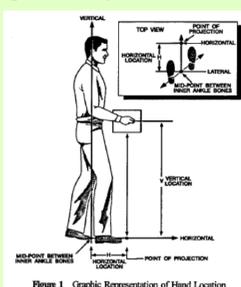
Using an estimated weight of 33 lbs. the NIOSH lifting index was calculated to be 1.01 and 1.44. A value over 1 poses an increased risk for some, but is still considered safe for a task that is not performed very often.

STEP 1. Measure and record task variables

Object Weight (lbs)		Hand Location				Vertical Distance	Asymmetric Angle (deg.)		Frequency Rate	Duration	Object Coupling
		Origin		Dest.			Origin	Destination	lifts/min	Hrs	
L(AVG)	L(MAX)	H	V	H	V	D	A	A	F		C
33	45	12	15	18	38	23	0	30	<.2 (.004)	<1	Good

STEP 2. Determine the multipliers and compute the RWLs

	RWL =	LC	×	HM	×	VM	×	DM	×	AM	×	FM	×	CM		
ORIGIN	RWL =	51	×	.83	×	.89	×	.9	×	1	×	1	×	1	-	32.37 lbs.
DEST.	RWL =	51	×	.56	×	.94	×	.9	×	.9	×	1	×	1	-	22.88 lbs.

STEP 3. Compute the LIFTING INDEX

ORIGIN	LIFT INDEX	OBJECT WEIGHT / RWL	33 / 32.37 lbs.	=	1.01
DESTINATION	LIFT INDEX	OBJECT WEIGHT / RWL	33 / 22.88 lbs.	=	1.44

LI>1: Task is increased risk for some.
LI>3: Task is high risk for most.

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For additional information please visit our website at http://edge.rit.edu/content/P09009/public/Home

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