Handicapped Steering Cycle

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Abstract: Traditional manual wheelchairs require considerable use and control of both arms for operation, thus adaptations are required for individuals with asymmetrical use of their arms. Building upon previous projects, the goal of this project was to create an accessory, to be installed on a standard wheelchair, which would allow full control of the wheelchair with only one arm/hand while addressing areas lacking in commercial products and previous designs, such as manufacture ability, attendant control, user comfort and ergonomics. After preliminary testing and analysis of three one-arm propulsion designs, the project team developed a design for a removable, lever-operated accessory which could be adapted to fit a range of the most popular standard wheelchair models. The propulsion system, connected to the main lever by a coupler link, consists of a dual gear-pawl assembly in which the desired direction of motion is chosen by moving a shifter to engage one of the two gears press-fit around clutches, each of which allows motion in only one direction, either forward or reverse. By including a neutral pawl position in which neither clutch is engaged, this design allows an attendant to propel and control the chair.

Keywords: wheelchair, lever-propelled wheelchair, levers, oxygen uptake, disabled people.

I. INTRODUCTION

Worldwide, 100-130 million people need wheelchairs, but less than 10% either own or have means of obtaining one because most of these people live in developing countries where wheelchairs are not available. It is predicted that these figures will rise by 22% over the next ten years for a number of reasons, including but not limited to the aging baby-boomer generation, ongoing wars, re-habitation of areas infested with land mines from prior conflicts, and other injuries and diseases. Current wheelchair technology is relatively well-established in that there is not a great deal of variation in the wheel chair market, which can create difficulties for individuals whose needs are not met by currently available model. Wheelchair design and functionality as a whole has been greatly improved over the past several decades, but there is still a need for new technology and innovative designs. The majority of assistive device users are over age 65, with increases expected as the baby boomers age and the average life expectancy increases. Many of the conditions that restrict an individual to reliance on a wheelchair also limit control of the upper extremities to the extent that the user can only operate the chair with one hand. Powered wheelchairs serve this need quite well but are expensive and thus inaccessible for many individuals. They are also difficult to transport without a specially-adapted vehicle, meaning additional expense for someone who wishes to remain independent and mobile. Therefore, there is a need for manual one-arm drive wheelchairs. Though some models are currently on the market, they require awkward hand positioning and a degree of dexterity beyond that of much of the potential user population.

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II. SPECIFICATION

1.	Overall wheelchair dimensions (minus accessory) shall not exceed 1300mm x 700mm x 1090mm (50” x 26” x 40”). [length x width x height].
2.	The most common material for wheelchair frame construction is metal, namely steel and aluminum. These two metals have high strength-to-weight ratios, and are easily worked into pipes and other shapes required for a standard wheelchair.
3.	Steel alloys commonly used for wheelchairs are mild steel, chromium-molybdenum alloy steel, and chromium-nickel-molybdenum alloy steel.
4.	Due to cost and availability restrictions, the team will likely use a combination of aluminum and steel to construct the accessory.

II. FORMULA

1. Force

$M = F \times X$

Where

F = force

X = distance between steering wheel and pivot

2. Friction

$F = \mu \times N$

3. Mechanical Advantage Of Steering System

$M = r \times F$

4. Area of frame tube

$Q = \prod (do^2 - di^2) / 4$

where

do = outer diameter

di = Inner diameter

5. Stress Generated In Frame

$\sigma = F/A$

Where

F = force

A = Area of fram tube
6. Factor of safety for live load

III. ALTERNATIVE MODE OF MANUAL WHEELCHAIR PROPULSION

Several modes of manual wheelchair propulsion may be found in the literature. These include the conventional hand -rim technique, lever-propelled, hub-crank and others. Systematic research has played an important role in the development and design of wheelchairs, in studies concerning vehicle mechanics and its interactions with the human movement system to better understand the wheelchair's user interface. A change in propulsion mechanisms has been used and non-conventional techniques have been proposed to reduce the impact of the conventional wheelchair propulsion technique on the quality of life of handicapped persons.

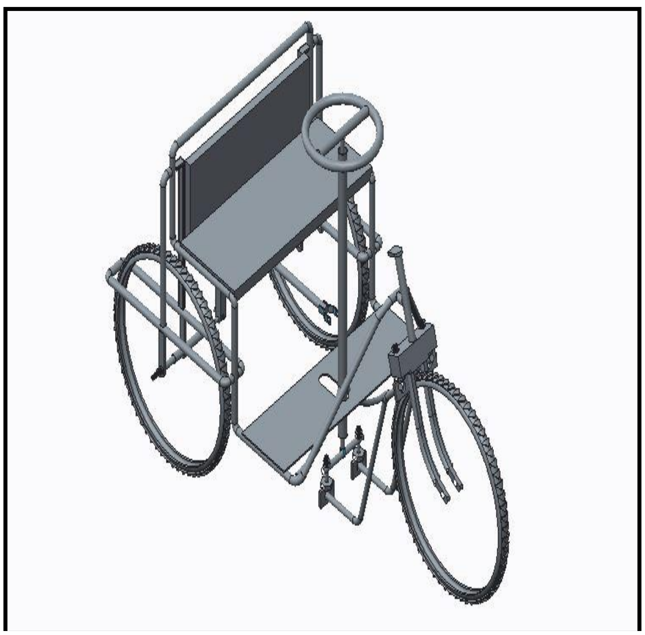

Fig.1- *MODE OF MANUAL WHEELCHAIR PROPULSION*

IV. WORKING PRINCIPAL

1. When we apply the force on steering in forward and backward direction liver and crank provide the motion to wheel chair by converting the sliding motion into rotary motion.
2. The motion of direction of wheelchair is controlled by steering.
3. The device is operated by to and fro motion of steering which help to rotate the wheel , the turning action takes place by tilting the steering forward and backward direction.
4. It provide a means of propelling a wheelchair using only one hand. This mechanism must allow the chair to move both forward and backward, and as such have a means of switching between the two directions. In order to propel the chair in a straight line, it must also move three wheels simultaneously. The following description outline several possible ways of accomplishing these goals.

V. STEERING SYSTEM

1. The user must be able to steer the chair at all times, unless an attendant is pushing the Chair. Maintaining control of the direction of the chair at all times is essential not only for user safety, but also to maximize the independence of the individual. When there is not an attendant pushing the chair, the user must have full control to be able to safely maneuver it.
2. The modification accessory cannot interfere with an attendant's ability to push/control the chair. This will be accomplished by providing a means of disengaging the steering to allow free motion of the casters.

Some current models of one-hand propelled manual wheelchairs have steering mechanisms which control the position of the front casters. This makes it very difficult or impossible for the chair to be steered by anyone other than the user, i.e. an attendant cannot have complete control of the chair. In order for the chair to be marketable to the largest possible population, this problem must be eliminated.

Fig.-2. *STEERING PRE-ASSEMBLED*

VI. BRAKING & PROPULSION

1. The propulsion system must move the wheelchair and be steerable in both the forward and reverse directions.
2. Brakes must be able to slow the wheelchair in addition to bringing it to a complete stop.
3. The basic function of brakes is to slow or stop a moving object (i.e. wheels) to prevent loss of control of the object.
4. The brake lever cannot require more than 35 pounds of grip force to actuate.

Individuals with disabilities and the elderly both may have moderate to severely diminished physical strength capabilities compared to able-bodied adults. As such, the actuation force limit was based on grip strength data from elderly men and women. For elderly men, the first, fifth, and tenth percentile grip strength averages (of values from the right and left hands) are 33.2 pounds, 41.1 pounds, and 44.3 pounds, respectively (Panero, 1979). For elderly women, the grip strength range is28.6-209 pounds. Thirty-five pounds was chosen because it is at the lower percentile range of these individuals, and will thus allow the majority of the target population tope rate the brakes.

VII. VEHICLE MECHANICS

In order to optimize performance and endurance, the vehicle mechanical losses must be minimized and the hand cycle well maintained. Rolling resistance issues that play in hand rim wheelchairs are equally relevant in hand cycles. Rolling resistance must be minimized through lightweight design and quality material, wheel alignment and maintenance. Generally air resistance will be more prominent in hand cycling, given the higher velocities outdoors. Air friction is highly speed dependent on and determined by the frontal plane area of the wheelchair-user combination and the aerodynamic drag coefficient, the latter is both form and surface dependent. Especially minimization of frontal plane area is suggested to be effective. Little systematic scientific knowledge is available on the specifics of aerodynamics in hand cycling. 'Hand cycle-user interface' Performance in a hand cycle is dependent on the fine-tuning of the crank set, handle bars, seat and the individual. This has also been described in arm crank exercise and other cyclic motions and allows subjective optimization in association to speed and power conditions.

Fig.3. *VEHICLE MECHANIC*

VIII. COMPONENTS USED IN THE MODEL AND IT'S SPECIFICATION

Sr. no	Name of part	Material	Quantity	Dimension
1	Bicycle style steering	Steel	1	60cm
2	Rim	Steel	3	2
3	Tyre of 20"	Rubber	2	20"
4	Tyre of 16 "	Rubber	1	16"
5	Flywheel	Brass and Steel		20cm
6	Foot strips	Rubber		15*10cm
7	Rod	Steel	4	90cm
8	Spokes	Steel		25cm
9	Seat	Wood	1	35*35cm
10	Brake wire	Rubber and Steel	2	120cm
11	Clutch	Rubber and Steel	1	10cm
12	Bearing	Steel	2	
13	Drive shaft	Steel		
14	Brake lever	Steel	2	6cm
15	Brake pad	Rubber	4	4cm
16	Cable Yoke	Steel		3cm

Disc brakes A wheelchair and hand cycle hybrid that incorporates a self-propulsion mechanism that converts push-pull motion to forward movement.

- Front-and-center propulsion on push and pull.
- 8 speed hub gear.
- Bicycle style steering.
- Foot stirrup.
- Gearing for hills.
- Anti rollback mechanism.
- 16" front and 20" rear wheels.
- Internal hub gear.
- Integrated driveshaft.

IX. CONCLUSION

The hand cycle has evolved into a contemporary assistive device for sports, leisure and daily use, as well as for training, outdoors. Even in rehabilitation, hand cycling is being advocated as a good training alternative in early rehabilitation of also frail individuals. Within that context there is a need for further research into optimal hand cycle design and fitting for different user groups. Apart from optimizing the wheelchair-user interface, one needs to carefully consider maximizing overall work capacity of users and further reduction of the vehicle mechanical losses to ensure a real optimum level of mobility. It is expected that the current booming development of crank propelled tricycles in the industrialized countries serves not only the young and active wheelchair user, but also the less well-trained individual or those with more extensive limitations. In the end, the frequent active use of other than hand rim propelled wheelchairs may help prevent some of the secondary complications among the wheelchair user population today. What has been assumed till today, is a lower overall mechanical strain (in conjunction with a higher efficiency) in hand cycling compared to hand rim propulsion. However, the upper body may be yet vulnerable to mechanical overuse when 'too much and too often' go together. Little is known of underlying mechanisms of overuse and should be on the future APA research agenda. At the end of this approximately 28-week project, the team achieved its primary goal of designing, manufacturing/assembling, and testing a prototype of a one-arm propulsion accessory for a manual wheelchair.

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SR NO.	DETAILS	DIMENSIONS (cm)
1	Distance between center of two rear wheels	72 cm
2	Distance between center of front wheel and rear wheel	128 cm
3	Length of connecting rod	50 cm
4	Radius of pedal	8 cm
5	Length of rear axle	35 cm
6	Height of seat from center of rear axle	37 cm
7	Height of steering from footpad	67 cm
8	Length of steering rod	55 cm
9	Length of outer rod	47.5 cm
10	Diameter of steering wheel	32 cm
11	Length of direction rod	67 cm
12	Distance between center of front wheel and steering rod (at center position)	67 cm
13	Height of seat from footpad	37 cm
14	Height of footpad from ground	33 cm