DETACHABLE VEHICLE UNIT

RAJESH KUMAR[1], KUNAL NIKAM[2],
AVINASH PATIL[3], AKSHAY PATIL[4],
NITIN PARAMANE[5]

[1]HOD, Dept of Mechanical Engg , Alamuri Ratnamala Institute Of Engineering And Technology, Shahapur , Thane, Maharashtra, India

[2,3,4,5]Final Year Student, Dept of Mechanical Engg., Alamuri Ratnamala Institute Of Engineering And Technology, Shahapur , Thane, Maharashtra, India

ABSTRACT: Detachable Vehicle Unit is mechanically controlled device designed to have selfmobility with the help of the user command. This reduces the user's human effort and force to drive the wheels for wheelchair .Furthermore it also provides an opportunity for physically impaired persons to move from one place to another. Detachable Vehicle Unit has gained a lot of interests in the recent times. These devices are useful especially in transportation from one place to another. The machines can also be used in old age homes where the old age persons have difficulty in their movements. The devices serve as a boon for those who have lost their mobility. Different types of smart wheelchair have been developed in the past but the new generations of wheelchairs are being developed and used which features the use of artificial intelligence and hence leaves a little to tinker about to the user who uses the wheel chair. The project also aims to build a detachable vehicle unit in a low cost or budget, so that maximum number of disabled people can afford it.

Index Terms: Standard Brake, Battery, Switch, Adjustment system, Motor, Sprocket.

I. INTRODUCTION

In human life transportation is playing very important role from ancient time, due to transportation and communication facilities we say that, world is coming closer and closer. Day by day new vehicles with variety of models are coming into market. Normal person i.e. person without any disability can avail this vehicles easily. But in our society the number of disabled persons is also considerable, some of them born with disability, some get disabled due to accidents (road, workplace, natural calamities, etc.), large number of persons get disabled due to war activities and due to many other factors. Depending upon the severity of disability, the disabled persons can use the transportation facilities; persons with lesser disability can use the facilities as it is for normal persons, some persons are able to use the vehicles with little bit modifications like retrofitted bikes and cars.

There are some utilities like wheelchairs, tricycles which are used by the disabled persons. In some cases the disability is so severe that person can't move from one place to other place without help. The persons with hand and leg disability are able to travel but they are unable to use the vehicles for normal persons as it is. So the vehicles are modified (customized vehicles) to make them accessible to the disabled persons. In this paper we will see the survey of some of the ways available for disabled persons for increasing mobility.Depending upon disabled part of body, different provisions are available like crutches, wheelchairs, tricycles, customized vehicles (retrofitted bikes, cars etc.). Crutches are most commonly used for walking for shorter distances, then manual wheelchairs [1] and hand-cranked tricycles [2] are useful for the persons with leg disability and automatic wheelchairs are designed such that persons with hands & legs disability can be benefited. In automatic wheelchairs many approaches are taken into consideration and depending upon that the control system of wheelchairs is designed, for example smart wheelchair with control through deictic approach [3], intelligent robotic wheelchair [4], path following, stair climbing wheelchairs [5] etc. Another option of powered tricycles i.e. battery powered or solar powered tricycles [6], [7] is available for persons with leg disability.

II. CONCEPT AND DESCRIPTION

Fig.1.

A. Manual

Persons with lower limb disabilities are mainly dependent on manually propelled wheelchairs for the mobility. Manual
Figure 1: Manual Wheelchair [9] wheelchairs are largely used in hospitals, which are generally

driven and controlled by helping person. The manual wheelchair is as shown in Fig.1. If the user himself is operating it, the controlling and driving of wheelchair is done by hands only. But as compared to legs, the hand work is less efficient and more straining; this leads to lower physical capacity of user. Therefore long term of use of manual wheelchairs is not advisable. To reduce the local discomfort and fatigue other propulsion mechanisms are available now. This alternative mechanism reduces drawbacks of hand rim driven wheelchairs. Many experiments on lever and crank propelled wheelchairs have shown reduced straining and more efficient working. The tricycle like arrangement as shown in Fig.2, is using these mechanism proper movements of arm shoulder joints is happening, which allows the higher velocity of travel with less physical strain. The new design of wheelchair is improved by considering the guidelines of ergonomics; also many innovations came in picture to improve the suitability
of wheelchairs.

Fig.2. Manual

2. Automatic

Because of the physical straining, driving of manual wheelchairs is not advisable for many disabled persons; also for the persons with more severe disability unable to drive the manual wheelchairs so there is need of automatic wheelchairs. Nowadays more user friendly wheelchairs are available in market, which are battery powered and controlled automatically or by using joystick. In joystick controlled wheelchairs all movements are depends upon the position or

movement of joystick such as neutral Position-no movement, forward-backward motion, right-left position-turning, etc., also other buttons like start, stop, horn are provided. Fig.3 shows the typical joystick used for the wheelchairs. There are many disabled persons who unable to move their hands and legs due to severity of disability. For them operating the joystick is also very difficult task, in such conditions the wheelchairs are designed with mobility assistance i.e. the motion is semi-autonomous or completely autonomous. The mobility assistance is useful for moving wheelchair in the complicated environment by avoiding the obstacles.

Smart wheelchair: As explained above there are many persons who cannot do movements of their limbs due to several reasons such as cerebral palsy, cognitive impairment or fatigue. The smart wheelchairs which are automatic or semi-automatic in operations can be used to increase themobility of user with severe motor impairment. The operations are controlled by using user-machine interface.But there is no single solution available which will complete all the requirements from the particular wheelchair of the different users. The improvement in wheelchairs control isdone in three ways: by improving assistive technology, the user-machine physical interface and controls which are shared by user and machine. The operations are in three
modes „stop", „manual", and „semiautomatic". In smart wheelchairs inputs are taken by detecting motion of facial
parts (i.e. blinking of eye, shaking), by voice and by button switch. The webcams are used to detect the obstacles in semiautomatic mode; also different sensors are used to detect the obstacles and current position of the wheelchairs. This helps to move the wheelchair efficiently without any collision.
Mobility assistance is main part in smart wheelchairs. 1. Deictic Approach [3]: This is semiautonomous approach
of controlling the wheelchair motion. In this the vision of environment is used as control interface, for moving from
one place to other the location within the environment is specified by the user by pointing the interface. After that the
wheelchair will move automatically at desired location.

Fig.3.Automatic

3. Background

The shortcomings of this configuration stem primarily from the fact that it is a front wheel drive system. Due to the aft center of gravity on a wheelchair, the front wheel drive system has very little traction on wet surfaces, and cannot climb hills. In addition, the cranks are essentially in the lap of the user, so it is not possible to steer under power- only while coasting.

The current configuration utilizes a sprocket and chain-driven hub with quick release fixtures at the head tube connection and the connection to the wheelchair, under the user's seat. It brakes by means of a coaster brake, so to stop, you just pedal backwards. The advantages of such a system are:

- increased mobility
- increased efficiency and steering - an unmodified wheelchair steers by braking on wheel, which continually causes the user increased energy expenditure
- exercise for the upper body
- versatility - by being able to detach the steering column from the wheelchair, as opposed to a fixed tricycle for exercise

Disadvantages:

- hand effort is required constantly
- difficult climbing hills
- difficult controlling on slopes
- a brain fade or losing sync on inclined surfaces can cause accidents easily
- both hands are constantly at work
- can cause fatigue in the driver

The main reason to choose this project was to do a complete hardcore mechanical project and make it successful. Also the need for hiring is also there by considering projects. In this country the benefits in our day to day life for the handicaps are in bad shape. We also decided this can be used as a help for them. The unavailability of expensive mobility scooters can be a real world problem for their chores and work. So this was the background and the real idea behind this project.

In the lead up to the project proposal, we did extensive research on domestic and international standards for wheelchair construction; the potential market for such a device; and the existing products and patents that were similar to our design. The results are summarized in the sections that follow.

The intent of our project is to produce a high-quality prototype specifically for use by our sponsor, but if it results in a commercially viable product, we believe that a global market exists for this type of device

4. Applicable codes and standards

The internationally accepted standard for wheelchair design is provided by the International Organization for Standardization (ISO). In order to test the strength of our design and guarantee strength and durability, we will design our wheelchair attachment to comply with ISO standards.

ISO 7176/ EISO[ii]

The international standard for evaluating wheelchairs is the International Organization for Standardization (ISO) 7176, International Standard for Wheelchairs. In 1996 Whirlwind Wheelchair International, an organization that works to promote safety of wheelchairs in developing countries, where such standards do not exist, developed their own Extended ISO (EISO) standards for testing the strength of wheelchairs. Some of these tests are more rigorous than traditional ISO standards such that they specify static and impact tests for active wheelchairs in a variety of environments, terrains, and loading conditions.

EISO standards cover subjects such as basic seating dimensions, ways of determining tipping stability, static and impact strength requirements, and testing methods to ensure long-term durability.

5. Existing Product

We reviewed several existing wheelchairs that had similar functions we want to incorporate in our final design. We used the following existing wheelchairs and wheelchair attachments as benchmarks for defining our specifications.

6. Potential market for this product

Such a product would appeal to any disabled persons who maintain the complete use of their arms and upper body, but either permanently or temporarily lack the use of their legs and lower body. This could be someone who is a paraplegic, or someone who has been in an accident and is temporarily without the full use of their legs. Our product is designed for the user who desires the functionality and increased mobility of a hand-cycle, but also requires the versatility and accessibility available in a standard wheelchair configuration.An estimated 1.6 million Americans residing outside of institutions use wheelchairs, most (1.5 million) use manual devices, with only 155,000 people using electric wheelchairs.iii In March 2003, the German Statistics Office calculated that 1.56 Million German citizens (1.9 % of the population) depended permanently or temporarily on a wheelchair. For Europe as a whole this translates to 7.1 Million people.ivAbledata.com, an online resource that provides objective information about assistive technology, states in the document informed Consumer's Guide to Wheelchair Selection, that "Wheelchair types vary nearly as much as the types of disabilities for which they are designed. A user who maintains the use of their upper body but has no use of their legs will obviously require a much different chair compared to an individual who lacks the use of both their upper and lower body. Similarly, an individual who has suffered a spinal injury and has lost the use of their legs will require a different

arrangement than an individual whose legs have been amputated".vBecause there are so many wheelchair designs that are customized for the needs of specific users, our product will have a larger target market as a removable attachment that accommodates the user's current wheelchair compared to a permanent hand-cycle wheelchair. Our product will allow users to remain in their customized wheelchairs but still have the added mobility offered by a hand-cycle when necessary. Since our product is an attachment, users don't need to sacrifice the comfort and familiarity of their wheelchair to have a hand-cycle wheelchair.

***Quickie GP**

The Quickie GP wheelchair will be the basis of our design, as this is the wheelchair currently in use by our sponsor. It is also a fairly standard rigid wheelchair that allows the user to adjust the camber of the rear wheels. Rear wheel camber is necessary for turning at higher speeds

Fig.7

***Hybrid Coyote**

The handcycle attachment that Mr. O'Kelly currently uses is a Team Hybrid Coyote. As mentioned in the introduction, this uses has been modified because the original was cumbersome and prone to failure. The current configuration uses a set of two quick releases at the junction of the head tube with the down tube and another set of two a chain-driven front wheel with a SRAM 7-speed internally-geared hub and a coaster brake. The attachment interface quick releases where the down tube connects with the chair. Thus far, this has been the best attachment, and it leaves much to be desired, so it is the datum on which we are measuring the success of our device.

***Quickie Cyclone**

For a while, Mr. O'Kelly used a Quickie Cyclone attachment. This is a device that attaches to a rigid (as opposed to collapsible) Quickie wheelchair, and consists of a front wheel, driven via a chain drive, attached to a set of cranks that can be turned by hand in a "rowing"

motion. Additional features of the cyclone are a seven speed drivetrain (accomplished by a SRAM grip shifter on the main vertical shaft of the cyclone and an internally geared hub laced into the front wheel) and a coaster brake. To attach the device to a wheelchair involves rotating the wheelchair, thereby twisting the connecting shaft into place. This is not as convenient as the latching mechanisms used on other devices and that we plan to use on our prototype. This system still is fundamentally encumbered by the limitations listed in the introduction, namely that it is front wheel drive, weighs 25 pounds, and cannot steer under power.Quickie has discontinued this product, probably as a result of these shortcomings. Their only current replacement offerings are fully rigid trike systems, for which the front

***Rio Dragonfly**

The Rio Dragonfly is the same concept idea as the Quickie Cyclone and is a lot like the attachment that Greg O'Kelly currently uses. The Dragonfly is an attachment with a hand-crank powered front wheel. Unlike Greg's current set up, the Dragonfly attaches to a multitude of other chairs including the Quickie chair that Greg is using now. Rio claims that the Dragonfly attachment can be attached or detached in under a minute by a single user. The Dragonfly is available as a one, three, or seven speed option. The speeds are housed in an internal hub unit. The overall weight and cost of the attachment depends on the number of speeds in the hub. The weights range from 21 lbs for the one speed and 25 lbs for the seven speed. This 25 lb weight is equivalent to what Greg O'Kelly uses now. The cranks are 140mm in length and attached to a top 40 tooth sprocket. A 190 link KMC Z-chain connects the top sprocket to an 18 tooth bottom sprocket. Like Greg's setup, the Dragonfly has a coaster brake and a 16 inch front wheel. This product cannot climb hills well either, due to the aft center of gravity of the wheelchair and user.

Fig 8 Rio Dragonfly Handcycle
Attachment with Rio Wheelchair

7.-1 Flexible Shaft

Flexible shafts are used for rotary power transmission in a variety of commercial, industrial, and medical applications. Flexible shafts are constructed of tightly looped coils that can be designed to handle high torque and high speed. Although most commonly used for rotary tools and other high-speed, low- torque applications, flexible shafts can be designed to handle high-torque low-speed application as well. Flexible shafts can make bends up to 90degrees without adversely affecting performance and efficiency.

Fig.9. Flexible Shafts with Sample Styles, Couplings, and Casings

FlexibleShaft	
Advantage	*Disadvantages*
• High efficiency • Quiet • Low maintenance • Safe, no exposed moving parts • Easy installation • Low tolerances	• Limited availability, not readily available

8. Rear Drive Method

The rear drive method subsystem includes ideas for the mechanism that will transfer power from the attachment interface to the drive wheels. This mechanism needs to be lightweight, quiet, and relatively easy to semi-permanently mount to the wheelchair frame with minimal modification to the wheelchair. We selected our final design analysis from the following configurations because we need to maintain the differential steering that the wheelchair utilizes without having the attachment engaged, and still maintain efficient power transfer.

The fore gearbox to aft differential idea was based off current drive trains seen in cars. Essentially we figured that the design concept could consist of some sort of transmission and rear differential. The gearbox would provide the different gearing options need to change speed in various driving conditions and climb hills. The gearbox and differential would be connected by either a drive shaft or a chain or belt. The differential would allow power transfer to both rear wheels

and allow for uninhibited tire scrub due to turning. The fore gearbox to aft differential would also be very efficient.

Fore Gearbox to Aft Differential	
Advantage	*Disadvantage*
• High efficiency • Part availability • Low maintenance	• Relatively expensive • Medium modification to wheelcha

9. Concept Evaluation

We developed twelve sketches for the overall system configuration based on combinations of the sketches drawn for the various subsystems. These were then put into a decision matrix, and evaluated against our sponsor's current setup (the datum) for relative number of parts (the fewer the better), easy usage (easy to attach to wheelchair), ease of maintenance and durability, easy production (minimal complexity), and finally, driving behavior (stability, steering, and efficiency). Each category was assigned a number on a scale of zero to four, with zero being far under the performance of the datum (unacceptable), a one being slightly under the performance of the datum (acceptable but not preferable), a two being equal to the datum (sufficient), a three being slightly better performance than the datum (good) and a four being far above the datum (ideal). The scores for individual attributes were summed to give the total score for each system configuration.

Benchmark of the Combinations of the Morphologic Box

combinations	1142	3142	1244	1141	1244	3233	3122	1412	1442	A41 2
few parts	3	1	3	2	2	1	2	3	2	2
easy usage	4	4	4	1	3	0	2	2	4	1
easy maintenance	4	2	3	2	1	2	1	2	2	1
easy production	2	1	4	3	2	1	2	4	3	0
good driving behavior	4	2	3	2	0	0	3	3	3	0
total	18	10	17	10	9	4	10	14	14	4
ranking	1	5	2	5	6	7	5	3	3	7

Decision Matrix Used to Evaluate Concepts.

Fig.11. Side View 1

III. RESULTS

Fig.10 Detachable vehicle unit.

Fig.12. Side View 2

Fig.13. Complete Project

IV. CONCLUSION AND FUTURE SCOPE

A. CONCLUSION

As a learning experience, this project was definitely a success. We learned about all aspects of the design process from ideation to prototyping and testing; and we also learned how to conduct business internationally, which was unique to this project.

B. FUTURE SCOPE

As according to mentioned above information , there are many types of wheel chair which is manual and have good features but nowadays technology has evolved so much that everything is getting automatic. So keeping in mind this will help handicapped people when they will get tired of pushing with hands normally, as they can attach unit easily to wheel chair. And almost within 2 to 3 years with more advance one, it will be seen on roads and hospitals, especially in india.

V. REFERENCES

1. Manual wheelchairs - Requirements and test methods; German version EN 12183/DIN12183. PDF version. Nov 1999.

2. Origins of Whirlwind Test Values (PowerPoint)", Whirlwind Wheelchair International Website, <www.whirlwindwheelchair.org> created September 2004, accessed October 17, 2016

3. Wheelchair Use in the United States". Kaye, Kang, LaPlante. USCF Disability Statistics Center. <http://dsc.ucsf.edu/>. May, 2002. Accessed Oct 2008.

4. Colin Furze and his YouTube channel "colinfurze''

5. Quora.com, reddit.com, ebikes.ca; the references are from the FAQs.

6. www.ebikes.co/tools/simulator.html