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Design and Fabrication of Dual-Purpose Wheel Chair

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ABSTRACT:

Wheelchair and stretcher are very commonly used in the hospitals, airports, railway station, shopping malls, etc. This design here is a modified wheel chair cum stretcher depending on the needs. This machine can be used to convert the wheel chair into a stretcher according the requirements. This can be accessed manually. The chair gets converted into a stretcher when the levers are engaged. The stretchers can be detached from the main frame according to the convenience of the patient as well the doctors, making it easier to access the patient with less effort and transporting. The folding mechanism makes it easier to store large number of stretcher put into the form of chairs in comparatively less space. The number of patients in world is increasing day by day. So in hospitals patients need to be shifted from wheelchair to stretcher, stretcher to beds, bed to wheelchair, or vice versa; which creates unsafe conditions for patients. There is a need for a Wheelchair cum stretcher to facilitate the disabled patient's mobility and to provide novel medical equipment for use in the hospitals.

I. INTRODUCTION:

Disability has affected thousands of families in the world. As of today approximately 650 million people, are suffering from disability. In developing country like India there are almost 21.9 million people with some or the other disability. Regardless of their disabilities, these people still need to get up each morning and live life. For most, this can only be possible with the help of a wheelchair. Wheelchair is a device which can empower and enable a person with a disability to live a normal and independent life. Over the years wheelchairs have evolved rapidly from the manual wheelchairs to the powered wheelchairs. But still these wheelchairs have not been able to satisfy the needs of the disabled people. It is therefore critical that the problems of disabled be understood and accordingly wheelchairs are developed fulfilling their needs.

II. LITERATURE SURVEY:

Sunny et al. [1] discussed about wheelchair cum stretcher which comprises of hydraulic jack, screw rod, Wheel, free wheel, waste lid and braking lever. Two lead screw setup with hinge joint is used form a stretcher or back to wheelchair. A port with lid is provided at the middle part to eliminate the human waste. Hydraulic jack is used to vary the height of stretcher or wheelchair. Brake lever is used to provide to stop wheelchair movement. Suryawanshi et al. [2] discussed about the conceptual design of inbuilt person transfer mechanism in a Wheelchair. The various concepts are generated for selection of Wheel chair. Different methods like FD, DARE analysis and Pugh concept selection method for converting the needs of the customers into a conceptual product are discussed in detail. This wheelchair developed can easily help the people disabled in legs to transfer themselves to bed without any assistance Alexander et al. [3] described that the use of gear motor mechanism for conversion of wheelchair into stretcher and vice versa. The patient can move themselves by their own hands with the help of some mechanism that is used to move the wheelchair which are wheelchair which are having their own advantages and disadvantages. It is thought to combine the concept of wheelchair and stretcher and design a system which serves the both purposes and hence in order to meet the patient requirement this paper aims at designing an electric wheelchair that can be converted into a bed/stretcher with variable adjustable positions with the help of electric motor. John et al. [4] discussed about the various combination of mechanism use to reduce the space i.e. caster wheel and porta wheel mechanism. The work "Multipurpose Medical Bed" is introduced to solve problems related to the conventional medical care equipment and would be cheap and affordable and could be efficiently used in hospitals to save space, time and to provide better care to the required. Ahmed et al. [5] worked on the use of pneumatic system for the conversion to stretcher from wheelchair and vice-versa. This helps the caregiver avoid heavy lifting situations that put their back at risk of injury. The caregiver can merely shift the patient from a bed on to the device while the device is in the form of a stretcher. Then the device can be converted into a wheelchair of diagnosis etc. Sivadas et al. [6] worked on wheelchair cum bed with side panel movement for bed has been designed using to lead screw to convey the required motion to the links. Two motors supply power to the lead screw via pulley attached on the lead screw. It has been found that worm gear was used to increase the required torque and the electric system can be used to reduce the health due to leakage in pneumatic system. Borkar et al. [7] present the explanation of recliner mechanism used for the conversion. The spring is used for setting the desired position. Mobility aids are used for transportation of patients. Wheelchairs and stretchers are the most commonly used mobility aids for the movement of patients. It proposed a design of wheelchair convertible stretcher which is a boon to the medical field. It is so made that it could be maintained and operated easily either by the patient or by the attendant according to the comfort of the patient. Kulkarni et al. [8] studied of different mechanism that is mechanical linkage, parallelogram mechanism, reclining mechanism and hydraulic mechanism has been done for the conversion. Using simple hydraulic components, the wheelchair can be converted into bed at designated spots where the trainer kit is placed. Using

hydraulics also gives an added advantage of being able to get the wheelchair into multiple other positions according patients comfort. Ghani et al [9] investigate the control of a stair climbing wheelchair used for indoor purposes. This paper evaluates different stair climbing mechanisms via crawler type, leg type, hybrid type and wheeled type. The model of a stair climbing wheelchair based on two wheels is generated using MSC Visual Nastran 4D (VN) design software. The humanoid model is developed using requisite anthropometric data. Various forces and torques acting on the wheelchair while climbing the stairs are evaluated. Preferably, the outer support assembly comprises wheels on either side of the chair. An inner support assembly, closer to the centerline of the chair, also supports the seat assembly. Franco et al [10] did work related to development of a stair climbing wheelchair that can move in structured and unstructured environments, climbing over obstacles and going up and down stairs. The wheelchair design is vividly elaborated. The wheelchair consists of a frame, seat and a linkage mechanism connecting the same. The frame consists of a chassis embedded with two motorized locomotion units, a support for two electrical gear-motors, two idle triple wheels units and a battery pack. The seat is a tubular structure that consists of a chair and a pivoting wheel. The linkage mechanism is responsible for relative motion between frame and seat during stair climbing operation. To successfully climb the stairs, it is required to move the seat backwards, then reorient it and finally lift up the pivoting wheel. When the seat is moved backwards, the center of mass of the wheelchair shifts to a safe position, and toppling is thus prevented. A four bar linkage is appointed for the same. The linkage mechanism is actuated by a mini-motor connected to a lead screw device. Murray et al [11] has elaborated the background as well as recent developments in mobility assistive mechanisms while discussing the relative importance of stairs and wheels. These various types include mobility scooters, track based stair climbers, clustered wheel concept and caterpillar wheel based devices. A mechanism is proposed which is based on the use of four wheels. The rear wheels are autonomously driven and front wheels are freewheeling castors. This proposed concept is numerically modeled and power calculations for linear actuator are made. Stair ascent and stair descent operations are described along with figures and equations. The control system and the stair edge sensor system are also investigated. The stepping algorithm is discussed in detail. The influence of external factors like cost, weight, aesthetics, range of operation, safety, operational efficiency, comfort are evaluated. The track based stair climber is also analyzed similarly. Lockton et al [12] discusses the retro fitting of electric power into manual wheelchairs. The existing products and configurations are reviewed in a comparative table. Various product specifications are categorized and briefly described. These include control devices, drives, steering and position. Various configurations via Twin-wheeled drive, rear- mounted, with differential steering, Single-wheeled drive, rear- mounted, with steering ahead of the wheel, single-wheeled drive, rear-mounted, with steering above the wheel, Single-wheeled drive, rear-mounted, with notation steering and Single-wheeled drive, front-mounted, with handlebar/articulated steering are evaluated. The motors, mechanics, control technology and usability are investigated for the above mentioned combinations.

III. COMPONENT SELECTION:

FRAME: The frame needs to be analyzed and tested physically as shown in figure 1.we have only performed cursory theoretical calculations and the most basic physical tests. Additionally, the arm rests specifically need to be reconsidered. We did not add the armrests as part of the initial design, opting to instead create a user control panel and then make an armrest to fit the control panel. The armrest should be reconsidered to account for greater Comfort.

Figure.1.

FRONT WHEEL: The front wheels require more thorough testing as they are a completely custom solution. Firstly, the wheels must be tested on a variety of surfaces and conditions to determine if there are any environments they are poorly suited to operate in. Primarily, testing on soft grass and dirt should occur to examine if the rollers sink into the dirt to cause sufficient difficulties as shown in figure 2. The durability of the machined rollers must be tested as we have no experience with the wear pattern the rollers may experience during use. such a modification will enable four wheel drive, which will enhance the off-road capabilities of the wheelchair. During the modification, the weight of the Omni wheel should be minimized, as the wheels will contribute the largest un-sprung mass to front, which will reduce the responsiveness of suspension.

Figure 2.

REAR WHEELS: The rear wheel requires fairly minimal future work outside of standard testing as shown in figure 3. Most significantly, custom spokes should be ordered to provide a more robust solution, as the current spokes are undersized.

Figure 3.

SEATING: Wheelchair cushions are cushions specifically designed to provide comfort and protection against injury for wheelchair users as shown in figure 4. They also aid in properly positioning the user in the correct posture. Various characteristics, combined with a number of cover material options, offer a myriad of possibilities, which can be manipulated to provide various performance properties. These properties are intended to provide the wheelchair user optimal comfort, stability, and postural support, as well as aid in the prevention of pressure ulcers.

Figure 4.

SAFETY: Although we planned on incorporating a number of safety features, our budget and time constraints did not allow for their full implementation. The current emergency stop button is the first feature that requires reconsideration. Currently the emergency stop cuts the logic of the speed controllers, but is not able to cut power directly as we are dealing with a large current range as well as 5 volt logic. Emergency stops for such a range proved to be unaffordable; however, transitioning to a true emergency stop would be a beneficial safety feature. Secondly, we wanted to implement speed oriented safety features which would limit the possible turning radius at high speeds. This feature was not able to be implemented due to time constraints, but would ensure the wheelchair would be far less likely to tip over at higher speed operation.

IV. DESIGN DETAILS:

- Before stretching Length=610mm.
- After stretching Length =1440mm.
- Surface to front sheet height=640mm.

- Surface to shaft height=190mm.
- Total Height =1060mm.
- Breath =500mm.
- Primary seat measurement= 355*460mm.
- Shaft =12mm.
- Back wheel diameter= 160mm.
- Front wheel diameter=102mm.

The above dimensions are measurements of the figure shown below named figure 5.

Figure 5

The basic design of the device has evolved from the concept of a convertible wheelchair. Thus the initial sketches for the project design included only the skeletal structure of a wheelchair. Then the convertible feature was included to the design at a conceptual level and tremendous amount of brainstorming was done. Since the fundamental aim of is to provide comfort to the patient as well as his/her caregiver, powered conversion of the device between chair and stretcher was given focus. In the second phase, the power source was to be selected. Electric motors have good load carrying capacity, speed control characteristics, precision etc.

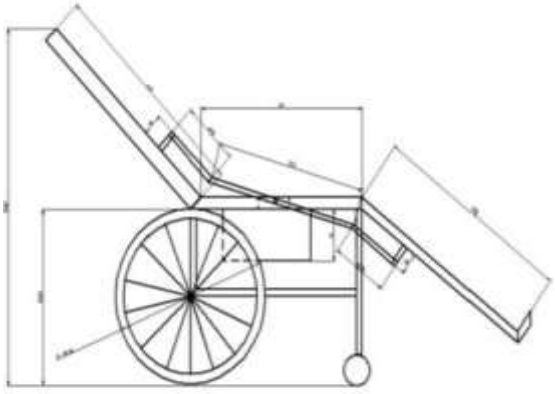

Figure 6

V. PROPERTIES

The material selected must possess the necessary properties for the proposed application. The various requirements to be satisfied can be weight, surface finish, rigidity, ability to withstand environmental attack from chemicals, service life, reliability etc. The following three types of principle properties of materials decisively affect their selection.

From manufacturing point of view, the various physical properties concerned are melting point, thermal Conductivity, specific heat, coefficient of thermal expansion, specific gravity, electrical conductivity, magnetic purposes etc. The various Mechanical properties Concerned are strength in tensile, Compressive shear, bending, torsion and buckling load, fatigue resistance, impact resistance, elastic limit, endurance limit, and modulus of elasticity, hardness, wear resistance and sliding properties. The various properties concerned from the manufacturing point of view are,

- Physical
- Mechanical
- Cast ability
- Weld ability
- Surface properties
- Shrinkage
- Deep drawing etc.

Manufacturing case

Sometimes the demand for lowest possible manufacturing cost or surface qualities obtainable by the application of suitable coating substances may demand the use of special materials.

Quality required

This generally affects the manufacturing process and ultimately the material. For example, it would never be desirable to go casting of a less number of components which can be fabricated much more economically by welding or hand forging the steel.

Availability of material

Some materials may be scarce or in short supply, it then becomes obligatory for the designer to use some other material which though may not be a perfect substitute for the material designed. The delivery of materials and the delivery date of product should also be kept in mind.

Space consideration

Sometimes high strength materials have to be selected because the forces involved are high and space limitations are there.

Cost

As in any other problem, in selection of material the cost of material plays an important part and should not be ignored. Sometimes factors like scrap utilization, appearance, and non-maintenance of the designed part are involved in the selection of proper materials.

VI. ANALYSING THE PROBLEM:

This is a basic model of wheelchair that are commonly used. These can only be used to move the patients in a seating posture with limited comfort. It's difficult to move the patients to a separate stretcher. This design basically consists of limited mobility. Here it is difficult for the patients by themselves to move on to a bed in need of some sleep and comfort.

- The main problem we faced is, which type of material we should use, after few failures we conclude that low weight and high strength material we should use.
- Strength of frame of the wheelchair base to hold heavy body.
- Strength of structure of the stretcher.
- How many linkages.
- Placing of the mechanism.
- Proper spacing for alteration in design during development.
- Placing of wheels.
- Locking system for the stretcher to wheelchair.
- Joints and hinges.

Figure 8 .Normal Wheel Chair

VII. RESULT

The bicycle wheel, front minimal toy wheel, several rods of mild steel and ceramic insulated plate is used in this experimental setup. The maximum load carrying capacity of the experimental setup is 150 kg. This is a basic model of wheelchair that are commonly used. These can only be used to move the patients in a seating posture with limited comfort. It's difficult to move the patients to a separate stretcher. This design basically consists of limited mobility. Here it is difficult for the patients by themselves to move on to a bed in need of some sleep and comfort.

Figure 10

MODEL	IGHT	PRICE
NORMAL WHEELCHAIR	27.21 Kgs	5000/-
SPORTS WHEELCHAIR	15 Kgs	17,500/-
ELECTRIC WHEELCHAIR	30-40 Kgs	46,000/-
OUR PROJECT	12 Kgs	8000/-

TESTING:

While testing the device, it encountered a problem of height of wheelchair which is not feasible for an average height person. In order to solve the problem the height of wheelchair is reduced from both sides in a proportion to be fit for average height person. shows the image of finally fabricated wheelchair cum stretcher with defecation system convertible device. The device figure8.1 is in wheelchair position where lead screw is in initial position. The head section, seat section and foot section are equipped with cushions. In this image the wheelchair cum stretcher with defecation system is in front view where the device is in wheelchair position. The highlights in this image are the head section, seat section, foot section which are equipped with cushions, rear wheels, caster wheels, motor, the connecting mechanism links, the lead screw mechanism and defecation lid.

VIII. CONCLUSION:

The final output of a wheel chair which gives multiple options to the user and attendee by providing ease of adjustable back rest, arm rest, leg rest provides comfort for the patient while resting. The adjustable arm rest provide ease of shifting the patient from chair to the bed. The design makes the dual-purpose wheelchair be stable and safe for the users under different operations. The knowledge gained from product design education is used to analyze the existing wheel chair problem identification, concept generation..

Due to the transferring from bed to wheel chair or vice versa, stresses are developed in the body of patient and as well as nursing. The above problems which are generated at the timing of patient transferring from bed to wheel chair can be eliminated by developing new design cum stretcher with a

detachable stretcher which can operated easily as well as used as a trolley when needed. The cost of this design may be little higher than the common wheelchair, but this design has many more features that can be helpful for the patient as well as the nursing staffs. Also we have understood that there are many scope for future improvements.

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