

Ergonomical designing of multifunctional wheel chair for children with cerebral palsy

■ **JYOTSNA TRIPATHI, U.V. KIRAN AND ANJALI MATHUR**

ABSTRACT : Cerebral palsy is a term used to describe a group of disorders affecting body movement and muscle co-ordination. Cerebral palsy is not a life threatening condition and in itself, is no barrier to leading a long and productive life. People with cerebral palsy enjoy satisfying careers, university education, social life etc for which wheel chair proves to be the best option. Seating and wheel chair devices like a wheelchair provides a patient with the freedom to accomplish many tasks on his/her own. The present study was designed to develop user compatible design criteria for the wheel chairs based on case analysis and related review and to evolve computer aided design of multifunctional wheel chair which includes features such as easily adjustable, portable and foldable, dynamic seat, 45 degree posterior tilt in space, wheels with easily controllable rakes, adjustable and detachable foot rest, attached commode, straps for arms and legs, lap table, padded arm rest, bag to keep immediate essentials and a bottle holder.

Key words : Cerebral palsy, Multifunctional wheel chair

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INTRODUCTION

Cerebral palsy is a neurological impairment, accompanied with a brain damage syndrome, which includes motor dysfunction, psychological dysfunction, convulsions or behavior disorders due to organic damage. It refers to a condition characterized by paralysis, weakness in coordination and/or other motor dysfunction due to brain damage. Cerebral palsy limits a child's ability to explore which in turn hinders intellectual and social development having significant implications for the child's educational development, independence and quality of life. The use of a mobility appliance like a wheel chair prevents the deformity to interfere with the

normal day to day functioning of the child (Crane *et al.*, 2004). The use of a wheel chair is emphasized to improve the physical functioning to lessen the restricted effect of the handicap (Stavness, 2000).

The children with cerebral palsy continuously sits in a wheel chair for long periods, which leads to strain on muscles. This strain may be reduced with the application of ergonomic principles in designing assistive aids. The present study aims at designing multifunctional wheelchair for children with cerebral palsy to fulfill their immediate needs using ergonomic principles.

EXPERIMENTAL PROCEDURE

The study was conducted at Allahabad city in three phases. In the first phase, to ascertain the availability of different models of wheel chairs, a market survey was conducted in popular shops of Allahabad city dealing with wheel chairs. In the second phase, a sample of ten children with cerebral palsy were randomly selected for case analysis to evolve the design criteria based on the ergonomic principles. In the third phase, from the analysis of results obtained and based on the review

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of literature, a set of criteria were developed to design the prototype of wheel chair in order to reduce the associated hazards and make it multifunctional. The criteria developed were further applied to evolve computer-aided prototype using Auto CAD and 3D MAX softwares.

EXPERIMENTAL FINDINGS AND ANALYSIS

Based on the review of literature, market survey and case studies where in information was collected from various sources i.e vendors, care givers, trainers, physiotherapists and the patients, the following needs of a wheelchair were identified.

Portability of the chair:

It was seen that all the respondents and the caregivers desired portability of the chair with either the seating system being removable from the frame, or at least having the frame still be collapsible with the seating system attached, so that the chair can be easily taken along when they are going out of station or to any other place easily and can be used whenever required, which can be a boon to the caregiver as well as to the child. The foldability of the chair is also required as and when the patient is not using it, it can be folded and kept aside.

Adjustable wheel chair:

Buying a new wheel chair every year is not feasible option and the target group is growing children, growth kits to allow the chair dimensions (seat height, seat depth, back rest, head rest, foot rest etc.) to extend is required. Adjustability of the system without the need of specialized tools is desirable. The proper posture while sitting should be straight back. The spinal column, with proper posture is an efficient support mechanism of the body. The chair should be designed to avoid slumping or sitting on the tail bone. When the spine experiences strain, other muscles come into play to support the spine. This is where the thighs, upper and lower back, abdomen, neck and shoulders come in. Adjustability in a wheel chair ensures it so that the shape of it conforms the spine and the sitting angle adjusted according to the specific need. The height of the seat also plays an important role in maintaining proper posture. If the back of the thighs are not in contact with the seat, the support available will also be lessened. The lessened support forces the person to exert more effort in maintaining proper posture.

Dynamic seat:

Extensor thrusts are symptoms of muscle control problems. The condition causes the major muscles in the body to contract simultaneously. As the extensor muscles are generally stronger than the flexor muscles, the person tends to straighten out. For wheel chair users, this leads to the user sliding or falling out of the chair. The most common remedy is to constrain the user with belt or chest straps, which are uncomfortable to the user, as these restraints creates large

forces on the back, thighs and feet.

Other problems from the restraints include sources from a constant seating position and moisture build up from lack of air circulation. These thrusts are common in people who have high muscles tone, one among them are the cerebral palsy children. So, while designing the seating systems of wheel chair critical component which has to be considered is the nature of extensor thrusts. A dynamic seat moves with respect to the wheel chair frame and contains both resistive and dissipative elements to absorb the energy during an extensor thrust which leads to a more comfortable experience for the user and also reduce breakage of chair components.

Tilt in space:

To enhance the comfort, extra-growth capacity pressure relief, tilt in space in the chair is very essential.

Easy to clean fabric:

Fabrics which are easy to clean and which can be designed to come off cushion easily for cleaning and changing can be used.

Lap table:

A lap table to fit across the arms of the chair, for working reading, eating etc can be designed. So that the caretakers do not have problem of shifting the patient and neither the patient has a problem of shifting. This has to be designed in such a way that it is fixed where ever required, so that there is no problem in the balance of wheel chair.

Padded arm rest:

The armrest should be padded so that it is comfortable for the patient to seat and the pressure on the arms also can be avoided.

Commode:

A commode needs to be fixed in the design of wheel chair, so that the patient can be taken in the wheel chair itself to the toilet. This feature helps both the caretaker and patient in lifting and shifting.

Brakes:

Easily controllable breaks that can be operated by the patient itself have to be included in the design to avoid accidents.

Foot rest:

Swingable and detachable footrest to permit the user to sit comfortably and stretch should be included.

Accessories:

Accessories like bag to keep all the immediate essentials

of the patient and a bottle holder to keep the water bottle should also be included in the design. Straps for arms and legs can be provided for the users who have involuntary jerky movements.

Prototype design:

Considering the user’s needs, taking into account the ergonomic principles and ISO standards for wheel chairs the following parameters with specifications were evolved to develop the computer aided multifunctional wheel chair for cerebral palsy children (Fig. 1 and 2).

- Dynamic seat
- 45° posterior tilt in space
- Lap table
- Padded arm rest
- Wheels with brakes
- Adjustable and detachable foot rest
- Attached commode
- Bottle holder
- Bag to keep magazines/stationary
- Box to keep essentials
- Straps for arms and legs

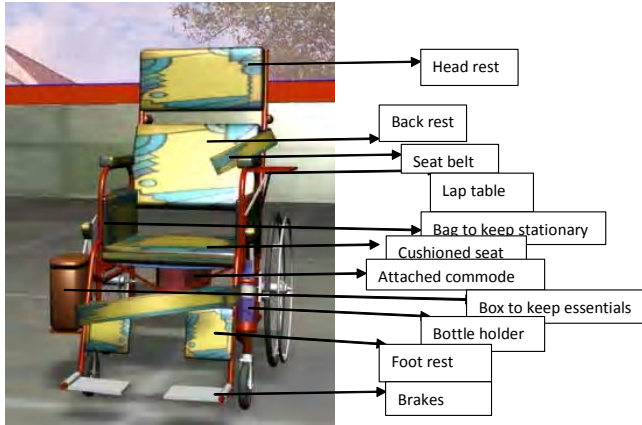


Fig. 1 : Computer aided prototype of multifunctional wheel chair for cerebral palsy children

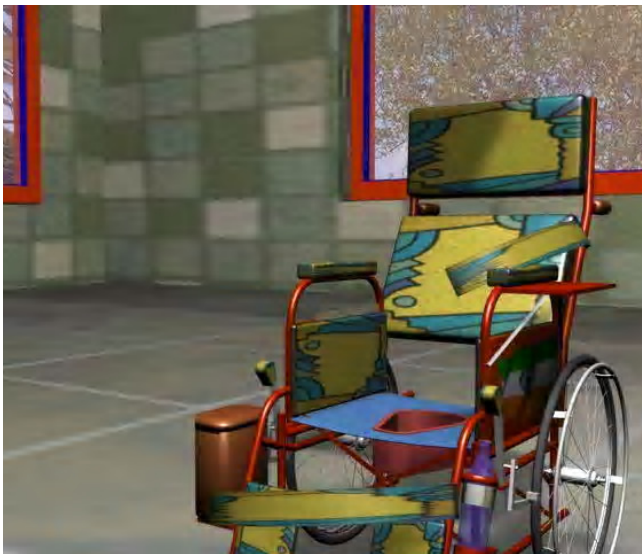


Fig. 2 : Front view of the computer aided wheel chair- showing all the features

- Chair with easy adjustability
- Portable and foldable wheel chair

Conclusion:

Medical, technological and societal advances have increased the quality of life dramatically for wheel chair users. As those with disabilities live longer and continue to strive for greater personal freedom, increasing demands must be placed on their wheel chair. The evolved computer aided multifunctional wheel chair will be of help to the users to overcome the problems faced by them as it is based on user’s needs. The design of wheel chairs will also be helpful for the caregivers, as it is adjustable and frequent shifting of the user will become less cumbersome due to its easy adjustability. As the chair is multifunctional, the users immediate requirements can be fulfilled with our anybody’s help. The proposed wheel chair design may be a boon to the users as well as caretakers, as they will provide more freedom to the user and reduce the user’s dependence on care giver.

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