



**NATIONAL TECHNICAL UNIVERSITY COLLEGE OF  
MALAYSIA**

**MANUAL WHEELCHAIR DESIGN  
IMPROVEMENTS AND  
DEVELOPMENTS**

Thesis submitted in accordance with the requirements of the  
National Technical University College of Malaysia for the Degree of  
Bachelor of Engineering (Honours) Manufacturing (Process)

By

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## **APPROVAL**

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## **ABSTRACT**


The plight of handicapped people is often overlooked and forgotten by society. The purpose of this project is to design and develop a manual wheelchair. Which “seat jack” feature with integral focus on affordability to end users. Many forms of mechanisms were analyzed and a Pneumatic system was chosen to be the most suitable and practical mechanism for our application. Therefore detailed analysis and variation for design of the pneumatic system were carried out giving sufficient considerations to the nature of the wheelchair structure, the various constraints of lifting a disabled person and the limited space below wheelchair structure. Modifications were made to the structure of the wheelchair to accommodate the designed pneumatic system. The Graphical Method was used to locate the optimum location of pneumatic cylinders with specified constraints. This project conclusively proves that the pneumatic system is the most cost-effective lift mechanism for the transfer wheelchair and therefore it should be incorporated into the final design of the wheelchair.

## ABSTRAK

Nasib orang cacat sering tidak diberi perhatian oleh masyarakat. Tujuan projek ini ialah merekabentuk dan menghasilkan kerusi roda yang mempunyai ciri "seat jack" dengan memberi perhatian penting kepada keboleh-mampuan pengguna. Pelbagai mekanisma telah di analisa dan sistem pneumatik telah dipilih sebagai sistem yang paling sesuai dan praktikal untuk aplikasi kami. Oleh itu, analisa terperinci telah dilaksanakan untuk merekabentuk sistem pneumatik dengan memberi pertimbangan secukupnya kepada sifat struktur kerusi, berbagai kekangan untuk mengangkat seorang yang cacat dan ruang terhad di bawah kerusi roda. Modifikasi dilakukan kepada struktur kerusi roda untuk menyesuaikan sistem pneumatik yang direkabentuk. Kaedah Grafik telah digunakan untuk mencari lokasi titik optimum silinder pneumatik dengan kekangan yang telah ditentukan. Projek ini membuktikan bahawa sistem pneumatik ialah mekanisma pengangkat yang paling kos-efektif, oleh itu mekanisma ini boleh diintegrasikan kepada rekabentuk akhir.

## DECLARATION

I hereby, declare this thesis entitled “A New Wheelchair Design Developments” is the results of my own research except as cited in the reference.

Signature :   
Author's Name : Afda Rizan B. Ismail  
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## **DEDICATION**

Firstly thank to Allah S.W.T for the opportunity to finish this project. I owe this project and my true happiness to my beloved parent. Since the day I started going to this university until today, they are very caring and supporting for me.



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# **SIGN AND SYMBOL**

**SPSS**

**Statistical Package for Social Science**

# CHAPTER 1

## INTRODUCTION

The most common image of disability is the people in wheelchairs. Many people think that, because people use wheelchairs, they would be helpless without human-made devices for mobility. But how many of us walk barefoot down the street? - Most of us prefer to wear (human-made) shoes or trainers. And many of us use a human-made car, bus or train to travel from one town to another. In our own way, we are all independent upon human-made items for our mobility. The transfer wheelchair is an innovation which modifies a tradition wheelchair by enhancing its mobility and usage. The objective of the invention is to design and develop a new wheelchair with unique features and it allows a greater mobility for disabled persons by decreasing their limitations of travel.

## **CHAPTER 2**

### **OBJECTIVES**

The objectives of this project are:-

1. To design and develop a new wheelchair with a unique of features and friendly user
2. To propose a new concept of patient equipment
3. User achieve greater independence

## **CHAPTER 3**

# **PROJECT PLANNING**

In order to meet the objectives, a detailed project planning was arranged which outlined all of the main areas that had to be covered (see appendix-A).

## CHAPTER 4

### LITERATURE REVIEWS

#### 4.1 Wheelchair development

Wheelchairs in one form or another have been in use for many centuries, with one of the earliest models recorded by an engraving on a Chinese sarcophagus dated 6 AD (Kamenetz 1969). Self-propelling chairs were a later invention, but by the time of the American Civil War records show that the war wounded used wooden chairs (figure-1) with large front wheels and small rear casters (Bennett-Wilson 1995) [1].



Figure-1.0: Civil war wheelchair

Over the years, changes in design and structure reflected the introduction of new materials, advances in medical science, improvements in access and the environment and changes in social attitudes.

The arrival of the automobile resulted in demand for a portable model. In 1932, following a mining accident, Herbert A. Everest, an American mining engineer, collaborated with Harry C. Jennings, a mechanical engineer, to design and manufacture a relatively 'light-weight' folding wheelchair (Bennett-Wilson 1986).

Although some improvements have been made to this earlier design, reflecting advances in technology and concern to meet the increased specified demands of recent wars, nevertheless the folding design of Everest and Jennings, which consists of a cross bar connecting two side frames and fitted with flexible seat and back supports, continues to be used as a basis for the standard non-powered wheelchairs of today (Bennett-Wilson 1995).

## **4.2 Market research and industrial surveys**

Before the product design specification can be determined. It's important to find out the existing design in the market. Consistently surveying of present product is carried out to get essential information especially about the customer need and their problems, available product in the market and potential future market.

#### 4.2.1 Classes of manual wheelchairs

Manual wheelchairs have developed rapidly in recent years. Fifty years ago there was only one style of wheelchair and it came in one colour (chrome). Now, there are numerous types of wheelchairs to choose from and they come in a wide range of colours. Wheelchairs have moved from being chairs with wheels designed to provide some minimal mobility to advanced orthoses designed to meet the mobility demands of the user. The proper selection and design of a wheelchair depends upon the abilities of the user and on the intended use [2]. There are eight classifications (figure-2 side view schematic) of manual wheelchair are used now days as follows:-

i. Depot (institutional) wheelchair

The depot or institutional is essentially the same wheelchair that was issued to veterans in the 1940s. The wheelchair may be a bit lighter, but the basic frame is unchanged. Depot wheelchairs are intended for institutional use, where several people may use the same wheelchair. These wheelchairs are typically used in airports, hospitals and nursing care facilities. Generally, they are inappropriate for active people who use wheelchairs for personal mobility. Depot wheelchairs are designed to be inexpensive, accommodate large variations in body size, to be low-maintenance and to be attendant-propelled.

ii. Amputee wheelchair

People with lower-limb amputations typically have a different centre of gravity location than do people who have their lower limbs. When seated in a wheelchair the centre of gravity of the person with lower limb amputations may be close enough to the rear of the wheelchair to require some modification to the wheelchair axle position. The amputee wheelchair came about because wheelchairs were originally designed for people who were anatomically intact. Thus the centre of gravity of the

- wheelchair and an amputee was too close to the rear axles.
- iii. Hemiplegic (one-arm drive) wheelchair  
People who have brain related motor impairments often require specialized wheelchairs which permit the optimum application of their motor abilities. Typically a one-arm drive wheelchair consists of a linkage connecting the rear wheelchair. This allows the user to push upon the push rim of one wheelchair and to propel both wheels. To effectively turn the wheelchair, the user must have the ability to disengage the drive mechanism and to propel each rear wheelchair independently.
  - iv. Foot-drive wheelchair  
Some people have weakness of the upper and lower extremities and can gain maximal benefit from wheelchair propulsion by combining the use of their arms and legs or by using their legs. The design and selection of a foot-drive wheelchair depends greatly upon how the user can take greatest advantage of their motor abilities.
  - v. Indoor (rear caster) wheelchair  
Some wheelchairs are designed to meet the special requirement of indoor use. Indoor spaces are more limited and one is often required to get close to furnishings and fixtures to use them properly. Wheelchairs have been and can be designed to be used indoors. Commonly, indoor wheelchairs use rear caster because of the manoeuvrability of these designs.
  - vi. Attendant- propelled wheelchair  
Not all wheelchairs are propelled by the person sitting in the wheelchair. In many hospitals and long-term care facilities wheelchairs are propelled by attendants. The design of these wheelchairs requires special consideration.