# DESIGN AND CONSTRUCTION OF A PORTABLE DEVICE TO TRANSFER PEOPLE WITH MOTOR DISABILITY BETWEEN WEEL CHAIRS AND AUTOMOVILES

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## Abstract

The country has a considerable group of people with motor disability, including tetraplegic persons, that for their transfer from the wheelchair to the vehicle and vice versa it is necessary a companion to charge them, which is why this project helps the need with the design and construction of a portable device for the transfer and without making any modifications to the vehicle the same that can be paired in any sedan type car

The methodology that was used to obtain data from the analysis consist in the method of field research through taking measurements of the geometry of vehicles, the measures of the wheelchair occupied by users and the interaction between the wheelchair and the vehicle.

The crane was designed by means of calculations and simulations assisted by computer, which allowed to determine if the prototype complies with the requirements, and thus it could make the device control and electronic design.

With all the established information we proceeded to the machining and Assembly of the device and its accessories, to continue with appropriate validation testing and correction of errors.

The results of this project show that the device helps the user transfer from the wheelchair to the right front seat of the vehicle type sedan, as it allows the disabled patient lift easily and place him on the car seat safely bringing the project was successfully validated.

## Key words

Device, transfer, motor disability, crane.

## Introduction

Since 2007, the Ecuadorian State mark changes to guarantee rights of persons with disabilities with the generation of a specialized regulatory framework, and is ratified on March 4, 2008, whose purpose is to promote, protect and ensure the enjoyment full and equal conditions of all human rights and fundamental freedoms of persons with disabilities and to promote respect for their inherent dignity (Valarezo, 2013).

The results of the census conducted by the Ministry of Public Health in April 2015, which states that there are 202,880 disabled nationwide, in Imbabura 4,916, and in Ibarra city 2494. ("National Registry of Disabilities," 2015).

Referring to the accompanying facilitating the transfer of the disabled, there are several risk factors that make hazardous manual handling the weight of the person and, therefore, increase the probability that an injury occurs, specifically, on the back of companion.

Most transfer devices for vehicles require that it be modified to meet its goal, have high costs and some have specific requirements, for example, it is necessary that its doors open 90 degrees for the passenger out of the car, an elevator chairs or heavy crane.

To solve this problem, a device that does not require any modification of the vehicle is proposed, which is more versatile because it can be used in different sedan cars, without requiring a prior preparation of the vehicle, so it is easy and safe used by companion and its user friendly.

## Methodology

In the device design is indispensable to limit the prototype features according to the user anthropometry, so it was necessary to investigate

various sources about the anthropometric measurements of the Latin American population, where relevant data are obtained for the design of the prototype, such as weight and height, which are 90 kg and 1.80 m respectively.

It is necessary to the geometric data of the vehicles, including considered: the opening angle of the door, the distance from the hinge of the door to the center of the chair and geometry of the access area to the front seat. The device will be designed for sedan vehicles as it is the car most used in the country.

It requires also know the geometry of the interaction of the chair to the vehicle, so it is necessary to take the angles between the center of the chair seat and the center of the vehicle seat, the distance from the joint of the door to the center the wheelchair and investigate the dimensions of the wheelchairs.

Figure 1. Angle between the center of the chair seat and the center of the vehicle seat.

The preliminary study of the materials used in the portable crane to transport disabled persons is vital for the pre-selection of suitable materials, so it is looking at catalogs of national suppliers, just as the availability and costs consulted of materials in different establishments in the city of Ibarra.

The software used contains the characteristics of a great variety of commercial materials for selecting the most suitable material, depending on the yield stress, the safety factor and the maximum displacement of the crane.

Once defined the solution preliminary calculations are made using material mechanics theory and then the Finite Element Method using SolidWorks® commercial program. In this program the pieces are made with greater complexity and areas of contact with determined efforts by the finite element method because it can´t be calculated with the theory of mechanics of materials.

Completed design plans are developed, which allow the purchase of materials for the machining of parts and subsequent assembly of the structure; materials electrical part is also purchased, i.e. an H bridge which allows to control the rotation of the actuator, one arduino Nano to enter programming control rotation of said motor, relay modules for circuit protection, among others. The harness is made with similar materials to the commercial product and model.

## Results

**CRITICAL DATA:**
Distance from the joint of the door to the center of the wheelchair is 84 cm.
Opening angle of the door 76º.
Angulo interaction between the wheelchair and the seat is 90 °.

**DESIGN REQUIREMENTS:**

1. Raising a load of maximum 882N i.e. 90kg.
2. The equipment can be disassembled for easy handling and portability companion.
3. It has to be easy to handle for the user to disassemble and assemble the device.
4. It has to satisfy all the security standards.
5. The product cost has to be moderated.
6. The crane will be supported on a base, product of the grade work entitled "Design and construction of a portable device basis for physically disabled people between wheelchairs and automobiles" by Raul Conterón.

**CINEMATICS REQUIREMENTS:**

Device adjusted to the right front door of sedan car, because the base will be hooked on the right front side of the chassis; position 1 is the device aligned toward the disabled patient in a wheelchair, in position 2 the patient hooked to the device and suspended in the air and in position 3 observed the disabled patient is already inside the car, as can be seen in the figures 2 to 8.

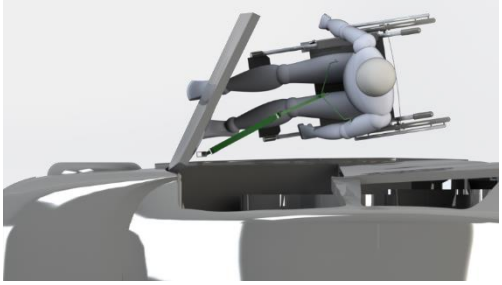

Figure 2. Top view position 1.

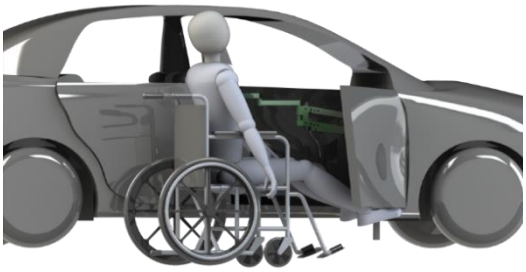

Figure 3. Side view position 1.

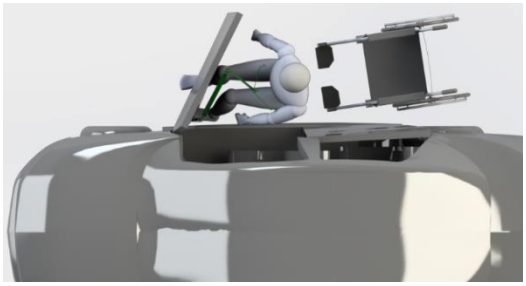

Figure 4. Top view position 2.

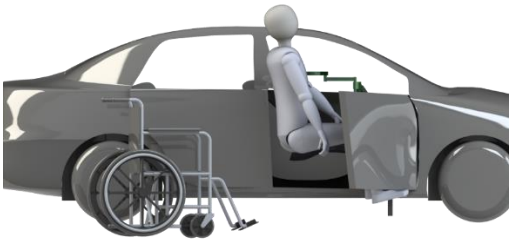

Figure 5. Side view position 2.

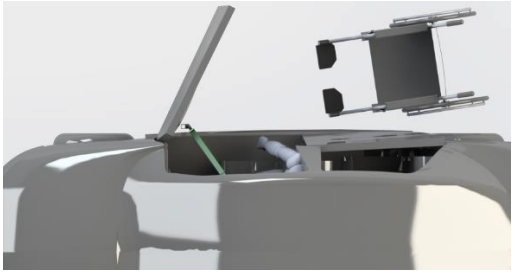

Figure 6. Top view position 3.

Figure 7. Side view position 3.

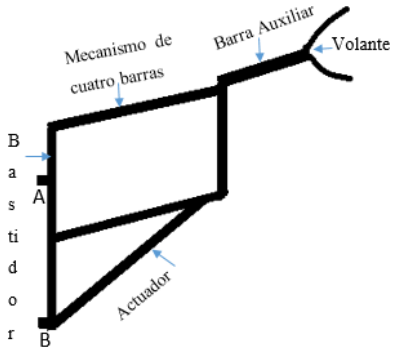


Figure 8. Conceptual design, transfer disables crane

**A, B supports**: allows the crane hook to the laptop base, while allowing rotation about the vertical axis.
**Frame:** Base where the actuator and the four-bar mechanism is placed.
**Four-bar mechanism:** can raise the auxiliary bar and the steering wheel without losing their horizontal orientation, to place the user in the right place. It also extends to accommodate the length of the crane according to the vehicle seat interaction.
**Actuator:** Motor raising to the crane.
**Auxiliary bar:** Rotates to locate the disabled patient in the right place.
**Steering wheel:** This is where the harness is hooked to move the user from the wheelchair to the vehicle seat.

## VALIDATION

With the correctly assembled device, proceed to attach the harness to the user, tests were performed with different people, where it was shown that the transfer device for physically disabled people fulfills its function satisfactorily without any problem, as shown in figures 9 to 12.

Figure 9. Transfer device assembled and hooked to the car correctly.


Figure 10. Person 1with harness hooked to the transfer device.

Figure 11. Person 2 with harness hooked to the transfer device

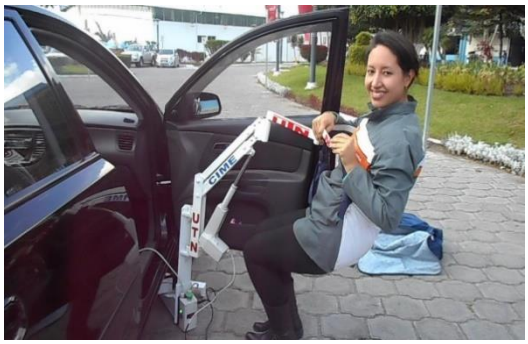

Figure 12. Person 3 with harness hooked to the transfer device.

## Conclusions

1. The device complies with the Latin American anthropometric characteristics investigated according to the area of influence.

2. The simulation was a fundamental key to detect flaws in both the design and the material tool.

3. The device allows patients with motor disabilities easy entry to the car because the kinematics of the system is adequate for the vehicle and the user.

4. The device provides security and confidence to the patient thanks to its high resistance and minimum displacement, which ensures full functionality and usefulness.

5. The device performs its function, was assembled with readily available materials, so its weight is increased compared to planned.

6. The actuator that was used was imported and above the required characteristics, as in the national market not found distributors electric actuators. Note that exploits only 33% capacity acquired actuator, being the closest having the calculations required by technical specifications.

## Recommendations

1. Continuation of undergraduate work with progress in reducing the weight of the device is recommended.

2. It is suggested to modify the design of the device so that it can be used in other vehicles, such as trucks, vans, among others.

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