CHAPTER 9
UNIVERSITY OF DELAWARE

School of Engineering
Department of Mechanical Engineering
Newark, Delaware 19716-3140

Principal Investigator:

Dick Wilkins (302) 831-2421
wilkins@me.udel.edu

Wheelchair Raiser

Designers: Jason Spisak, Matt Scarborough, Kabie Henderson, Eric Mei
Client Coordinator: James Siam
Advisor: Ralf Tschirschnitz
Supervising Professors: Dr. A4 Keefe, Dr. D. J. Wilkins
University of Delaware
I26 Spencer Lab
Newark, DE 19716

INTRODUCTION

This device addresses a height disadvantage endured by wheelchair users. It allows the user to raise the chair and him or herself to the approximate height of a standing person. The device is attached to a normal wheelchair, without interfering with the original functions of the chair. It is attached with clamps, such that it can be easily removed and re-attached. The system is fully self-contained, requiring no assistance from anyone other than the user. The device was kept as light as possible, so that the user is not forced to transport excess weight. The design ensures that the chair remains level throughout operation, regardless of the user's position. A device for a similar function currently available on the market costs over $13,000 - more than ten times the cost of our design - and raises the user only eight inches, compared to 15 inches with the present design.

SUMMARY OF IMPACT

A person in a wheelchair is faced with new challenges every day. Lifting the person up 15 inches allows an individual to sit at the height of a normal standing person. This reduces problems in several situations in the home and workplace.

TECHNICAL DESCRIPTION

The design employs four hydraulic cylinders to lift the chair, with four more cylinders assembled for a pump. Primary criteria were: (1) the need to ensure even deployment of the lifting device under uneven loads; and (2) stability.

The pump was composed of four cylinders assembled in parallel, all driven by the same ball screw. This design, with four points on the floor, allowed for more stability than three, and was actually less expensive because of additional adaptations required by a three-cylinder system. The cylinders were threaded on both ends, with the ball nut and the threaded ends of the rods rigidly attached to the same steel plate. The backs of the cylinders were fixed on the other end to a second steel plate sandwiched between two thrust bearings at the end of the ball screw. A third plate was added for additional rigidity. All four pump cylinders move together.

Since hydraulic fluid is incompressible, the lifting cylinders must move together with the pump. The pump assembly must be rigid, and the plates must remain parallel. If they do not, the cylinders may bind. To address this issue, deflection in the plates under a load was reduced to a maximum of 0.016 inches under worst case loading conditions. ("Worst case loading," here, refers to the weight of a hypothetical 300-pound person, plus the 81-pound weight of the chair, plus the 47-pound weight of the lifting system, all with a center of gravity directly over one of the cylinders.)

The fixture points for the attachments were determined by the geometry of the chair. Steel clamps were used as a base for welding. In the rear, the locations of the cylinders were constrained by the need not to interfere with the ability of the chair to tilt back — such as required for maneuvering onto a curb — while remaining as stable as possible. Therefore, the cylinders were placed as far back as possible, while keeping the feet on the cylinder within a radius of 12 inches from the hub of the wheel. With one-inch clearance off the ground, that point is approximately 4.8 inches behind the axle. The locations of the top rear clamps were in turn determined by geometry once the bottom was set.

The system is powered by an electric motor mounted on top of the pump assembly. The torque requirement is surprisingly low, much less than most hand drills provide. The motor is permanently mounted with a switch located on the armrest of the chair for easy access by the user.

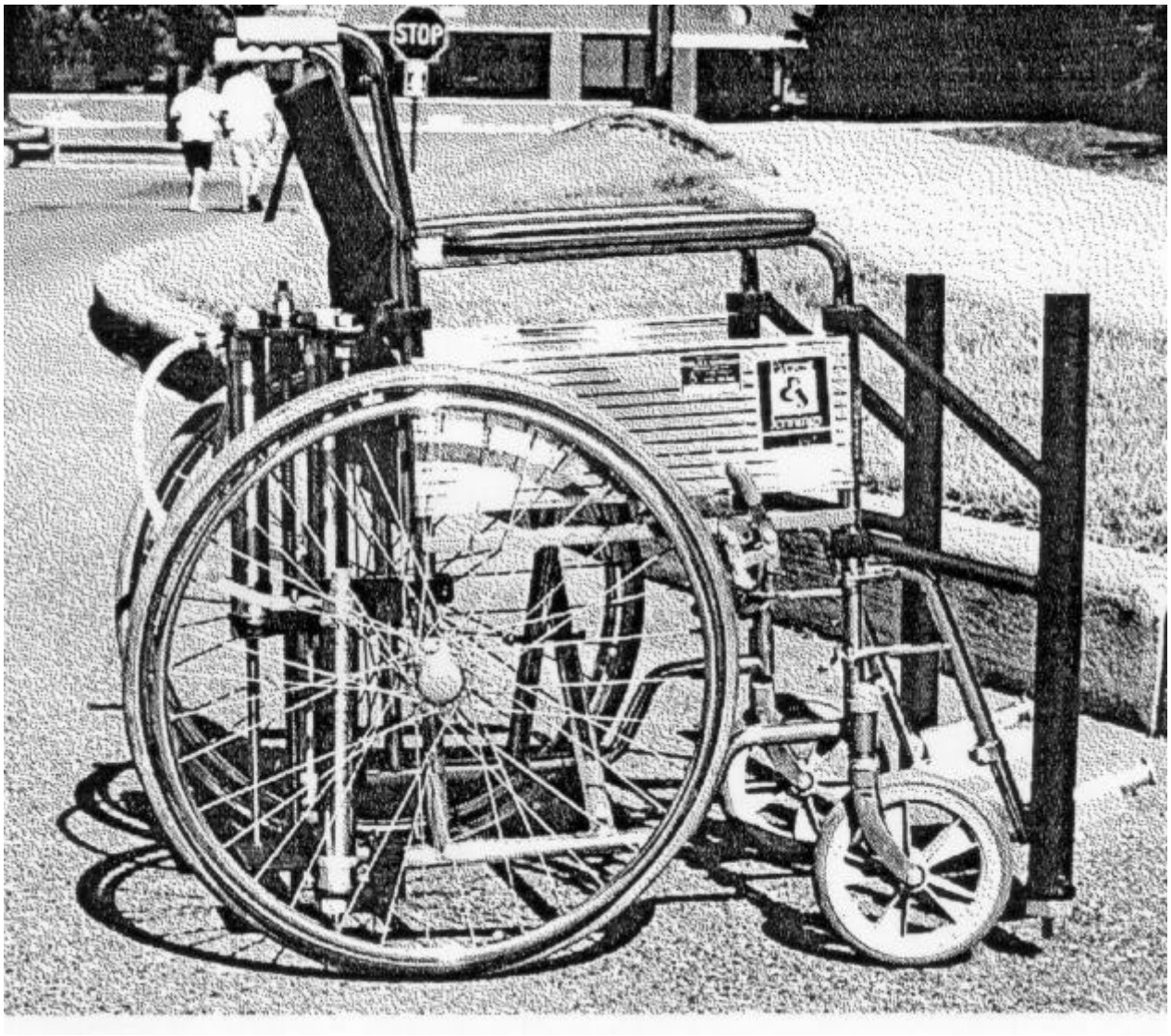

Figure 9.1. Photograph of the Wheelchair Raiser.