CHAPTER 19
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WHEELCHAIR MOUNTING CLAMP FOR A LAPTOP COMPUTER

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INTRODUCTION

Computer clamps for persons who use laptop computers while seated in wheelchairs are generally designed for specific wheelchairs. Thus, when users replace their wheelchairs the cost of a new clamp may be problematic. A laptop mounting device was designed for use on wheelchairs with rectangular seat base support.

SUMMARY OF IMPACT

The client needed a sturdy, economic, and safe method of mounting a laptop computer directly to a wheelchair. The intent of this project is to design a mount that will accommodate a multitude of wheelchair styles. The mount could also be used for attaching communication systems and other devices to hospital beds or floor-mounted tables. This technology may be used in the home, office, and automobile for attaching various items to chair frame structures.

TECHNICAL DESCRIPTION

Design requirements were that the device:

- Be easy to manufacture;
- Be interchangeable from powered to non-powered chairs;
- Be designed for chairs with rectangular tubing frames;
- Be easy to assemble;
- Not require alteration of wheelchair seating material;
- Maintain computer positioning relative to the client regardless of chair tilt;
- Be manufactured from a lightweight, easy-to-machine material.

The design incorporated a wrap-around clamp fixture (see Figures 19.1 and 19.2). The wrap-around was sectioned into a three-piece unit with a split top. Figure 19.2 is a graphic representation of the clamping system.

The exploded view (Figure 19.2) indicates all components required to manufacture and to assemble the clamping fixture. The fixture consists of a Jaw (1), Plate (2), Jaw (3), Plate (4), and eight ¼ - 20 cap screws of various lengths. Table 19.1 provides a breakdown of component costs on a prototype run compared to a batch run. The cost of the part when produced on a large production run will be significantly less than shown here. The costs shown are estimates for production. However, all materials and machining were donated for this project.

Aluminum was selected for construction material because it is strong, ensuring safety and reliability, and lightweight, so that it will not add excessive weight to the chair. It is also easy to machine, which will help maintain lower production costs. For this prototype, conventional machining methods were used. In mass production, components could be machined in batch production, or basic shapes could be extruded or die cast then, machined.

A static analysis of the system revealed a safety factor of 23. Therefore, the chance of failure is remote. In addition, the AL 5052 material chosen has a yield strength of 27 kpsi and a tensile strength of 34 kpsi. In all evaluations of the system, the maximum shear stress theory was applied to determine failure and safety factors. No changes in material were required.

System testing was performed by mounting the system to a stationary tube and by performing a pry evaluation to determine if the device yielded or loosened. Pry evaluation consisted of applying an external load at the clamp mount surface. During testing, no failures were observed.

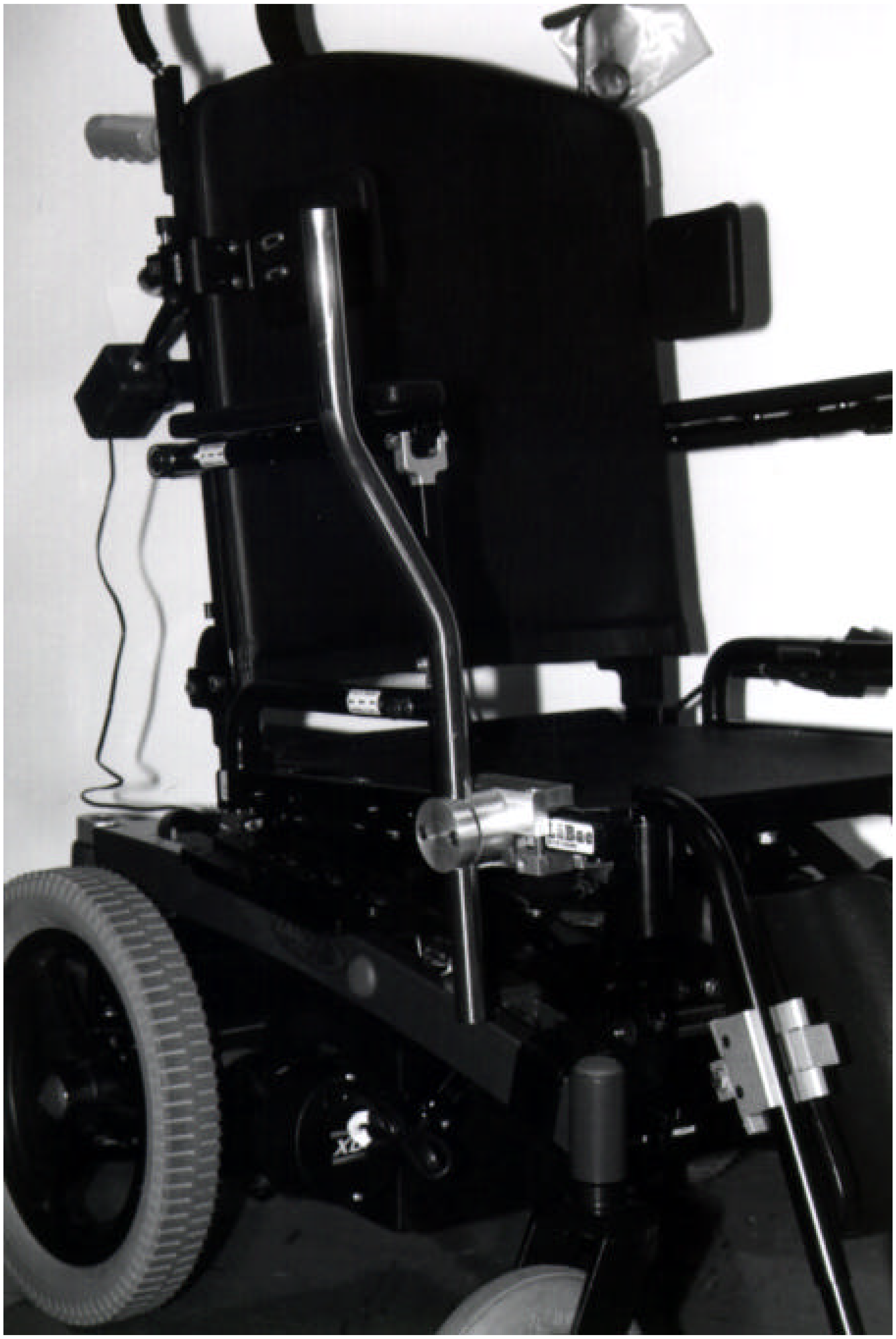

Figure 19.1. Wheelchair Mounting Clamp for a Laptop Computer.

Table 19.1 Parts and Projected Costs for the Wheelchair Mounting Clamp for a Laptop Computer.

Part Number	1 Piece Production Run *	10 Piece Production Run *
Jaw (1)	$60	$30
Plate (2)	$20	$10
Jaw (3)	$40	$20
Plate (4)	$40	$20
¼ - 20 Cap Screw	$5	$5
Total	$165	$85

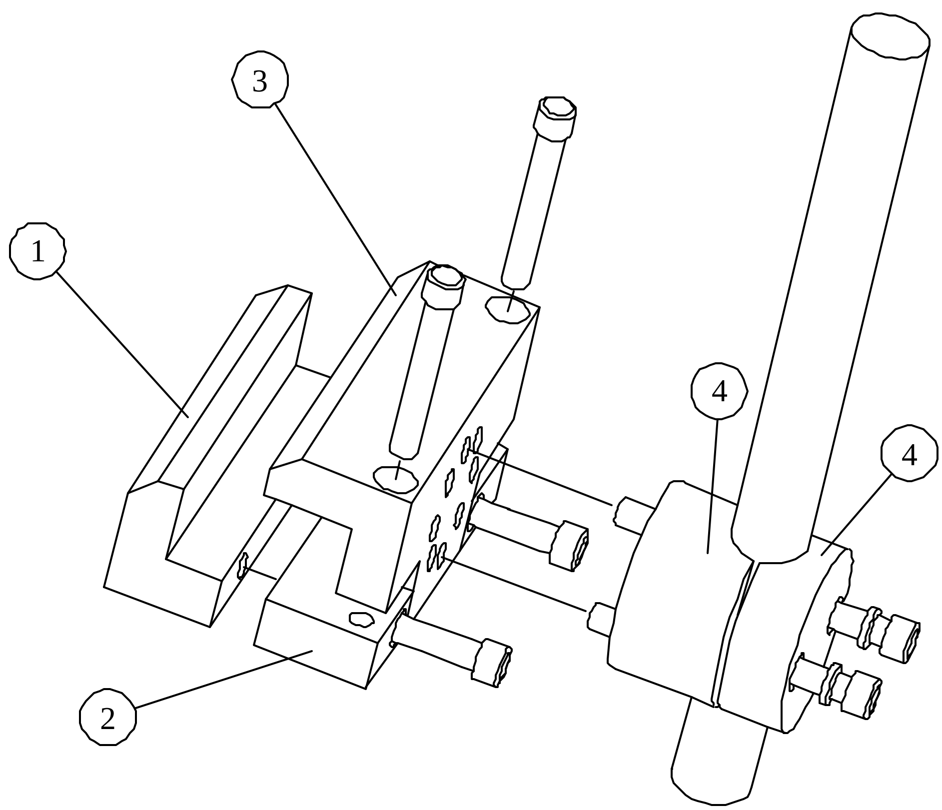

Figure 19.2. Diagram of the Wheelchair Mounting Clamp for a Laptop Computer.

ADJUSTABLE PLATFORM FOR AUGMENTATIVE COMMUNICATION DEVICES

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INTRODUCTION

Augmentative communication devices are useful tools for persons with disabilities at work, leisure, and school. The devices are normally situated in a fixed location. In some cases, the operator may need to be mobile while having access to them. The adjustable platform for augmentative communication devices made it possible for a person who has decreased fine motor control due to cerebral palsy (CP) to continue his employment in an environment that requires him to move his communication system from place to place from his wheelchair.

SUMMARY OF IMPACT

This adjustable platform was designed to help a client with CP to easily and quickly move his augmentative communication devices from one workplace to another. Ability to adjust the platform from 0 to 45° allowed the client to use various types of augmentative communication systems, including laptop computer-based types. The platform's height and width are adjustable to allow for use from wheelchair or while standing. The platform is easy to use with a quick setup time and can be disassembled to fit in small areas for storage. The casters allow portability with a simple anchoring system. All materials used are recyclable and of high quality for increased life and durability. The system will help the client or any individual with CP to obtain and maintain employment.

Figure 19.3. Photograph of the Adjustable Platform For Augmentative Communication Devices.

TECHNICAL DESCRIPTION

Specifications were that the platform:

- Allow the user adjust its height and the angle;
- Support a variety of communication devices, including laptop computers;
- Support a variety of weights;
- Be stable, with the ability to withstand offset loading with minimal vibration;
- Tilt up to a 45° angle to prevent light reflection on the screen;
- Be made of non-slip materials;
- Enable the user to move from room to room with devices attached;

- Be easy to use and allow for quick assembly and disassembly;
- Be portable, allowing easy movement to different locations and floor types;
- Be strong and durable;
- Fit in a small area after being disassembled; and
- Be economical.

Design Description

Detailed drawings were generated using AUTOCAD software. The design consists of a base that is made from 2" x 2" steel tubes. One left and one right foot extend telescopically from the body. The feet and central extensions are made from 1.75" perforated square steel tubes. The platform is made from 3/4" particleboard Formica and is covered with a non-slip pad. The platform is mounted on a "T" shaped structure made from 2" x 2" steel tubes with hinges. All tubes have 1/8" wall thickness. Adjustments can be made in four different directions. The foot extensions telescope left and right to fit different sizes of wheelchairs, while the central extension moves vertically for height adjustment. In addition to angle adjustment, the platform telescopes in and out to compensate for the difference in user sizes. The client required a tilting angle up to 45°. With the use of the friction hinges, the angle exceeded 60°. The friction hinges can support up to 45 lbs.

As mobility was of great concern, the system was mounted on four rubber wheels. Two of the wheels can twist at 360° and are equipped with strong brakes. The two other wheels are straight to facilitate steering, minimize drift, and increase stability. Pins (7/16") are used to hold the components in the desired position. Finally, the system was sprayed with a heavy industrial paint coat to prevent rust and improve its appearance. The chosen color, antique white, matches almost any furniture color.

Manufacturing and Assembly

After accomplishing the detailed drawings and completing the parts list, the system was constructed. The square tubes were cut to the desired sizes at a 45° angle using an automatic hydraulic saw. Light filing was necessary to eliminate the burrs and to allow close alignment of the tube edges for proper welding. The tubes were aligned and welded together according to the designed shapes. To obtain a smooth surface, a grinding process was necessary to even the edges. Drilling for the holding pins and tapping for the mounting hinges were the last machining processes. The system was then assembled and subjected to a bench test to evaluate its function.

While the system was being painted, the wooden platform was assembled. One stainless steel hinge was used across the platform to achieve the tilting option. Two adjustable friction hinges hold it at the desired position. After all components were painted, the wheels were mounted. Finally, the system was evaluated.

Bench Test and Product Evaluation

Initial design evaluations revealed concerns with certain areas of the platform framework, which required stiffening to reduce the possibility of vibrations during operation. Reinforcements were added to distribute the loading, thus eliminating the problem. After assembly, one of the four casters was noted to be not touching the ground. This misalignment was due to welding affection. Components were heated and adjusted to minimize the offset. The casters were brought to an acceptable planar to eliminate the problem. Heavy loads were placed on the end of the platform to simulate people leaning their partial or entire weight on the platform. There was negligible deformation.

Ease of adjustment of the framework was an important concern. Filing and grinding were necessary in some areas in order to improve telescoping smoothness. The last test included communication device retention to platform at maximum adjustment. Several types of laptops and devices were placed on the surface while it was tilted to an angle of 60°. The devices remained in place and no problems were exhibited.

It is estimated that the system will cost $492.85. However, area companies donated all the parts for the project.

MOUTH STICK DOCKING STATION

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INTRODUCTION

Some patients with quadriplegia use a mouth stick to change channels on their televisions. The mouth stick requires a receptacle for storage when not in use. The mouth stick docking station is a device used to hold a mouth stick for a patient with quadriplegia. The design is flexible, adjustable, comfortable, and reliable. It enables the patient easily to grasp and release the mouth stick.

SUMMARY OF IMPACT

The design is adjustable and easy to use, thereby freeing caregivers and enhancing the patient's independence. The system is portable and adaptable for various bed units, as well. With the unit mounted to a headboard, the patient still has freedom and space to carry out other activities. The unit is easy to reposition for transferring patients in and out of bed.

TECHNICAL DESCRIPTION

The mouth stick docking station is made of machined aluminum alloy attached to a flexible gooseneck. The gooseneck is mounted to a hospital bed frame using a triangular flange. The system is designed to prevent the mouth stick from falling out of place after its release.

The choice of aluminum alloy enabled the reduction of the amount of force applied while holding the mouth stick. The system is illustrated in Figure 19.4.

Figure 19.4. Mouth stick Docking Station.

Testing and Reliability:

Tests were conducted to verify the success rate of adequately placing the mouth stick on the docking station. Each result was compared against a wooden docking station model with a success rate of 15 out of 20 attempts. The results of the tests indicated a success rate of 19 out of 20 trials. The increase in success rate may be attributed to the wider v-shaped aluminum prototype. Aluminum was chosen over wood for manufacture because the use of a wider wooden slot would jeopardize the structural integrity of the docking station. Although the wooden docking station integrity could be improved through greater bulk, increased mass may cause a large bending moment on the flexible gooseneck.

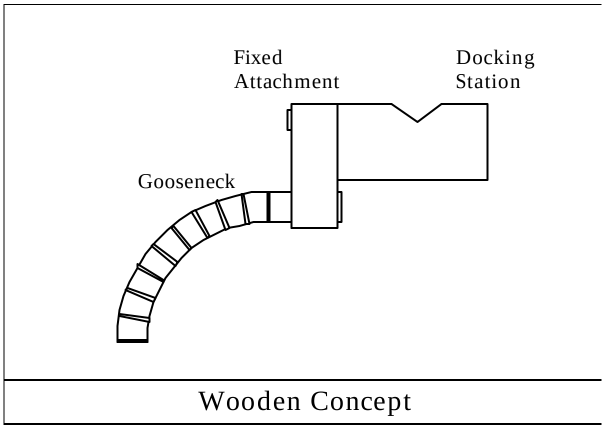


Figure 19.5. Wood Concept for the Device.

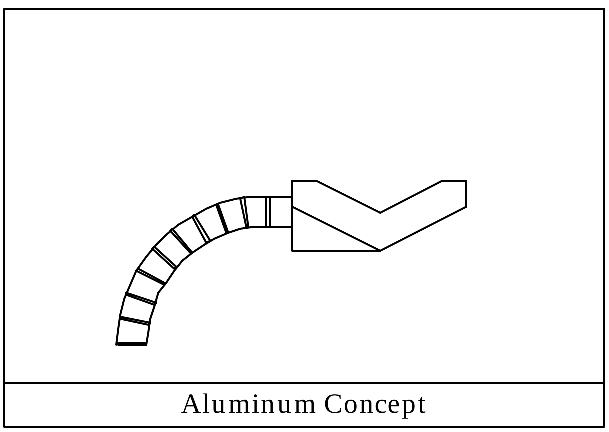
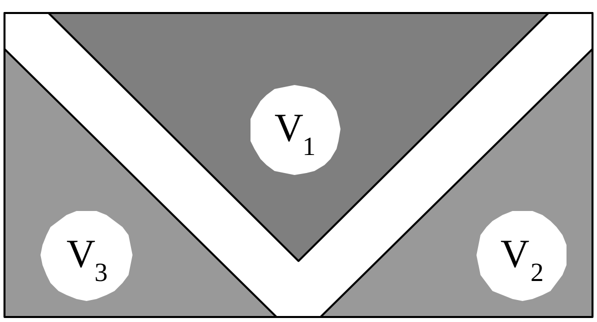


Figure 19.6. Aluminum Concept for the Device.



Calculations for reducing the volume were made for the surface areas V1, V2, and V3. Weight reduction was achieved by machining off these materials. Three areas of reduction were considered, the two corner sections next to the taped hole and the bottom outer corner, as seen in Figure 19.7.

The total cost of the project was $115.89.

LAPTOP COMPUTER CARRYING SYSTEM

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INTRODUCTION

This project was developed for an adult with cerebral palsy who uses a laptop computer for communication. The patient is ambulatory and needed more mobility at his job. His augmentative communication system must be available to him at all times. Therefore, a comfortable, ergonomically correct method for the safe transport of his laptop computer without his having to disassemble and place it in a carrying case each time is optimal.

The device is positioned in front of the patient to enable him to see the monitor and access the keyboard with his hands. Frequently, his job requires him to guide two individuals with cognitive impairments around the store by holding their hands. The working environment for his main activity has a tiled and carpeted floor with a small step separating the two. The aisles are large enough for adequate turn space.

SUMMARY OF IMPACT

This laptop computer carrying system enables the client to have his communication system at his disposal at all times. The client can use it to safely transport his laptop computer in an ergonomically correct way to a variety of settings in his environment. The device was designed to be in front of him, while still permitting the freedom his hands to do other necessary operations. The design folds up well and is light enough to transport easily.

TECHNICAL DESCRIPTION

Design considerations included that the device be lightweight, safety, compact size, height adjustability, ease of assembly and disassembly, ease of rolling rigidity, and static stability. The design consisted of crevices rather than pins for the main body. Support was added, as well as a wedge for mobility along with a twist key for simplicity. These criteria were taken and combined into a package that would fold up easily.

The material used was "off the shelf" lightweight aluminum. The two cross members on the base were for rigidity and a foundation for the support and main shaft. The targeted total weight was less than 20 pounds. The final product weighed 17.5 pounds. This design was viewed using CATIA, and further analysis showed that it was both statically and dynamically rigid.

Performance Evaluation

After completion, the system was assembled and disassembled repeatedly to ensure capability, repeatability, and ease of assembly. The device was rolled over concrete, carpeted floors, and tiled floors to guarantee dynamic rigidity and stability.

Tests revealed design specifications were met and satisfied the client's needs.

Cost Analysis

Description	**Cost**
Swivel Wheels 2" 51mm	$14.36
4" Heavy Duty Strap Hinge	$1.87
1" Narrow Non Removable Hinge	$1.53
Light "T" Hinge	$1.47
1/8"X1/2"X4' Aluminum Angle	$9.97
1/8"X1/2"X8' Aluminum Angle	$19.85
1"X1/16"X48" Aluminum Square	

Square	
1”X3/4”X4’ Aluminum Square	$15.47
1/8”X36” Rod	$1.47
Total	$72.82

The estimated material cost of the project was $72.82

Figure 19.8. Laptop Computer Carrying System.

LOWER EXTREMITY EXERCISE SYSTEM

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INTRODUCTION

The purpose of this project was to build a device to stimulate the lower extremities of a patient who had a stroke. The caregiver requested mechanical stimulation to weakened motor joints.

SUMMARY OF IMPACT

The patient regained function on both sides. It is anticipated others could benefit from this mode of accelerating stroke recovery.

TECHNICAL DESCRIPTION

Various options were considered, including revising an existing massage system, such as, the "Foot Fixer" or the type of pad used on a chair. However, the system inputs could not be controlled and the inputs were not repeatable. The decision was to design a system with controllable frequency and vertical pitch on which the patient's feet rest. By pulsating the patient's feet with vertical amplitude at variable frequency, pulses from the instrumentation transmit through the motor joints.

The original design called for a stationary platform on a set of turning rods instrumented with small bumps to make contact with the platform. During operation, these bumps would transmit pulses to the platform, which would then be sensed by the patient's feet.

To accommodate the demand for a robust system, the design was converted to a camshaft like design. The platform is made of metal. The design consists of two shafts, four brackets, four rollers (disks), four roller bearings, and two steel plates. As the shafts are timed accordingly, inputs can be controlled.

A cam or roller had to be set 0.125 inch off center to rotate about a shaft to enable the vibrating platform n to move vertically with a pitch of 0.125 inch. Initially, there were two shafts, 1.125 inches in diameter. The

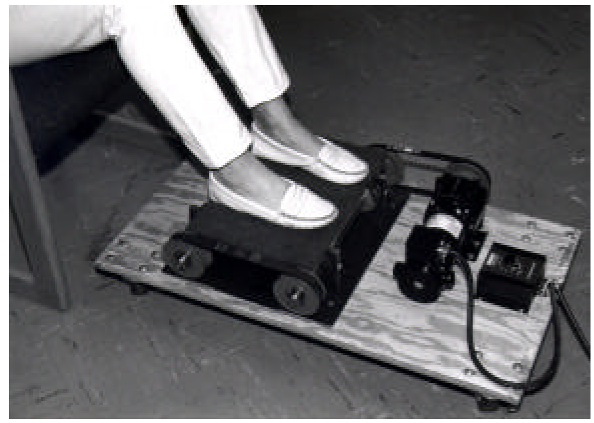

Figure 19.9. Photograph of Lower Extremity Exercise System.

ends of the shafts were turned down to 1" to fit the couplings for the cog gear. The vertical motion was created by four simple rollers, 2.5 inches in diameter. There was a hole drilled into the rollers to accommodate the shaft. The hole drilled was 1.125 inches and was offset 0.125 inch from its center. The purpose of this offset was to create the elliptical motion required to obtain the vertical motion for the platform.

The four rollers were drilled and tapped along the outer perimeter to enable them to be fastened to the shafts. Also, these holes facilitated the indexing of the rollers to ensure that they line up perfectly. To allow easy rotation, bearings were used. The four bearings were 1.125 inches in inner diameter, 1.5 inches in outer diameter, and 0.5 inches thick. To support the bearing and the rod, a bracket was fabricated. The bracket began with 3.5 inch by 5 inch by .5-inch stock. Then all four pieces of stock were simultaneously machined down on a milling machine. The brackets were then drilled.

To ensure the four holes lined up perfectly, the brackets were again drilled and clamped together. The parts were then assembled to check fit. The bearings were not press fitted into the brackets. Instead, the bearings were secured using setscrews. There were two setscrews holding the bearings in place. To fasten the brackets to the plate, the eight holes were first drilled into the plate. Then the brackets were put in place and marked for accurate hole locations. Next the cog gears were added to one end of each shaft. The cog was tapered to create a press fit when tightened with a screw to the coupling. The bracket-to-plate hole locations were determined from the distance center to the center of the cog and the timing belt. Once the locations were marked, the holes were drilled and tapped.

Subsequently, the platform was ready to be fully assembled. First the roller was secured to the shafts, lining up all the holes. Then the bearings were placed on the shaft about 9 inches apart. Once the bearings were in place, the brackets were secured. The brackets were tightened to the bearings using setscrews. Finally, there were two shaft assemblies. Again the assemblies each consisted of the shaft, two bearings located approximately 9 inches apart, and two brackets, which held the bearings in place. These assemblies were then secured to the plate using flat -head screws. The mechanical displacement platform was then mounted to the control system. The mechanical platform was fabricated from donated materials. The two shafts, the plate, and the four rollers were also donated.

DRIVE MOTOR AND MOUNTING PLATFORM

The plywood used to support the system was standard ¾ inch. The platform has the dimensions of 18 inches by 32 inches and four industrial strength wheels mounted at each corner. The motor was a 90-volt Dayton ¾ HP motor with a Dayton variable speed controller. The motor was wired for an input of 120V to enable use in household applications. The patient or an caregiver can vary the 120V input to the controller by changing the voltage going into the motor through a calibrated turning knob. The greater the voltage, the faster the plate vibrates.