

CHAPTER 15

TEXAS A&M UNIVERSITY

Dwight Look College of Engineering
Department of Biomedical Engineering
3120 TAMU
College Station, Texas 77843-3120

Principal Investigator:

William A. Hyman (979) 845-5532

w-hyman@tamu.edu

REHABILITATION FORCE TRANSDUCER WALKWAY

Designers: John M. Green II, Micah J. Johnson, David G. Teltschik

Client Coordinator: Clarice Butler

Sherwood Rehabilitation Center, Bryan, Texas

Supervising Professor: Dr. William A. Hyman

Department of Biomedical Engineering

Texas A&M University

College Station, TX 77843-3120

INTRODUCTION

The goal for this project was to develop a gait-training device that would provide various textures to assist patients needing proprioception therapy. The device needed to fit within the existing parallel bars. It also needed to have different surface textures so patients could improve their balance and coordination in response to stepping on the surface of the device. In addition, the physical therapists wanted a form of biofeedback to determine exactly how much weight was being placed on each leg. Traditional force plates can cost thousands of dollars due to their three dimensional measurement capabilities. The goal became incorporating the accuracy of one-dimensional (vertical) force plates into the design to give the necessary feedback to the physical therapists. The finished system is shown in Figure 15.1.

SUMMARY OF IMPACT

During gait-training therapy, patients are instructed to place as little pressure on their legs as possible. They are to place most of their weight on the parallel bars instead. Gradually, they move to placing increasing amounts of weight on their legs. However, the percent of the patient's body weight is never really known without the use of a real time force plate analysis device. This causes problems because it is uncertain what percentage of body weight is being placed on the legs at any given time. It is difficult to increase from a percentage that is unknown. Commercial force plates were not feasible for this project because of their expense. Therefore, this system was built around strain gages used in deformation plates to provide the uni-axial, vertical force. The resulting real time feedback will provide the therapist with percent body weight totals related



Figure 15.1. Rehabilitation Force Transducer Walkway.

to the manually entered input weight of the patient.

TECHNICAL DESCRIPTION

The walkway can be considered both mechanical and electrical. There are five major components: 1) 233 megahertz Pentium II® computer with monitor; 2) mobile computer station; 3) National Instruments® Data Acquisition board, signal conditioner and cable; 4) custom 25-pin and 37-pin connectors; 5) left and right treads with four different textured surfaces each. The surfaces are comprised of finished oak, foam, tile, and padded carpet.

The functional components of the device are the deformation plates (see Figure 15.2). Strain gages, placed in both tension (top) and compression (bottom) configurations, are incorporated into these plates. The device utilizes current deformation plates used in electronic consumer scales. However, these scales use a microprocessor to determine the load applied. This device uses only the deformation plates and configures them in a Full-Wheatstone bridge. Once configured in a bridge circuit, the change in resistance resulting from deformation produces a change in voltage across the bridge.

Based on the dimensions of the parallel plates, left and right treads were constructed. Both were designed to contain four force transducer measurement pads each, spaced approximately 6 inches apart. The frame was first constructed out of 1-inch x 4-inch oak and 3/8-inch plywood. Due to the height of the device, entrance and exit ramps were incorporated. (Figure 15.3) The exit ramps serve another purpose as well, allowing wiring access between treads and to the computer. The force plates were wired with extension wire according to the full bridge circuit and connected to a common terminal. This allows a common loss due

to increased resistance throughout each bridge. Pads of different materials were then positioned so they would distribute weight to the deformation plates when stepped upon. Once the pads were placed in the 12-1/4-inch x 14-3/4-in plywood based opening, the surfaces were shimmed to the top level of the device. Handles were added to the device, allowing it to become portable via two-person lift. A removable centerboard was also provided. This is helpful for patients whose legs cross over during attempted ambulation.

The computer was assembled with both donated and purchased components. Two of these components are a DAQ board and a signal conditioner built specifically for measuring the voltage differences of strain gage bridges. The signal conditioner utilized was the SC-2043-SG eight-channel strain-gauge signal conditioner. The SC acts like a filter, amplifier, and transformer for the strain gauge signals. The DAQ board used in this design was the PCI-6043E 68pin DAQ board from National Instruments. The DAQ board received the conditioned analog signals from the signal conditioner and converted those signals to a digital signal that the computer could use. A trial version of LabVIEW™ was also installed in order to use the computer as an instrument. After custom connectors were made to complete the connection between the force plates and signal conditioner, an executable program to detect voltage changes was developed. The final step was to formulate an equation that would relate the change in voltage to the load applied. Gym weights were used in a calibration run to obtain that equation. This equation was then used in the program to show the physical therapists how much weight was applied to each pad.

Total project expenses were about \$2785.

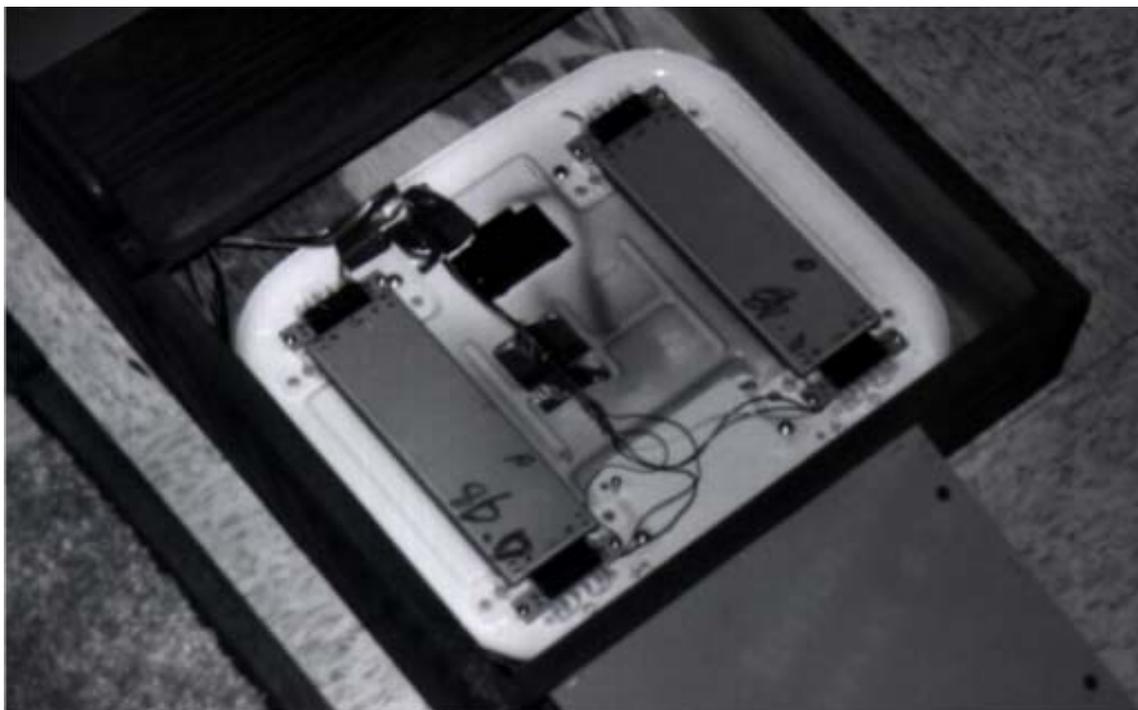


Figure 15.2. Deformation Plates Orientation with Full Bridge Design.

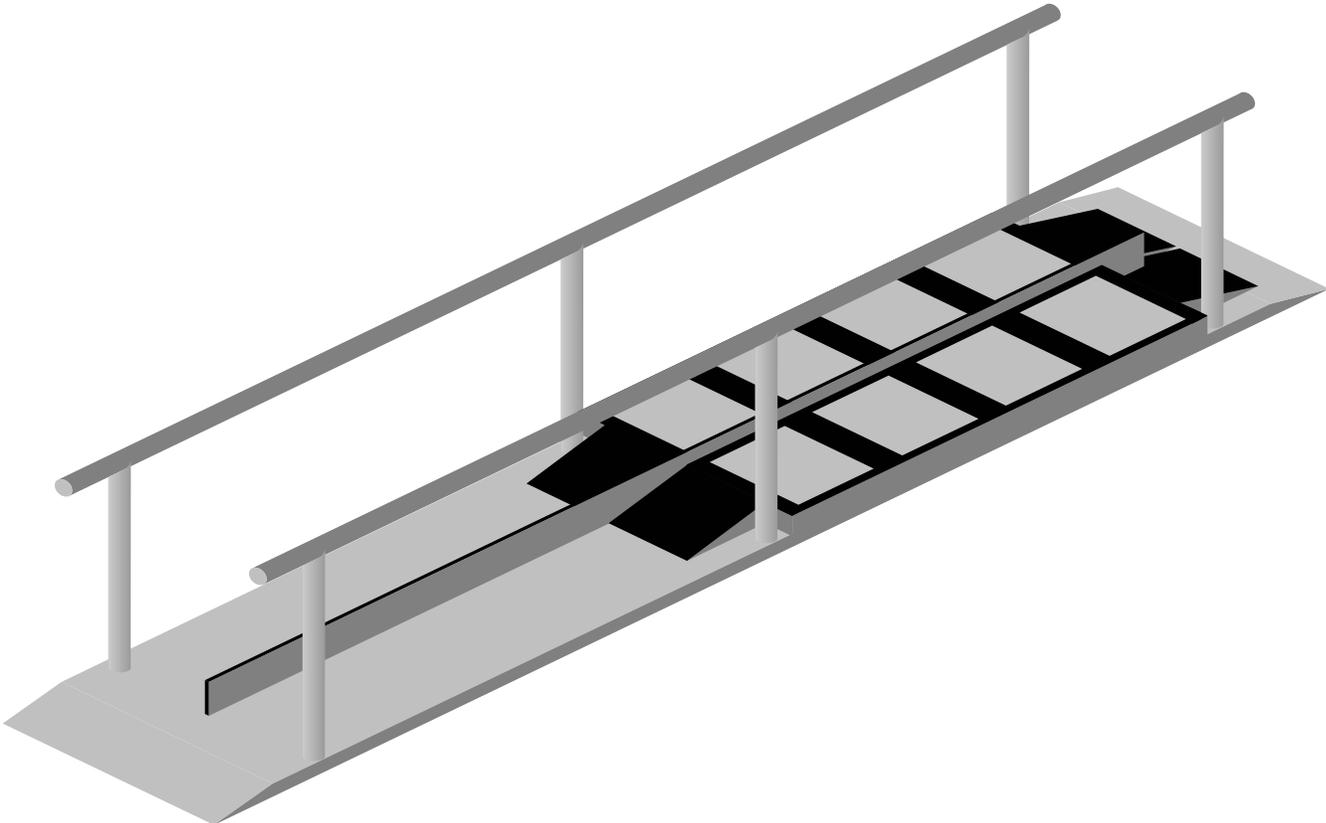


Figure 15.3. Rendering of Assembled Walkway System.

ROTATING FOOT BLOCKER

Designers: Kate Davenport, Sarah Steinhorst

Client Coordinator: Clarice Butler

Sherwood Healthcenter, Bryan, Texas

Supervising Professor: Dr. William Hyman

Department of Biomedical Engineering

Texas A&M University

College Station, TX 77843-3120

INTRODUCTION

A rotating foot blocker was designed for use in physical and occupational therapy. The idea for this project stemmed from a meeting with a local occupational therapist (OT). He reported that it is very difficult to help patients shift from a seated position to a standing position. To do this, he must place his feet in front of their feet to keep them from slipping. He must then use his body strength to lift them from a seated position. He also mentioned difficulty with rotating them to a different angle for ambulation, especially if they have knee or hip problems. A full day of lifting the patients in this way causes unnecessary fatigue on the OT's back and legs. In addition, there is the risk that a patient may fall.

The foot blocker consists of pinewood and a lazy susan bearing. The bearing sits between two circular wood pieces. The top circle serves as a foot support and the rotating portion of the device. The bottom has a non-slip surface to keep the device from slipping when used. On the top rotating circle, a block was added to support the patient's toes. A pin-locking mechanism was also added. The unit is small and portable, allowing it to be transferred to different patients' rooms.

SUMMARY OF IMPACT

The foot blocker to met three key design requirements in that it: 1) prevents the patient from slipping while shifting from a seated to standing position, 2) is safe for the patient, and 3) operates on a swivel for easy rotation of the patient.

TECHNICAL DESCRIPTION

The overall design of the device is fairly simple. It is similar to a lazy susan television stand. The challenge of this project was to securely attach the bearing to both the upper rotating circle (circle A) and to the bottom base circle (circle B). However,

once A is attached directly to the bearing, B cannot be connected directly because the bearing does not come apart. The screws connecting B to the bearing would penetrate into A, halting rotation.

Arcs were routed into A so the screws from B could penetrate and still allow free rotation. The top piece of wood was pre-cut into an 18-inch diameter circle with a thickness of 1 inch. Pine was selected due to availability, but any finished wood product could be used. For the bottom piece, an 18-inch diameter circle was cut from 1/2-inch pine. Four arcs were routed into the underside of A to create the stopping mechanism. When the entire system was placed together (the bearing, A and B), the screws attaching B to the bearing penetrated into the routed arcs. However, the non-routed segments between arcs stop the screws. This allows for free rotation up to 90-degrees, preventing the patient from excessive rotation and loss of control.

Two holes were drilled at either extreme of the 90-degree rotation. A pin was placed through the holes to create a locking mechanism. A 12-inch circle was cut from a rubber mat and attached to B with epoxy glue. This created a non-slip surface to interface with the ground. A 12-inch x 1.5-inch x 1-inch block was added to the top of A, 1/2-inch below the pinhole. This serves as the toe-stopper, or the area where the patient's toes rest when lifted from a seated to standing position. Wood glue and four brackets on each side of the block were used to secure the block to A.

In order to use the final device, the OT places the patients' feet on top of the device, with their toes resting against the toe-stopper. The therapist may then easily lift the patient without fear of either the device or the patient slipping. Once the patient is standing on the device, removal of the pin enables 90-degree rotation. This allows easy access to wheelchairs or beds.

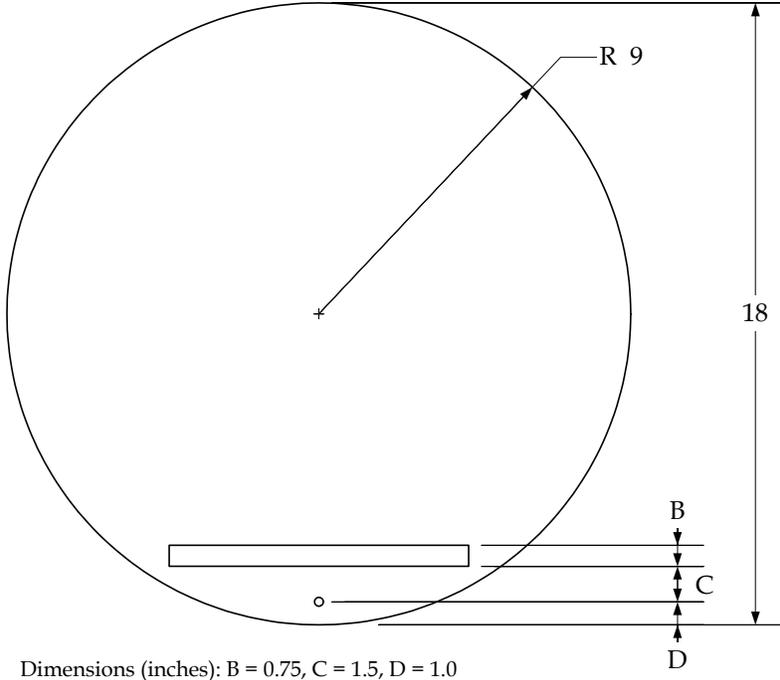


Figure 15.4. Top View Showing Position of Toe Stop.

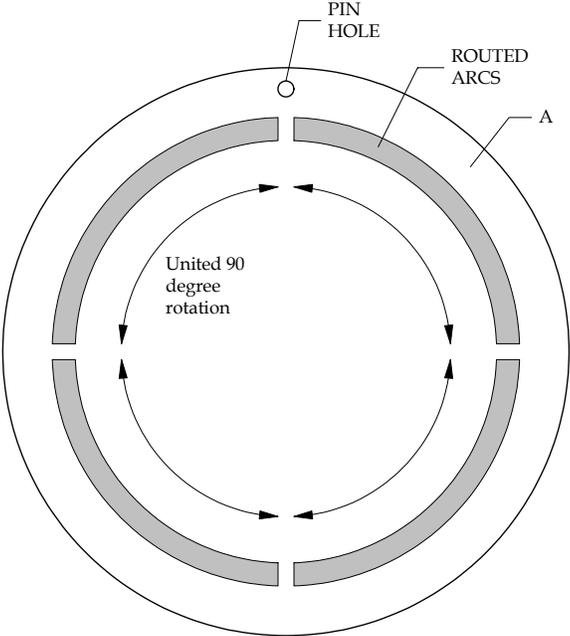


Figure 15.5. Underside of Top Showing Routed Areas and Pinhole.

