HBS Systems Shin Support
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Group 7

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Abstract

Potential models of an ergonomic shin support system were developed in this project with the purpose of refining the current product through expanded applications, cost, and improved aesthetics. Investigations of end users' needs and ergonomic tests were performed to determine how to best achieve those objectives. Through focusing on end users' unique needs, these objectives were achieved in the future design considerations for marketability of the product.

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1. Introduction

The purpose of this project is to improve the current design of an ergonomic shin support, which is an innovative workplace health maintenance device that supports people who working in manufacturing, warehousing, retail, office and other places where employees must stand. The existing prototypes are designed for any environment with regards to their design, materials, and construction.

Figure 1. Current models

2. Design overview

The proposed solutions will maintain the basic mechanical function of the current model produced by HBS Systems. To use the shin support, the user rests their shins on the pad by bending their knees slightly with their feet positioned under the pad as shown in Figure 4. This decreases the work of balancing and provides comfort and relaxation in the muscles. As a result, it can help people to reduce joint pain and fatigue from standing.

Figure 4. HBS1001

3. Mechanical Subsystem

Theory

Theoretical analysis starts with the description of the forces applied to the system. The free body diagrams in Figure 6 show these forces as applied to the mechanical system and the user. In order to calculate the forces, the forces were balanced:

$$\sum F_y = 0 \quad [1]$$

$$\sum F_x = 0 \quad [2]$$

For the forces on the pad then:

$$\sum F_y = 0 = W - N - F_{Person} cos73° \quad [3]$$

$$\sum F_x = 0 = f - F_{Person} sin73° \quad [4]$$

Where W is the weight of the user, N is the normal force applied to the base, F_{Person} is the force the user applies to the pad, and f is the friction force between the base and floor. All forces are in Newtons.

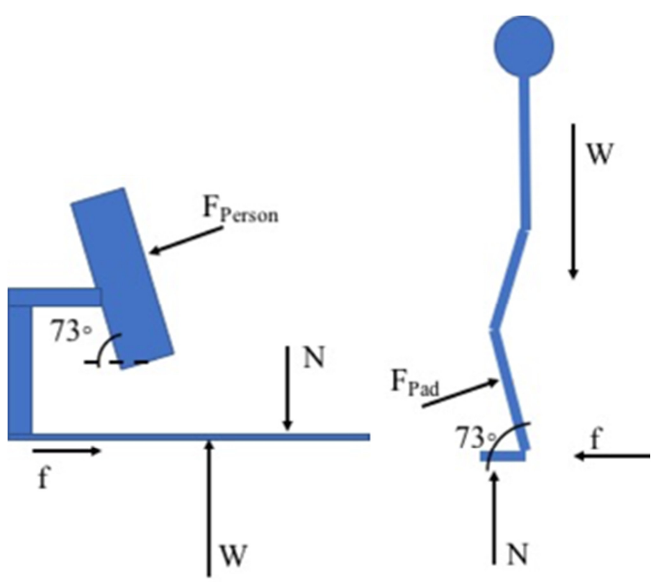

Figure 6. Free body diagrams of system and user

It is important to note that the F_{Person} in this case is the maximum force that can be applied just before any possible loss of balance occurs as f, the friction force is defined as:

$$f = \mu N \quad [5]$$

Where μ is the coefficient of static friction just before any possible loss of balance occurs. Therefore, the maximum y-component of F_{Person} is multiplied by cos73°, or approximately 0.292. This means that the maximum vertical force taken by the pad is approximately 29.2% of the user's weight.

Current Model

The current system includes the HBS 1001, shown in Figure 7. This is the stand-alone design that was the starting point for the designs developed in this project.

The current design of the shin support is suitable for a commercial environment.

Figure 7. HBS 1001 [17]

Physical Testing

To investigate how well the current model worked, two different types of testing were conducted. The first was using a scale to measure the difference in the weight of the user while leaning on the support versus standing straight. The reduction in weight due to leaning on the support was between 3 and 17%. It is important to note that the highest reduction in weight was not greater than the theoretical 29.2%. For analysis purposes, the chosen percentage of the user's weight applied to the pad was 20%, which is higher than the average weight applied during testing. The user's weight was chosen to be 300 lbs, which is above the 95^{th} percentile of male weight to account for misuse of the support system [19]. These numbers give a 267 N normal force applied normal to the pad, calculated as shown below. This is the force applied in the FEA simulations.

$$0.2 * 300\ lbf\ \frac{0.45\ kg * 9.81\frac{m}{s^2}}{1\ lbf} = 267\ N$$

The second type of testing was ergonomic posture and balance tests to investigate how the support changed the user's stance. The testing set up is shown in Figure 9. A typical test is shown in Figure 10. The balance test measured the movement of the center of pressure.

Figure 9. Ergonomic testing set up

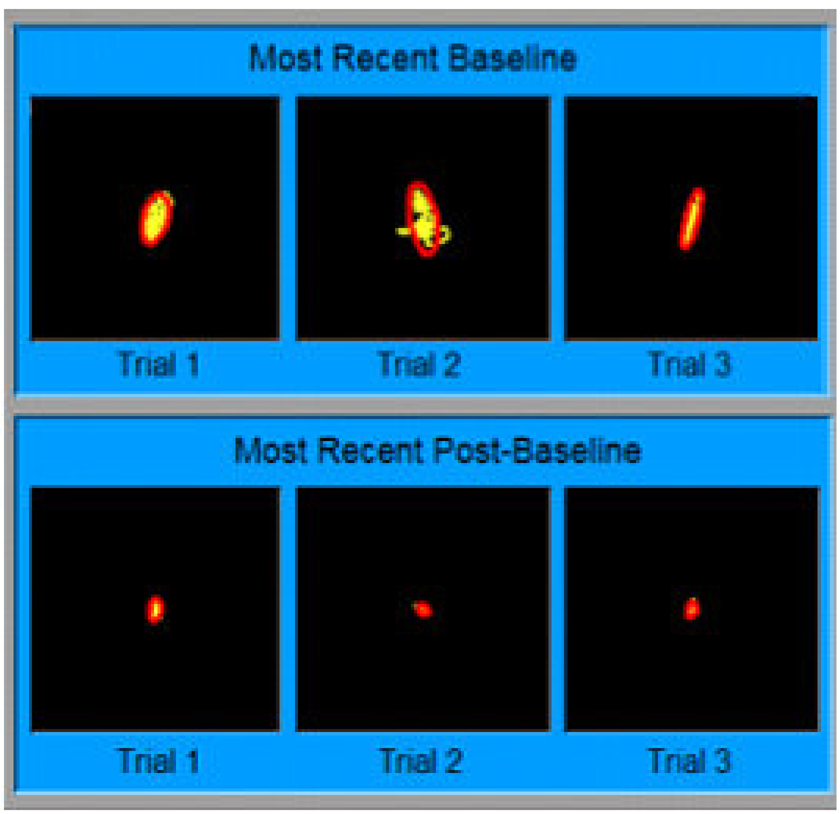

Figure 10. Ergonomic testing results Balance test