Dynamic Balance Device, BME 200/300

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Date: September 19, 2024

Project Function

Patients who have suffered from strokes often sustain long-lasting subsequent symptoms such as a deficit of awareness of one side of their bodies and lack of static and dynamic balance, leading to injuries and falls. Currently, the solutions for physicians to use in addressing this issue are either too expensive to easily acquire, or inadequate and difficult to use, failing to provide sufficient attention and support to the patient. The goal of this project is to design a convenient and reliable tool to assist post-stroke patients perform visual scanning training and functional reach tests for regaining dynamic balance. As opposed to the existing yard stick with a yellow dot attached to the end, our device must be professional and contain a target as well as display different colors and shapes. Ultimately, the product should be convenient, affordable, and multifunctional across different therapies for patients suffering from post-stroke conditions.

Client Requirements

About the client:

Dr. James Trevathan is a physical therapist based in Neenah, WI and affiliated with the Children's Hospital of Wisconsin-Fox Valley and Theda Clark Medical Center. He works with patients who suffer from post-stroke conditions and seeks to develop a professional tool to improve the current method of performing dynamic balance training.

Design Requirements

1. **Physical and Operational Characteristics**
    a. *Performance Requirements:* the device must help post-stroke patients improve their balance and visual scanning in the case of hemispatial neglect syndrome. It should contain a target for patients to reach and display different colors and shapes for visual scanning. It must also include a scalable difficulty system to register and analyze patient performance and improvement. Lastly, the power source should be located at the bottom to counterbalance the weight and make it easy to hold and manipulate.
    b. *Safety:* the device must be stable and lightweight to prevent strain, fall, or difficulty for patient use. All electronic components must be safely guarded to prevent hazards, any edges should be rounded, and the design should prioritize ergonomic handling to prevent injury.
    c. *Accuracy and Reliability:* The device should have a long-lasting calibration mechanism to ensure consistent target positioning and color and shape display. Also, the difficulty grading system should accurately measure and keep track of patient performance and improvement and display it in real-time.
    d. *Life in Service:* The device should withstand daily use (8 hours a day, 5 days a week) and function effectively for at least 1 year with minimal maintenance, excluding major components such as the rod, the light disk, and the electronics.
    e. Shelf Life: The device should be able to last up to 3 years in storage with no change in functionality or deterioration of components.
    f. *Operating Environment:* The device will be used for physical therapy in indoor environments. The device should be waterproof, as it will be wiped down to be cleaned often.
    g. *Ergonomics:* The device will be used by a physical therapist to aid in the neurological rehabilitation of patients who have experienced a stroke. The device must be easily held and controlled in one hand, allowing the user to be able to aid the patient if necessary. Additionally, the colored target portion of the device should be easily adjusted by a control panel near the handle.
    h. *Size:* The size of the stick portion should be a maximum of 3 feet in length. The display needs to be a target with at least a 3 inch diameter.
    i. *Weight:* The device needs to be under 5 pounds with the majority of the weight located in the handle of the device to prevent fatigue while holding it up.
    j. *Materials:* The materials for this device need to be able to withstand multiple cleaning wipes, daily usage, and be lightweight. The screen materials need to be lightweight as well and need to have the ability to portray the primary colors.

k. *Aesthetics, Appearance, and Finish:* The device should have a professional and high quality appearance. The device must be easily wiped down to be cleaned. The light up portion of the device must display various bright colors. Additionally, the design will include measurement markings so the user is easily able to determine how far the patient can reach.

2. Production Characteristics

a. *Quantity:* One prototype of our device is all that is needed. More of the prototype device can be developed further after client approval.
b. *Target Product Cost:* The target cost of the product is within $200.

3. **Miscellaneous**
    a. *Standards and Specifications:* The product should adhere to regulations set by the Federal Food and Drug Administration. Since the product does not have a chemical/drug component, it is expected that the product should pass unhindered. Additionally, it may need to adhere to IEC code 62353, a set of electronic regulations related to medical equipment. All electrical equipment should be safely insulated from incidental access and fire risk. Lastly, the battery pack should be installed in a manner to minimize clunkiness.
    b. *Customer:* The client is a doctor specializing in neurological rehabilitation and desires this product to be used in everyday therapy, making both ease-of-use and durability high priorities. Similarly, the device should be professional-looking and operate on the same level as current devices on the market. The client specifically requested that in an ideal-world the device should have features such as noise-makers or light up pods built-in to make the product more fun for patients. The client has also requested a balanced and easy to wield device, as current options are unwieldy.
    c. *Patient-related concerns:* The device should be designed to test the range of how far a patient can reach when used by the client. The device should also be easily sterilizable with a wipe. The product should be accessible to a doctor only able to use one hand to maximize patient safety, as well as be set at different intervals to easily measure patient progress.
    d. *Competition:* Current competition involves a homemade version of the product made out of piping and laminated cardboard, as well as significantly larger and more expensive equipment–including the Bioness Integrated Therapy System. The homemade version of the product is effective in purpose yet unprofessional and could use upgrades designed at making the product more fun for patient use. The Bioness device is a touchscreen that lights up with different targets for the patient paired with a board to pivot beneath patients, testing their dynamic balance. While it is effective, it is tedious for the client to activate, and prohibitively expensive for smaller clinics. Likewise, there are similar neurorehabilitation devices such as Hocoma's Balance Rehabilitation System, however they are also expensive and serve a slightly different function than the product is meant to.