Project Design Specifications—Leg Ergometer

Amy Weaver, Laura Bagley, Lacey Halfen, Deborah Yagow, Lein Ma

September 20, 2007

Function: The goal is to design a leg ergometer to be used by William Schrage in his lab. The test subject will use the ergometer to maintain a constant kicking motion while the femoral artery is imaged using an ultrasound. The information is used to determine blood flow to the leg during exercise.

Client Requirements:

- Must be sturdy, last more than a few years
- Adjustable for subject heights 5'4" to 6'4"
- Boot to attach foot to the device must be adjustable for different foot sizes
- Maintain a constant wattage throughout testing
- Wattage (0-100 W) and kick rate (30-60 kicks/sec) output to a laptop through an A/D converter
- Flexible range of motion for kicking
- Leg must be able to fully extend when kicking
- No resistive forces against the leg for return to normal position of the leg after kicking
- Should be set up for right leg testing

Design Requirements:

1. Physical and Operational Characteristics
   a. *Performance Requirements:* The ergometer should be able to be used at a rate of 30 to 60 kicks per minutes (kpm) and 5 to 100 W of constant power. The kpm and power output should be measured and sent to a laptop through an A/D converter (supplied by the client). The kicking leg should have a range of motion of 90 to 180º from the horizontal and allow for some lateral movement. The subject should sit in the chair 30º from vertical. The boot attaching the foot to the resistance mechanism should be adjustable to different foot sizes.
   b. *Safety:* The ergometer should be able to hold an average sized build with height range 5'4" to 6'4" without putting extreme stress on the components. There must be no possibility of the resistance failing to act against the kick. Also, any elements under tension should be enclosed such that if they come lose, they do not cause harm to any persons near the device. The whole device should be as enclosed as possible so that nothing can get caught in the moving elements. The kicking path must remain clear of any components of the device.
   c. *Accuracy and Reliability:* The device must be able to be set to a single wattage and run at that setting for at least 5 minutes without deviating more than + /-- 2W. Any data collected from the machine should be consistently accurate.
   d. *Life in Service:* Product should have a lifespan of at least five years.
   e. *Operating Environment:* The ergometer needs to be durable enough to withstand the test subjects' weight. It also needs to withstand numerous tests with variable force levels and minor transportation.

f. *Ergonomics:* The device must accommodate test subjects from 5’4” to 6’4” with variable weights. The subject should also sit 3’ above the ground at an angle of 30º from vertical. The kicking portion of the ergometer needs slight lateral flexibility to accommodate different test subjects. Overall, the device should be comfortable for the test subjects as well as the researchers to use.

h. *Size:* The ergometer needs to be no larger than 5’ long by 3’ wide by 4’ tall.

i. *Materials:* Materials used should be able to withstand heat and friction without changing performance. Also, materials that can withstand the weight of the device must be used.

j. *Aesthetics, Appearance, and Finish:* The design should be streamlined and compact, with as few extra parts as possible.

2. Production Characteristics

a. *Quantity:* The client only requires one unit at this time, although there is the possibility of additional units used in the future.

b. *Target Production Cost:* The total budget for this project is $2,000.

3. Miscellaneous

a. *Standards and Specifications:* Not applicable.

b. *Subject-related concerns:* The ergometer should provide relative comfort to the user while maintaining stabilization of the thigh while kicking.

c. *Competition:* Ergometers are available in many different styles including ellipticals and stationary bicycles. There are examples of ergometers similar to this proposed design in use in several research facilities. One example of this type of ergometer was used in a research study published in the following article: P. Andersen and B. Saltin, Maximal perfusion of skeletal muscle in man. J Physiol