

# ***Product Design Specifications – MRI Step Dynamometer***

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Client: Prof. Naomi Chesler

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## **Problem Statement**

In order to better understand the effect of exercise on patients with pulmonary hypertension, Professor Chesler would like to use MR-imaging to accurately measure the vascular changes in blood pressure and flow during exercise. Our task is to develop an MRI-compatible exercise device for patients undergoing cardiac MRI scans. It should allow the patient to exercise while within the MRI bore and have adjustable workloads so patients of varying fitness levels can generate sufficient cardiac output.

## **Client Requirements**

- MRI-compatible
- Comfortable supine exercise motion
- Sufficient resistance to increase cardiac output
- Adjustable workload

## **Design Requirements**

1. Physical and Operational Characteristics
  - a. *Performance requirements:* The device should provide a natural exercise motion that can be performed while the patient is within the MRI bore. The workload provided must increase the patient's heart rate to >85% of their maximal predicted heart rate, which is equal to 220 beats/min minus the patient's age. It needs to be adjustable for various patient fitness levels and sizes (150-200 cm).
  - b. *Safety:* All materials must be MRI-compatible (non-magnetic) for the safety of the patient, scanner, and medical staff. The exercise motion cannot put the patient at risk for injury during use.
  - c. *Accuracy and reliability:* The design should provide consistent workload settings from patient-to-patient. All patients should be able to reach the target pulmonary blood pressure.
  - d. *Life in service:* The device must be able to withstand clinical use for five years.
  - e. *Shelf life:* N/A
  - f. *Operating environment:* The design will be used in clinical or research settings in the presence of an MRI scanner and ECG leads.

- g. *Ergonomics*: The motion should be natural, fluid, and controlled without any undesirable friction.
- h. *Size*: The device must allow for exercise within the bore of any MRI scanner. The standard measurements of the bore are 42 cm from the couch to the top and 60 cm in width.
- i. *Weight*: The weight on the couch cannot be greater than 150 kg, so the device will not exceed 25 kg. Individual components should not weigh more than 15 kg to ensure portability.
- j. *Materials*: All components must be durable and made of non-ferrous materials.
- k. *Aesthetics, appearance, and finish*: The device should be quiet and not intimidating to the user.

## 2. Product Characteristics

- a. *Quantity*: One working prototype
- b. *Target product cost*: \$150.00

## 3. Miscellaneous

- a. *Standards and specifications*: Must pass inspection for use in MRI and be IRB approved for human trials
- b. *Customer*: Hospitals, clinics, and research labs
- c. *Patient-related concerns*: Comfortable, safe, and durable
- d. *Competition*: BV Lode Ergometer, prototypes from other universities, and past and present UW BME design projects