

An MRI-compatible leg exercise device for assessing cerebral blood flow responses to exercise

Group Members

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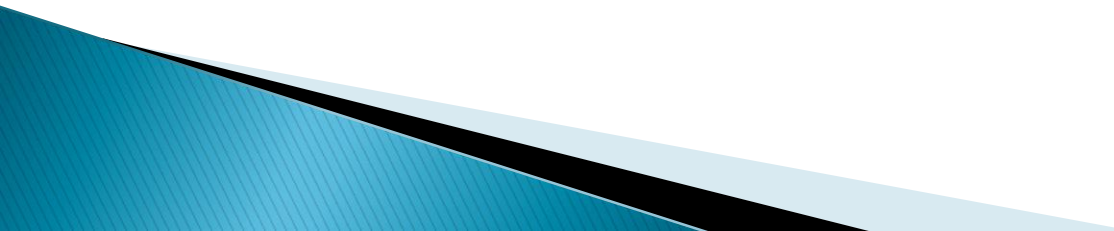
Advisor

Dr. Michael Toepke

Client

Dr. William Schrage

Overview

- ▶ Client Description
 - ▶ Problem Definition
 - ▶ Previous Designs
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 - ▶ Product Design Specifications
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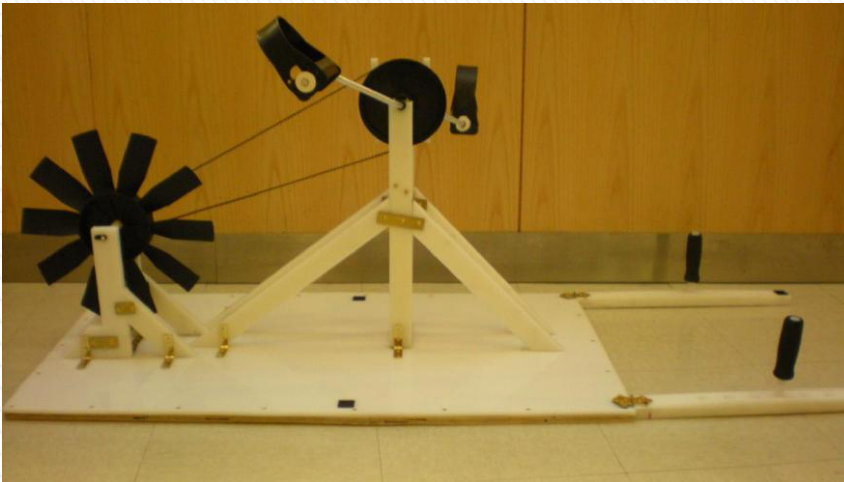
Client Description

- ▶ Dr. William Schrage
 - Assistant Professor of Kinesiology
 - Cardiovascular Research Center (CVRC)
 - Vascular Biology
 - Research
 - Effects of exercise on cardiovascular conditions
- ▶ Proposal
 - Create a MRI-compatible exercise device

Problem Definition

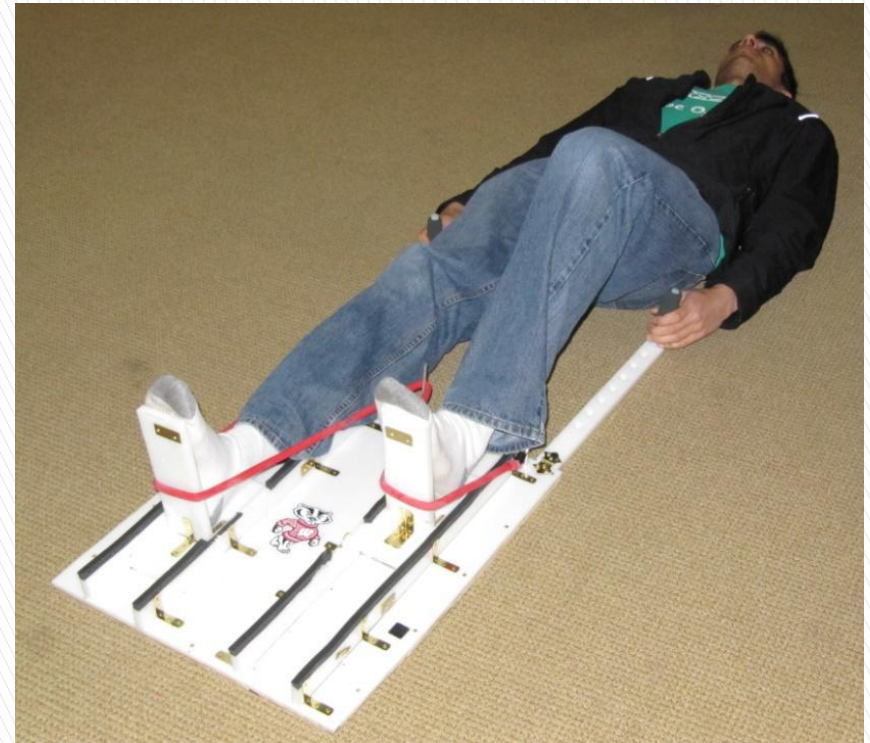
- ▶ No current method for performing exercise within an MRI
 - Exercise prior to insertion into the MRI machine
 - Movement will cause low-quality MRI images
- ▶ Goal:
 - Measure blood flow and blood vessel diameter during exercise
 - Minimize movement
 - Increase heart rate to 120–130bpm

Previous Designs



Source: <http://bmedesign.engr.wisc.edu/websites/project.php?id=29>

Cycling Design



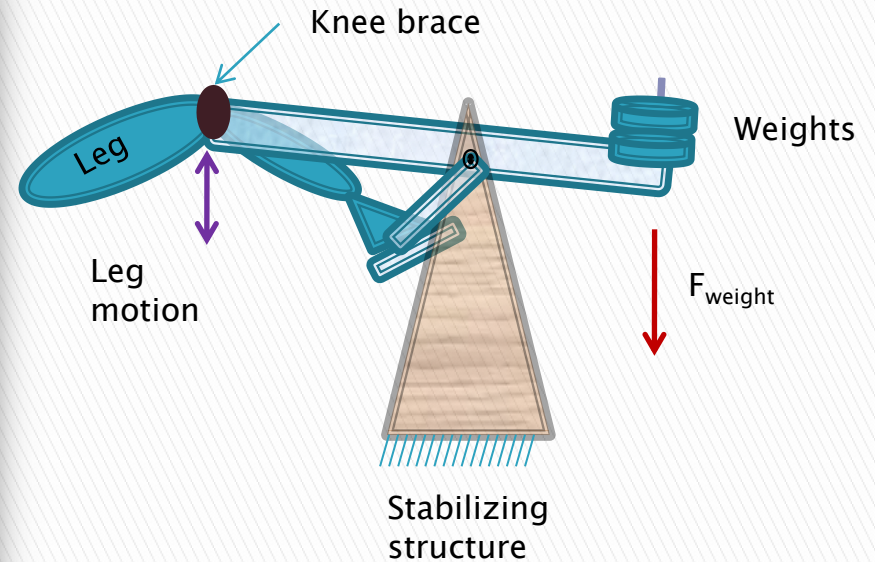
Source: <http://bmedesign.engr.wisc.edu/websites/project.php?id=295>

Stepper Design

Previous Design: Fall 2010



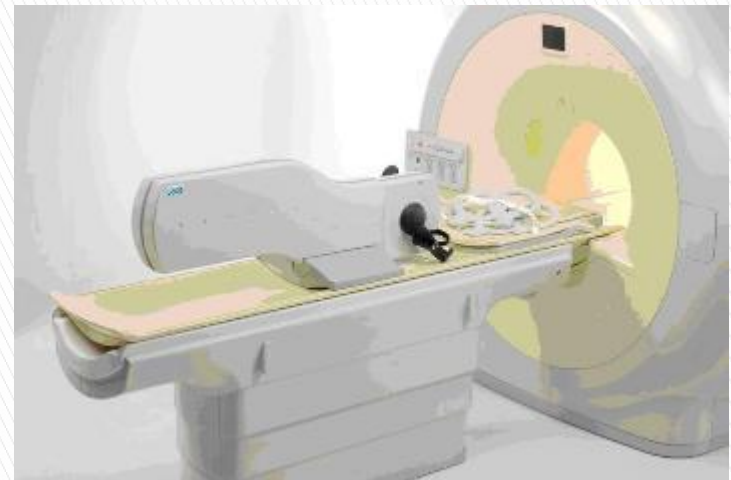
Lever Design



Linkage

Commercial Device

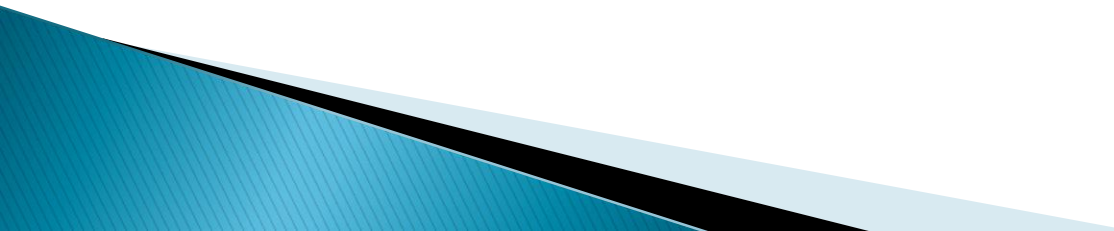
- ▶ Cycling design
- ▶ Incompatible with many MRIs
 - GE
- ▶ High cost



<http://bestech.com.sg/HTML/lode.htm>

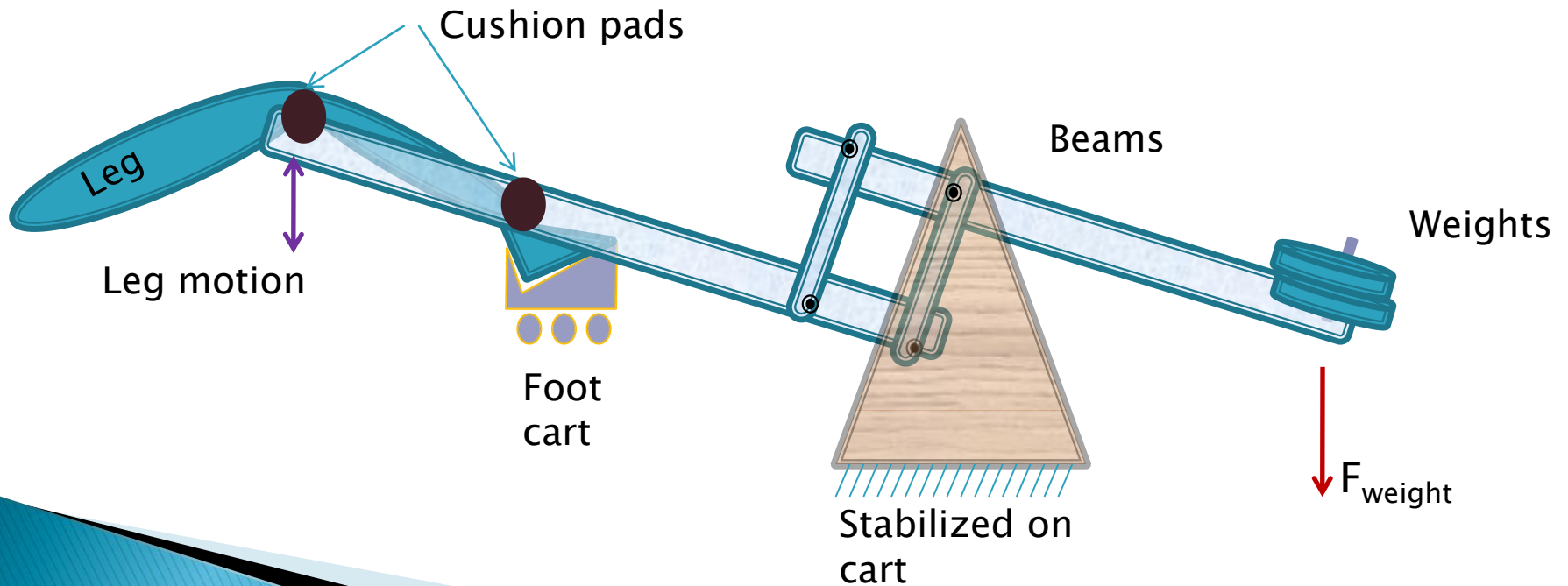
Lode B.V. MRI Ergometer

Product Design Specifications

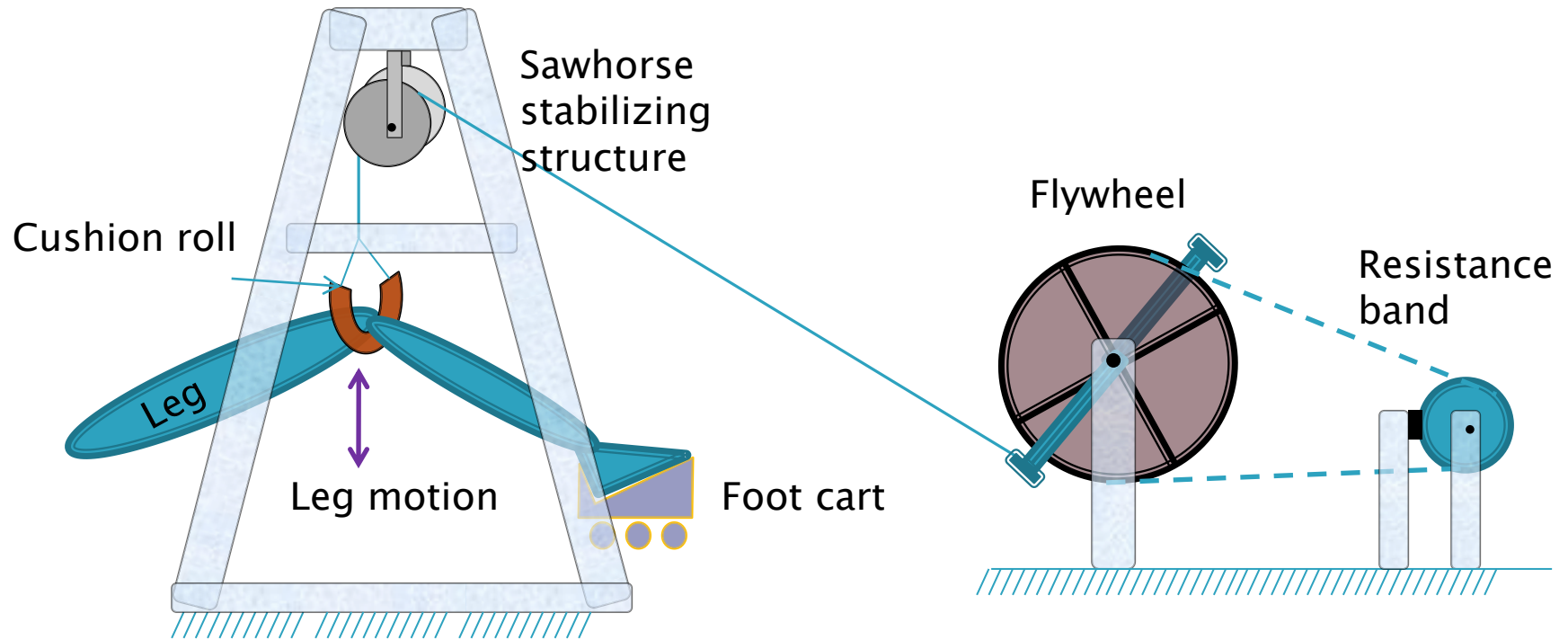
- ▶ MRI compatible
 - ▶ Increase heart rate to 120–130bpm for 10–15 minutes
 - ▶ Limit head movement
 - ▶ Produce “natural feeling motion”
 - ▶ Height range of 5’4” to 6’4”
 - ▶ Life in service: 3 years
 - ▶ Easily sterilized
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Design Alternatives: Beam Design

- ▶ Four member linkage
- ▶ Foot cart
- ▶ Cart for stability
- ▶ Adjustable weight resistance



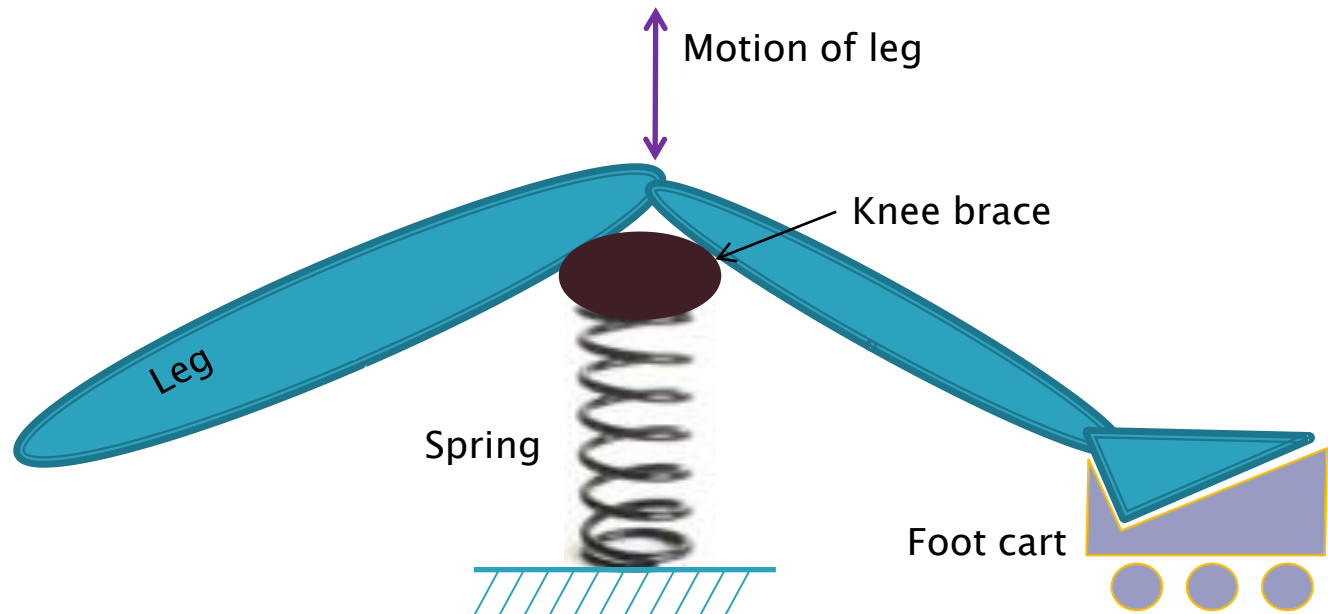
Design Alternatives: Pulley Design



- ▶ Dual pulley system
- ▶ Foot cart
- ▶ Cart for stability
- ▶ Adjustable resistance band

Design Alternatives: Spring Design

- ▶ Dual spring system
- ▶ Foot cart
- ▶ Attached to knee brace



Design Matrix

Criteria	Beam Design	Pulley Design	Spring Design
Effectiveness (25)	22	23	18
Safety (20)	15	18	13
Patient comfort (20)	15	17	10
Portability (15)	12	10	14
Cost (10)	8	8	10
Durability (10)	6	6	8
Total (100)	76	82	73

Future Work

- ▶ Improve prototype
- ▶ Order non-ferromagnetic materials
- ▶ Test effectiveness
 - Increase heart rate
 - Range of users
 - Clear MRI images

Acknowledgements

- ▶ Dr. Michael Toepke
 - ▶ Dr. Bill Schrage
 - ▶ Dr. Kreg Gruben
 - ▶ John Harrell
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