

# Ergometers and Accessibility

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# RERC-AMI

## ■ Rehabilitation Engineering Research Center – Accessible Medical Instrumentation

- Marquette University
- Western University of Health Sciences
- University of California Ergonomics Lab
- Human Spectrum Design
- University of Wisconsin at Milwaukee
- University of Connecticut



## ■ Goals

- Research, develop and evaluate methods and technologies to increase the usability and accessibility of diagnostic, therapeutic, and procedural healthcare equipment for people with disabilities (patients and providers)

## ■ Accessibility

- All persons should have access to healthcare products, facilities and services and to employment in the healthcare professions regardless of disability

# RERC-AMI Projects



## Development Program D2

- Develops new medical instrumentation in response to problem areas identified and documented in R2
- Provides a test ground for the instrument developed in Program R3

# D2: National Senior Design Competition Background

## ■ National Student Design Competition

- Develop modifications to existing medical instrumentation (including devices, fixtures, and information technologies) and/or new instrumentation in targeted areas
- 2004-2005 competition
  - 16 universities and
  - 3 devices
    - weight scales, syringe dosing and **ergometers**
- Ergometers
  - *Aim:* A creative cycle ergometer that is usable by individuals with a diversity of abilities
  - *Specs:* It must be easy to get into, feel stable, be easy to adjust even with low strength or flexibility, have an easy-to-view display, and be targeted for under \$1000 retail. (Can start with existing unit, if less than \$500 retail.)
  - *Clients:* Joan, Lloyd, Sophia, Arnold, Wanda, Bob

# National Senior Design Competition

## Ergometer Results

### ■ University of Rochester – VersaErg

- Color contrasting edges
- Interface frame on a track
- Locking mechanism for the track
- Zero step over
- Sliding magnifying glass
- Braille
- Circuitry for audio output
- Swivel seat
- Enlarged seat
- Adjustable straps



### ■ University of Wisconsin- Madison – Team Ergo

- Two-way resistance arm exercise bars
- Cane holders
- LED pedals
- Zero step over
- Touch screen LCD monitor
- Rotating seat and seat assist



# Tech Reports

Tech Reports include an executive summary, a background, a product table, survey, evaluation, and recommendations

## ■ Student Design Competition Ergometer Report

- 6 senior design ergometer projects
- <http://www.erc-ami.org/ami/tech/tr-ami-003-sr-des-ergometers.aspx#appendix>

## ■ Cardiopulmonary Report

- Stair climbers
- Ergometers
- Ellipticals
- Treadmills
- [http://www.erc-ami.org/ami/tech/tr-ami-mu-003\\_cardio-exercise.aspx](http://www.erc-ami.org/ami/tech/tr-ami-mu-003_cardio-exercise.aspx)

# Tech Reports

Team name		Recumbent (R) Upright (U)		Ease of Adjustment	
University		Bike Length		Resistance Set	
Cost		Seat Height		Levels of Resistance	
Weight Limitations		Seat Width		Levels of Resistance	
Portable		Moving/ Stationary Handlebars		Blood Pressure	
Step up (s) Walk on (w)		Swivel Seat		Heart Rate	
Preprogrammed Courses		Adjustable Seat Height		Temperature	
Resistance Mechanism		Adjustable Seat Length		Respiration	
Manual (M)/ Powered (P)		Adjustable Incline		Speech	

# D2: Ergometer Project

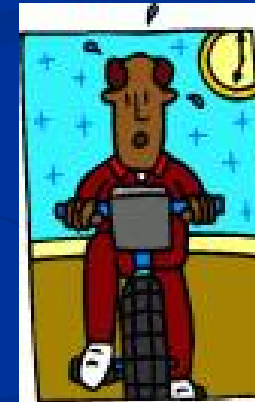
## ■ Focus group:

- Identify prevalence and specific barriers to using ergometers by persons with a range of abilities and disabilities
- Concerted efforts are needed to design and produce affordable, accessible exercise and rehab equipment for all without regard to level of ability/disability
- N=5 (2 females: 3 males)
- Subjects: 2 vision impaired, 3 mobility impaired

# D2: Ergometer Project

## ■ Focus group

- Speaker: I would rather have the recumbent bike. To me, I like that much better. And you feel more secure.
- Speaker: Adjustable that your feet won't slide off or if you wiggle, it jumps out. And steadiness, like Velcro around.
- 5 main desirable device features
  - An easily adjustable wide seat
  - Moveable handlebars
  - Monitors with audio technology
  - Easily adjustable pedal straps
  - Sturdiness



# D2: Designing an Accessible Ergometer for People with Disabilities

## ■ Background

- According to the healthy people 2010 report and public health objectives, people with disabilities are 20% less likely to engage in any leisure-time activity than those without disabilities (56% vs. 36%)
- To address consumer needs, understanding accessibility issues for exercise and rehab devices for people with a range of abilities and disabilities is necessary

## ■ Focus

- Ease of transferring, safety and overall accessibility
- Evaluating the accessibility of specific device features on the ergometer



# Device Features

- **Braille:** to act as a vision aid
- **Seatbelt:** for added stability
- **Optional moveable handlebars:** for upper body workout
- **Velcro pedal straps:** to aid in positioning
- **Audio blood pressure/HR monitor**
- **Rotating Seat:** to aid in transferring
- **Low stepover:** to aid in transferring



# Device Features

- **Text-to-Speech pen:** to read the display panel
- **Reflective tape:** to highlight features
- **Kickstand adjustable track:** to allow the subject to easily reach the handlebars, pedals and interface
- **Lighted magnifying glass:** to act as a vision aid
- **Magnifying sheet:** to act as a vision aid



# D2: Designing an Accessible Ergometer for People with Disabilities

## ■ Methodology

- Pre-activity interview
- Explanation and demonstration of each device feature
- 2 Activity sessions
  - 1 session allowing the subjects to test and analyze each device feature and compare each to a specific counterpart (Velcro vs. plastic)
  - 1 session allowing the subjects to only use the device features they believe are beneficial to them and comparing these features to a generic setup



# D2: Designing an Accessible Ergometer for People with Disabilities

## ■ Methodology

- Post-activity interview at the end of each activity session
  - Questionnaire examples
    - How well were you able to use the ergometer with the plastic pedal straps?
      - Not at All/Somewhat/Moderately/Very/Extremely
    - How well were you able to use the ergometer with the velcro pedal straps?
      - Not at All/Somewhat/Moderately/Very/Extremely
    - How safe did you feel when using the ergometer?
      - Not at All/Somewhat/Moderately/Very/Extremely
    - Were you able to reach everything you needed?
      - Not at All/Somewhat/Moderately/Very/Extremely

# Tools

- **MU-Lab:** to collect video and audio data to analyze the accessibility of the ergometer
- **Multimedia Video Task Analysis** <sup>®</sup> (MVTA, NexGen Ergonomics): to analyze accessibility barriers as well
- **Protocol Manager (PM):** to store each subject's comments and the pre-activity and post-activity data
- **Modified Ergometer:** to analyze which device features are beneficial to each subject



# Subjects

- # of subjects: 12
- Gender: 7 female and 5 male
- Age: 55+
- Range of disabilities including upper extremity paralysis, congestive heart failure, visual disabilities, arthritis and chronic pain
- Each subject has ridden an ergometer at least twice a week in the past month

# Video Example

No Picture

data060523\_114237\_875

# Results

- Which features are most beneficial overall?
  - 12/12 kickstand track
  - 12/12 moveable handlebars
  - 11/12 velcro straps
  - 10/12 audio blood pressure/heart rate monitor
- Which features are most beneficial to each specific disability?
- What were the most common barriers people faced?

# Conclusions and Future Directions

- A fundamental change in policy and practice guidelines will encourage healthcare agencies to purchase and utilize the most accessible devices available for all individuals, regardless of level of ability/disability
- Accessible device features will be recommended for future ergometer designs
- More research must be conducted through human subject testing to develop a universally accessible ergometer

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