

# Design Challenges in Assistive Technology

Doug Schwandt

ENGR110-210, January 21, 2010

Perspectives in Assistive Technology

# Outline...

- Design Process
- Project Examples:
  - Handbike/Sunburst – arm-powered bikes
  - Inter-Limb Resistance – space exercise
  - Kine-Assist – robot assist for physical therapy
  - DARPA Revolutionizing Prosthetics - bionic arm
  - Alter-G, M300 G-Trainer – defy gravity
- Perspective

# Design Process

- Need (create one if necessary; be passionate)
- State-of-the-Art (it may already exist)
- Conceptual Design (this is the fun phase)
- Select Preferred Concept (tools/intuition)
- Detail Design/Analysis (don't give up!)
- Working Prototypes (make it work, sleep deprivation)
- Testing (does it really work?)
- Final Device (deliver something good)
- Documentation (you'll build on it; share the credit)
- Technology Transfer (get it out there!)

Principal Designer:  
Doug Schwandt, MS

Bicycle Frame Builders/Designers:  
Keith Bontrager  
Gary Hale  
Peter Johnson  
Tim Paterek  
Chris Schwandt

Other Significant Design Contributions:

Gordon Abraham, MS  
Jim Anderson, JEM

**Peter Axelson\***, MS  
Phil Barkan, PhD  
Irv Housinger

Larry Leifer, PhD  
Candy Mintz, PhD  
Fred Tatch

**\*Project Envision/Creation**

# Handbike Arm-Powered Bicycle



## Features

- **Arm-Powered Bike for People with Lower Limb Disability**
- **Adjustable Side-Wheels up for Two-Wheeling and Fastened Down for Transfer**
- **Multiple Gears**
- **Folding Crank Tower for Easy Access**
- **Steer to Balance**

## Applications

- **Recreation, Transportation, Competition, Exercise**

## Commercialization

- **Recreational Mobility Inc. (1983-1984)**
- **New Dimensions Design, Inc. (1992-1996)**
- **Mobility Engineering, Inc. (1996 - present)** [www.mobilityeng.com](http://www.mobilityeng.com)





# Sunburst & Handbike Tandem

Principal Designer:  
Doug Schwandt, MS

Bicycle Frame Builders/Designers:  
Gary Hale  
Keith Bontrager

Significant Design Contributions:  
Jim Anderson, JEM

British Columbia Collaborators:  
Marshal Smith, Provincial Prog  
Admin, Disabled Athlete  
Kate Hunter-Zaworski, PhD  
Shayna Hornstein, PT

Gary Hale, builder & co-designer, with young cycling enthusiasts.



## Features

- Arm/Foot-Powered Bike for Able-Bodied and Disabled to Share
- Separate Gearing for Recumbent Front Rider
- Upright Rider in Back Steers
- Not Only for Disabled Riders
- Easy to Communicate and See Ahead

## Applications

- Recreation, Transportation, Competition, Exercise

## Collaboration

- British Columbia Provincial Program for 1981 International Year of the Disabled Program thru Univ BC

## Unrelated Commercialization

- CounterPoint Conveyance, Inc.
  - Jim Weaver
- Viewpoint Tandem
  - Bilenky's Cycle Works Ltd. ViewPoint
  - <http://www.bilenky.com/index.htm>



Photo: Bruno Schlumberger, *The Citizen*, Ottawa, Ontario, Rehabilitation Engineering Society of North America conference, June 19, 1984.

# Inter-Limb Resistance Exercise Device

## NASA-VA Collaboration:

- Space Exercise (NASA)
- Rehab Exercise Potential (VA)

Investigators:  
Scott Parazynski, MD (Astronaut)  
Alan Hargens, PhD

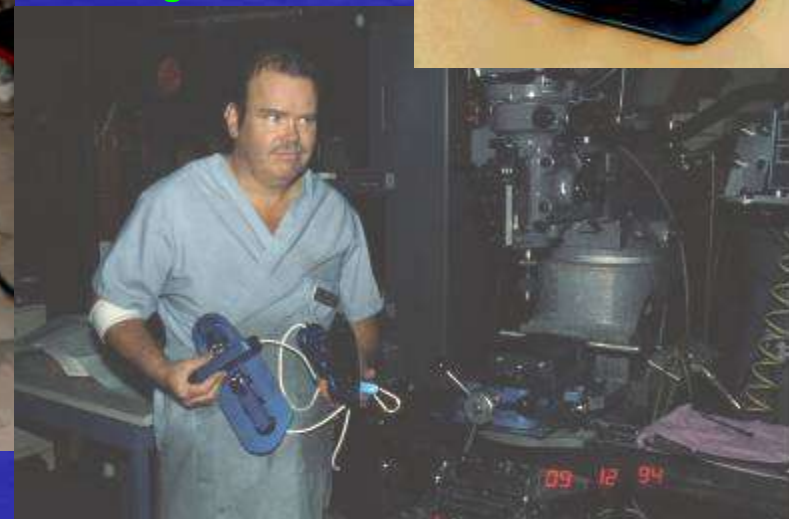
Design/Fabrication:  
Doug Schwandt, MS  
Jim Anderson, JEM  
Donna Hooker (JSC Contractor)  
Maurice LeBlanc, MS CPO  
Lin Liang, PhD  
Russ Hays



On-Board STS-66 space shuttle launch



Jim machines ILR flight hardware



Tests On-Board NASA's KC-135 Parabolic Flight Microgravity Simulator

Principals:

David Brown, PhD

Edward Colgate, PhD

Michael Peshkin, PhD

Clinical/Marketing:

Ela Lewis, MSPT, NCS

James Patton, PhD

Rehab Institute of Chicago

Engineering/Design:

Julio Santos-Munne'

Director of Engineering

Alex Makhlin, MS

Tom Moyer, MS

Douglas Schwandt, MS

Concept Development & Human

Interface Design:

IDEO (Evanston)

# KineAssist™ -- Assistive Device for Physical Therapy



## Features

- Assist clinicians in gait & balance training, in a functional context.
- Challenge clients to their maximum limits without increasing the risk of falls.
- Maintain consistency with current practice and infrastructure.
- Allow more therapy, by minimizing set up time.
- Will be used during transition, standing balance, ambulation and dynamic balance therapy.



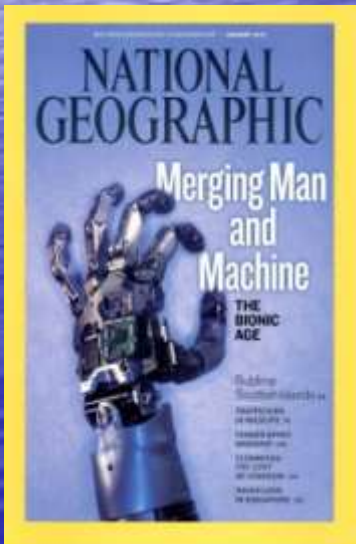


# DARPA- Revolutionizing Prosthetics Bionic Arm



## Features

- Mimic sensory-motor capabilities of natural hand
- Fingertip sensors return the sense of touch to amputees.
- Haptic tactor interface; neural integration or EMG
- Over 80 sensors, 10-13 controlled axes of motion in hand alone.



KineaDesign part of RP 2009 team, led by Johns Hopkins Applied Physics Laboratory (JHU/APL) under the direction of HDT Engineering Technologies (formerly new World Associates).

<http://kineadesign.com/portfolio/prosthetics/>

<http://ngm.nationalgeographic.com/2010/01/bionics/fischman-text>

# Differential Pressure Walking Assist

## Investigators/Therapists:

Charles Burgar, MD

**Robert Whalen, PhD, inventor**

Yang Cao, MD (China)

Ellie Buckley, MS PT

## Design/Fabrication:

Doug Schwandt, MS

Jim Anderson, JEM

Greg Breit, PhD

Christine Diraghi, MS

Josh Beach, MS

Monroe Postman, BEE ProEng



## *Features*

**Adjustable (Low) Pressure  
for Comfortable Lift**

**Variable Speed Treadmill**

**Therapist Arm Ports**

**Design Prevents Falling**

**Advantages over Water Therapy  
or Overhead Harness**

## *Applications*

**Walking Retraining**

- Stroke
- Incomplete Spinal Cord Injury
- Hip/Knee Surgery Rehab

**Exercise Therapy**

- Obesity
- Neuropathy
- Balance Disorders

## *Commercial*

**Alter-G Inc (<http://www.alter-g.com/alterg/ad.aspx>)**



# G-Trainer, Alter-G Inc.



## *M300 Features*

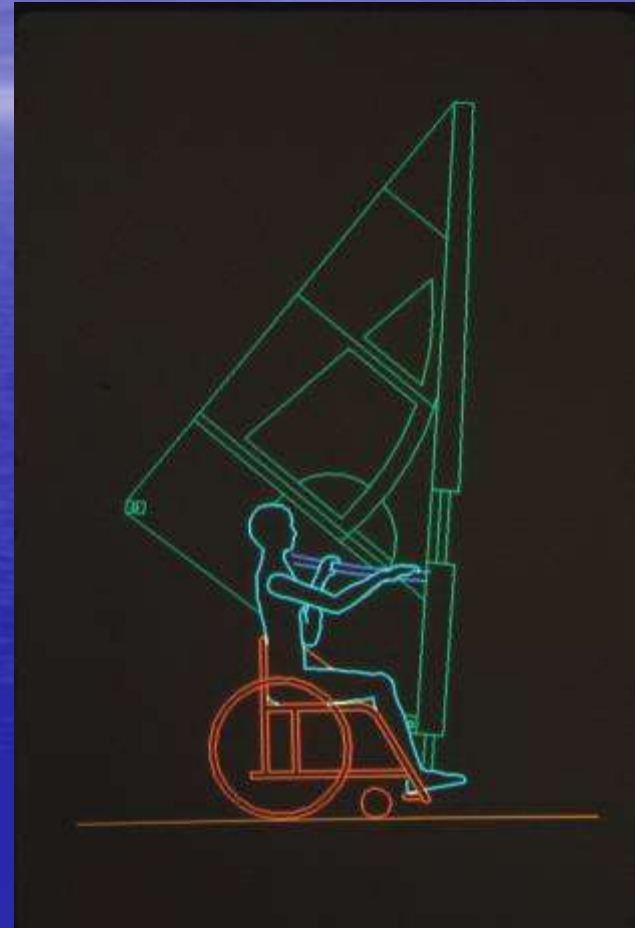
- Control unweighting from 100% to as low as 20% in 1% increments
- Allows full range of motion for upper and lower body
- Natural gait mechanics promote improved balance and strengthening
- Keeps user in place, supports laterally and prevents falls
- Highly comfortable at any level of partial weight-bearing for prolonged exercise
- Accommodates a wide range of body types (90 – 400 lbs)
- Easy-to-use controls for decrease/increase in body weight, speed and incline.

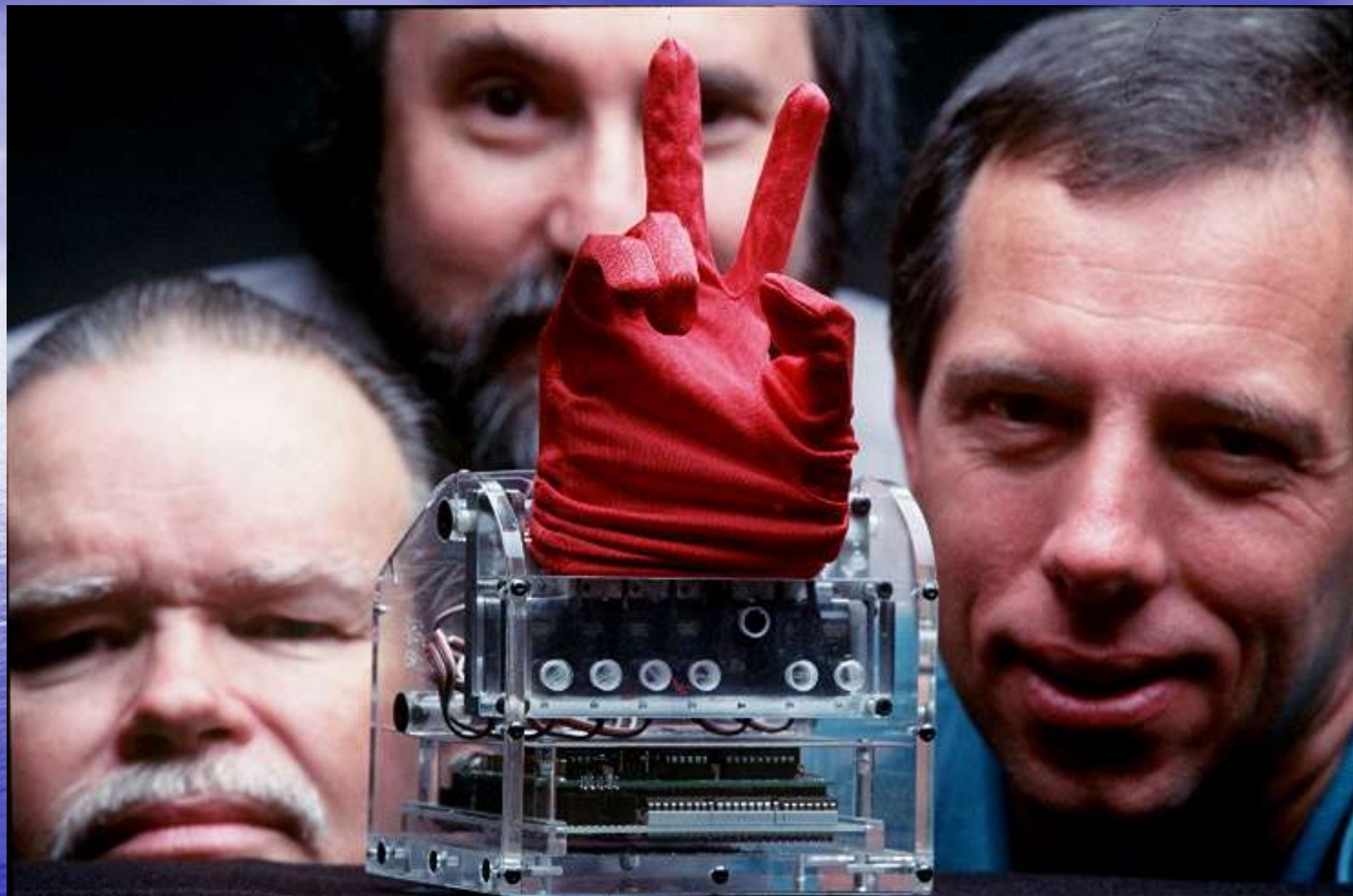
[www.alter-g.com](http://www.alter-g.com)

# Perspective

- Involve the client throughout the design process!
- Use the tools (SolidWorks, Skype, Internet, etc.).
- Review your notes and continue to learn.
- Work in a team – stay flexible - consult the experts.
- “Don’t bite off too much.”
- “Mt. Everest is climbed one step at a time.”
- “Never enough time to do it right – always enough time to do it over again.”
- “No quick and dirty – the *quick* is soon forgotten, and the *dirty* lives on and on.”
- Quotes mostly from Jim Anderson, Journeyman Experimental Machinist, champion rehab machinist.

# Windsurfing Wheelchair





Jim Anderson, Dave Jaffe, and Doug Schwandt with Ralph.

Photo/article: Bob Frost, "Helping Hand," West magazine, San Jose Mercury News, May 2, 1999.