Design Challenges in Assistive Technology

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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
- Perspective

Design Process

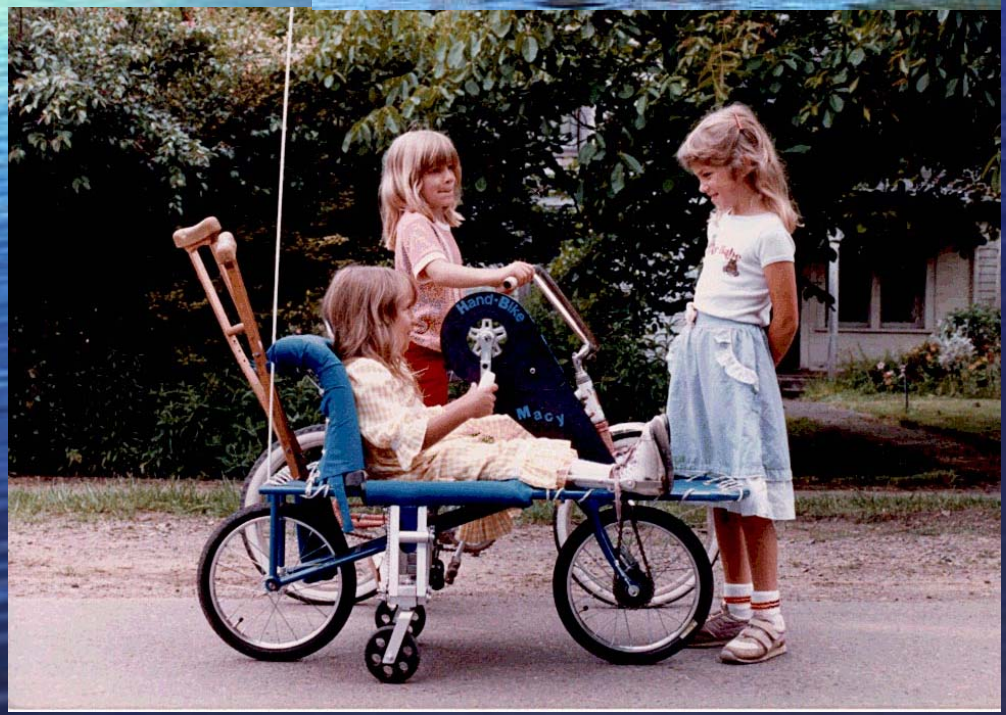
- Need (create one if necessary; be passionate)
- State-of-the-Art (it may already exist)
- Conceptual Design (this is the fun phase)
- Select Preferred Concept (tools/intuition)
- Detail Design/Analysis (don’t give up!)
- Working Prototypes (make it work, sleep deprivation)
- Testing (does it really 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

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`

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

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

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

Inter-Limb Resistance Exercise Device

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

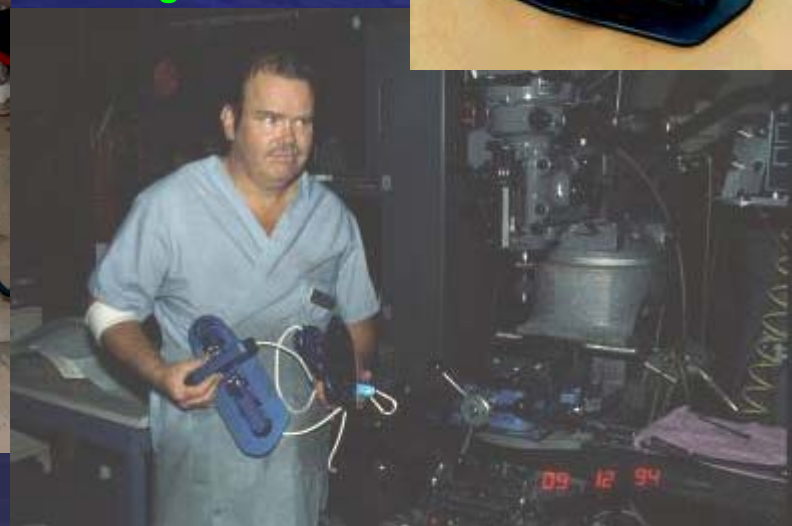
NASA-VA Collaboration:

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

On-Board STS-66 space shuttle launch

Jim machines ILR flight hardware

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



Space Physiology Laboratory, NASA Ames Research Center
http://spacephysiology.arc.nasa.gov/

KineAssist™ -- Assistive Device for Physical Therapy

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)

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.**

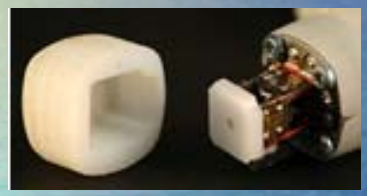
http://kineadesign.com/portfolio/kineassist/

Haptic Tactor -- Prosthetic Haptic Interface System

Principals:
David Brown, PhD
Edward Colgate, PhD
Michael Peshkin, PhD

Engineering/Design:
Julio Santos-Munne'
Director of Engineering
Alex Makhlin, MS
Douglas Schwandt, MS

Sensing Systems



Features

- **Revolutionizing Prosthetic's Program, DARPA.**
- **Return the sense of touch to amputees.**
- **Fingertip sensor.**
- **Haptic tactor.**
- **Embedded controller system.**

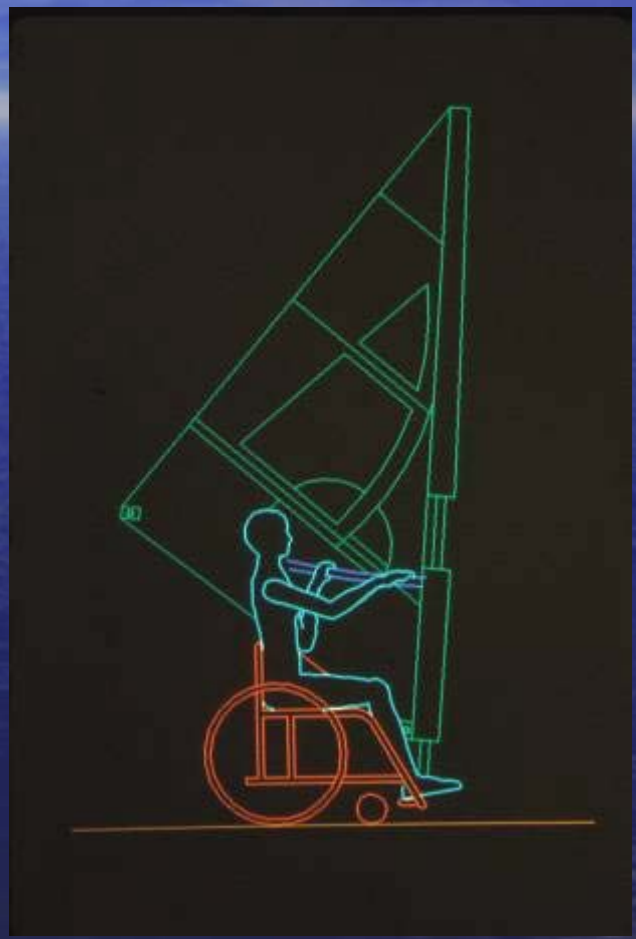
KineaDesign participating with the Rehabilitation Institute of Chicago Neural Engineering Center for Artificial Limbs laboratory, and Liberating Technologies, Inc., on the ground-breaking Revolutionizing Prosthetics Program 2007 under the direction of Deka Research & Development Integrated Solutions Division.

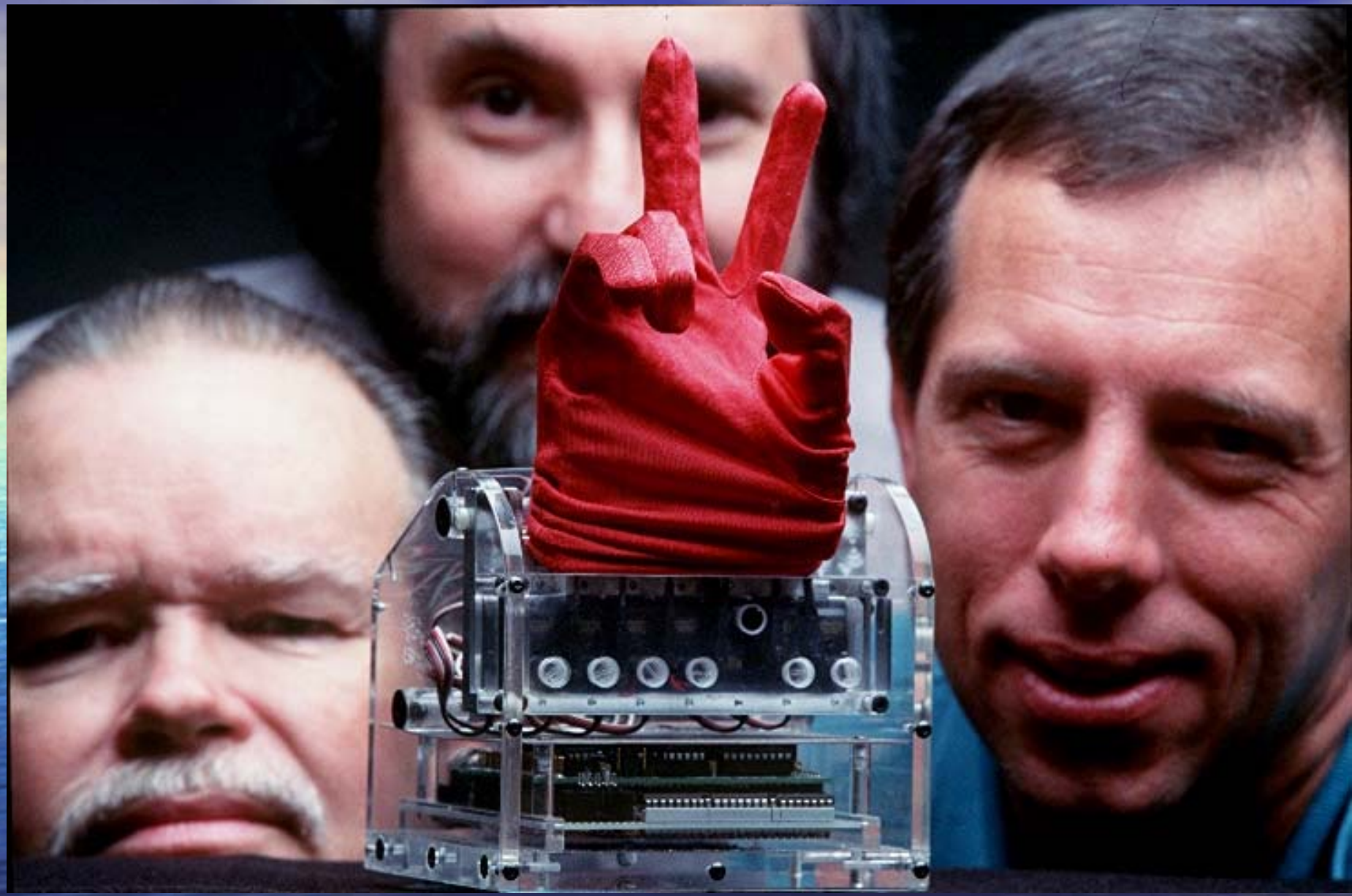
http://kineadesign.com/portfolio/tactor/

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.

Differential Pressure Walking Assist

Investigators/Therapists:
Charles Burgar, MD
Robert Whalen, PhD
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**

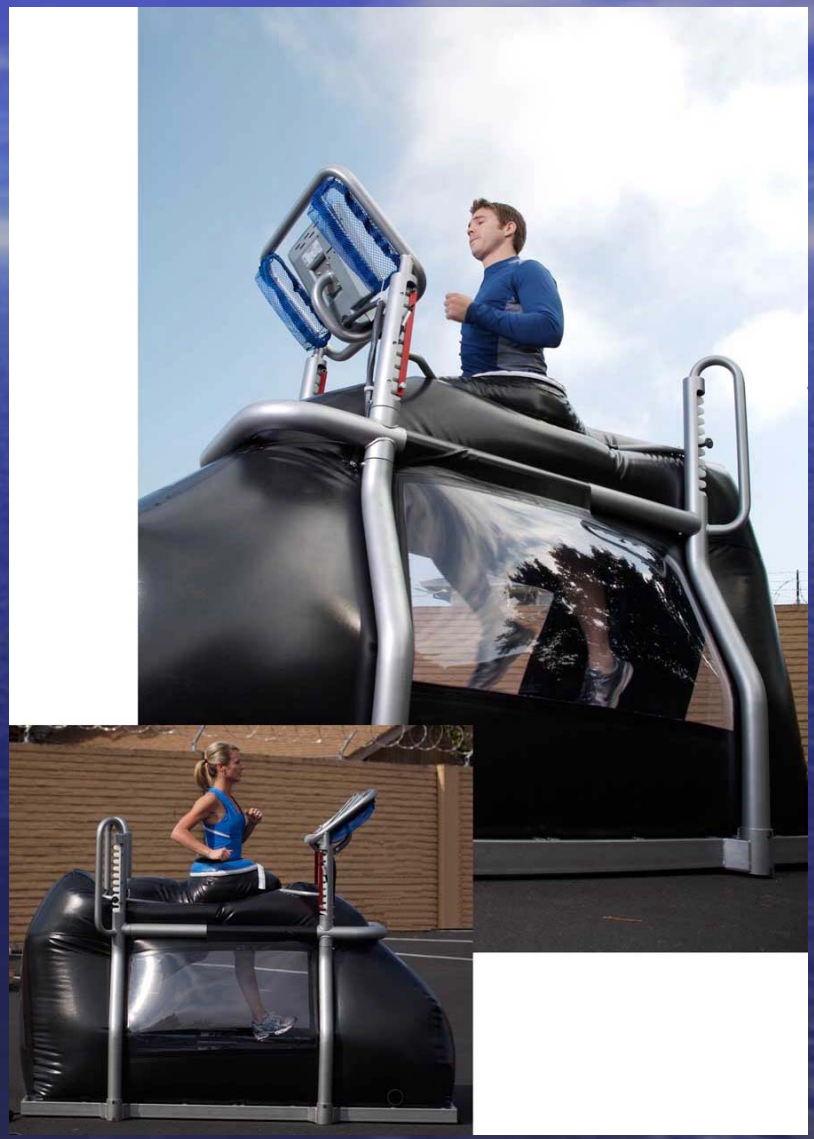
Applications

- **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.



www.alter-g.com