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May 8th, 1:30 PM - 3:00 PM

## Assistive Technology (AT): Opportunities for Interdisciplinary Research, Education, and Service Delivery

Alkim Akyurtlu

*University of Massachusetts - Lowell*

*Et al.*

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4th Annual UMCCTS Research Retreat

# Assistive Technology (AT)

Opportunities for interdisciplinary  
research, education, and service  
delivery

May 8<sup>th</sup>, 2013

# Presenters

- **Alkim Akyurtlu**, PhD, University of Massachusetts Lowell  
Associate Professor Electrical and Computer Engineering Department
- **Deirdra Murphy**, PT, DPT, MS, MHA, University Massachusetts Lowell  
Associate Professor and Program Director Physical Therapy Department
- **Alexandra Bonardi**, OTR/L, MHA, University of Massachusetts Medical School (UMMS)  
Associate Professor, Family Medicine and Community Health, UMMS
- **Tom Mercier** – OTR/L, MA Department of Departmental Services  
Deputy Director of ATServices MA Depart. of Developmental Services
- **Craig Armiento**, PhD, University of Massachusetts Lowell  
Professor, Department of Electrical and Computer Engineering

# Outline

- Definitions and framework
- Trends: drivers of R&D
- Case example(s)
- Opportunities

**>1 billion  
people in the world have some  
form of disability**



# Disability and AT

- A critical element for successful participation in the community (employment, school, recreation, etc.) for people with disabilities or chronic illnesses is  
.....Assistive Technology

# Assistive Technology

- The Assistive Technology Act of 1998 definition :
- “as any item, piece of equipment, or product system that is used to increase maintain or improve the functional capabilities of people with disabilities.”

# AT

## Low-Tech

- Commercially available materials.
- Less expensive
- Easily adapted
- Example
  - Pencil grip
  - Large Print Book

## High Tech

- Specialized
- Expensive
- Example:
  - Wheelchair that Christopher Reeve used



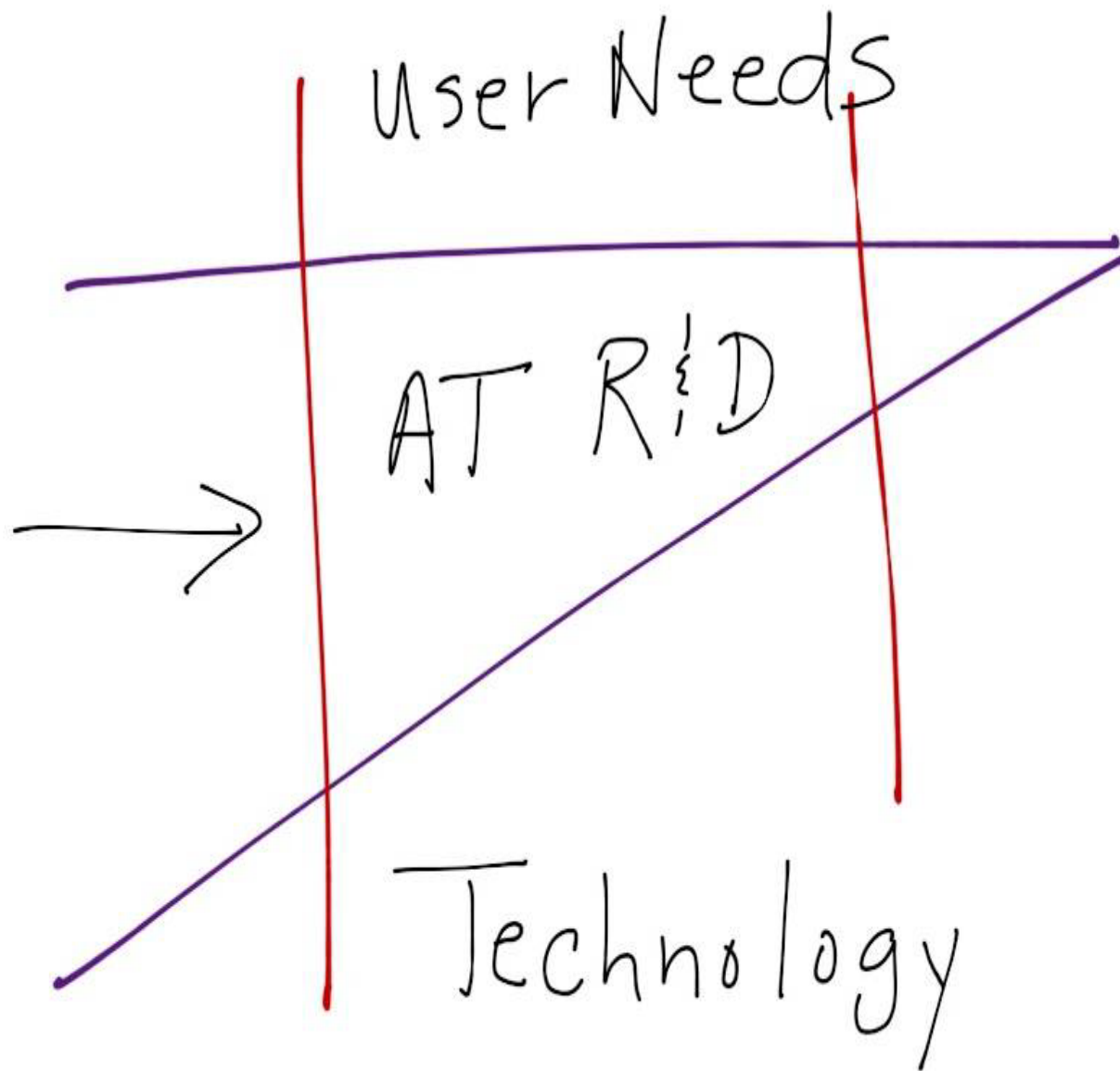
- Families and Clients (people with disabilities)
- Organizations (education, employment, commerce, etc.)
- Practitioners
- Policy makers, AT funders, public sector program administrators

# Assistive Technology

- Increased “raw” accessibility in mainstream supply
  - low prices undercut AT
  - mainstream market disrupts AT professions & programs
  - some popular products lack accessibility
- Underutilization

# Trends

- Proliferation of technology
  - Disruptive technologies (e.g. smart phone, no-touch environmental control)
  - Exponential rate of technological evolution (impetus for rapid move to market before product 'expires')



# Trends

- Universal Design
- Customization
- Aging population
  - >65 years-12.4% in 2000 to 19.6% in 2030
  - Chronic Illness
- Person-centered supports
- Consumer direction

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# Translational Research

“Systematic effort to convert **basic research** knowledge into practical applications to enhance human health and well being.”

E. Wethington (2010)

- can be seen as linear
- many possible applications of basic research

# “Knowledge Translation”

“A multidimensional, active process of ensuring that new knowledge gained through the course of research ultimately improves the lives of people with disabilities, and furthers their participation in society.”

~ NIDRR 2005



# Rehabilitation Engineering

“Engineering sciences to design, develop, distribute technologic solutions to problems confronted by individuals with disabilities....”

➤ predicated on identified need in functional area

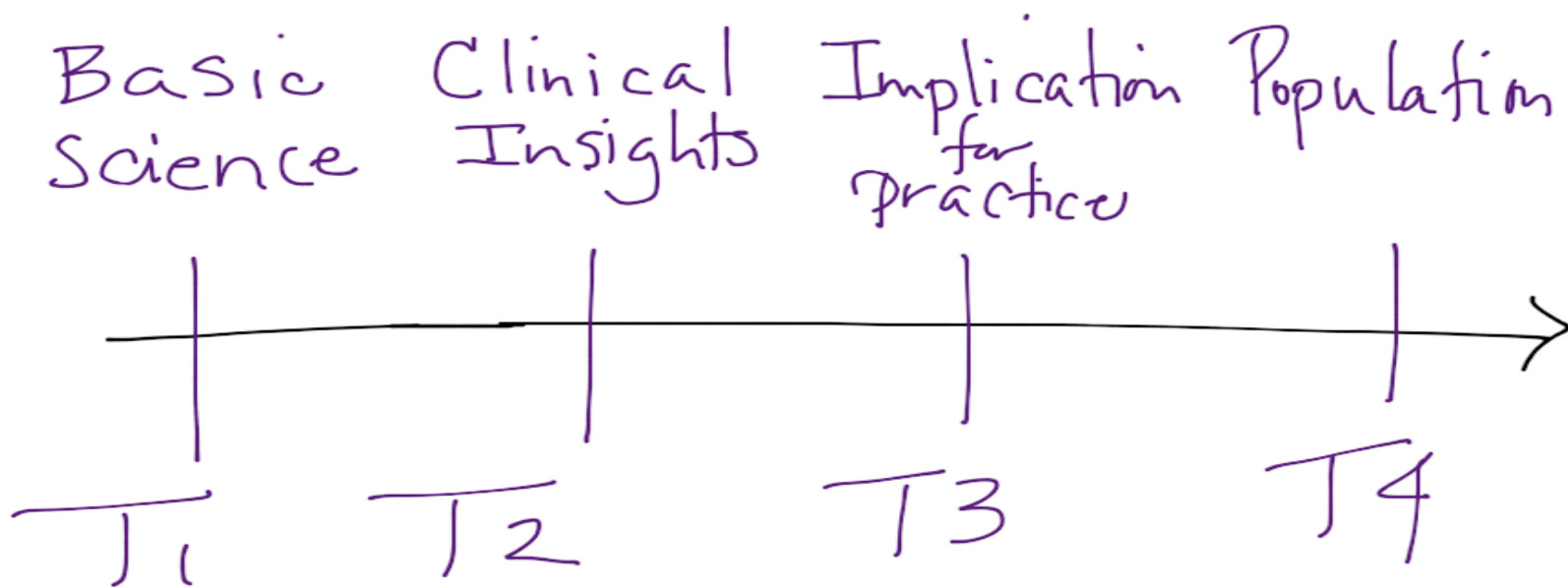
# Translational Research in the Context of AT

- Functional needs identified
- Multidirectional  
research > development > commercialization  
(flow with feedback loops)
- Multidisciplinary

# AT on the translational research continuum.

- Brain-computer interface technologies
- Sensors for ‘smart homes’ .
- Advanced materials for affixing.

# AT on the translational research continuum.



# Andrew



# Computer Access with Morse Code

- 28 year old woman
- Totally Blind from birth
- Cerebral Palsy which severely limits functional use of limbs
- Functional Head Control
- Has used Morse Code method to access computer in the past.
- Now has new system

# User Control

- ASL Head Array



# Computer Language





# Computer Access



# Problem List

- Mechanical Function of Head Switch
- JAWS Function
- Screen Reading
- Accessing email
- Set-up and Breakdown of Equipment

# People Needed

- Individual
- OT
- Student volunteer
- MCB Staff
- Parent
- House Staff

# Barriers to Translational Research

- Different ‘cultures’ (engineers, clinicians, care providers)
- Traditional incentives reward PI (focused expertise) vs. multidisciplinary teams
- Time and complexity in multidisciplinary groups
- Research paradigm seeks experimental conditions that are hard to achieve in clinical or community context.

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4th Annual UMCCTS Research Retreat

# Assistive Technology: Teaching Engineering Design with Social and Global Impact

Craig Armiento\*, Alkim Akyurtlu\* and Deirdra Murphy#

Assistive Technology Research Center

\* Electrical & Computer Engineering (ECE) Department

# Physical Therapy Department

University of Massachusetts Lowell

Lowell, MA



May 8, 2013



# The UML Assistive Technology Program

- Electrical & Computer Engineering (ECE) seniors are required to develop an assistive device for their senior Capstone project
  - Each student team is assigned to help a specific client or group
  - Custom design based on the individual's specific needs
  - Two course sequence includes team projects and communication skills
- Our Assistive Technology program is unique
  - Part of the undergrad ECE program for 22 years
  - Nationally and internationally recognized
  - Partially funded by NSF - projects published in annual NSF report
- Service to a community of mentally/physically disabled clients
  - Program supports over 20 agencies in Massachusetts
  - Program has delivered over 1,700 projects to clients
  - No charge to the individuals or agencies
- The program is expanding internationally
- The program is now pursuing the application of advanced technologies to tackle AT problems

# Client Agencies

- **Kennedy Day School, Boston**
  - Children 1-20 years, physical & mental disabilities.
- **Hogan Center, Mass Dept of Mental Retardation, Hathorne, MA**
  - Kelly AT center physical and mentally disabled persons.
- **VA Hospital, Bedford, MA**
  - Veteran's computer center and Nursing hospital care for disabled Vets.
- **Nashua Center, Nashua, NH**
  - Disabled adults, help to employ, start business.
- **Shore Educational Collaborative, Chelsea**
  - Special Ed program. K-12 and 18 Boston school districts
- **Coastal Education Collaborative, Southbury, MA**
  - K-12 Special Ed program up to 21 years of age.
- **Life Link, Lowell, MA**
  - Program for physical & mental disabled adults
- **Helping Hands, Boston, MA**
  - Monkey helper for the disabled, spinal cord disabled person

- **New England Education Consortium, Eastern Mass, MA**
  - K-12 Special Education program up to 21 years of age.
- **Seven Hills Groton, Groton, MA**
  - Special needs school
- **Boston Home, Boston, MA**
  - Nursing care facility
- **Chelsea Jewish Nursing Home**
  - Nursing care facility
- **Northeast Rehabilitation Hosp, Salem, NH**
  - Persons with physical disabilities
- **Boston Chapter National Spinal Cord Injury Asso. Woburn, MA**
  - Persons with spinal cord injury.
- **New England Pediatric Care, Billerica**
  - Disabled children- live in program
- **Lawrence, Lowell and Nashua High Schools**
  - Special Ed programs
- **Perkins School for the Blind, Watertown**
  - Blind students with special needs up to 20 years of age



# How Do We Help Clients?

- Interface with a Computer
  - Allowing a client to use whatever abilities they have
- Controlling a client's environment (home, hospital room)
  - Control lights, TV, call a nurse, etc.
  - Patients with Amyotrophic Lateral Sclerosis (ALS) - system must adapt to deteriorating abilities
  - locked-in patients (sharp mind but limited body movement, no voice)
- Mental stimulation
  - Severely mentally-challenged patients, autistic children



**Joystick interface for iPod** for a boy with very limited dexterity

# How Do We Help Clients?

- Improving Mobility
  - Wheelchair modification to enable control
  
- Enabling a client to work



**Audio Mixing Board** to allow a blind person to work as a disc jockey on a local radio station



**Head controlled wheel chair steering system** for a boy unable to use a joystick

# Commercial Technologies for AT Projects

- Voice recognition chips and software
- Accelerometer and gyroscope chips to sense motion (MEMS)
- Touch screens
- Wireless communications
- Hub motors for improved mobility (e.g., wheelchairs, tricycle)
- Infrared eye tracking technology
- Sensors for vital signs (e.g., blood pressure to warn of a seizure)
- Biosensors for device control (e.g., EMG)
- Haptic Feedback – vibrate for corrective devices (gait, balance)
- Ultrasonic and IR sensors as aids for the blind

# Academic Value of the Program

- Technical skills for engineering students
  - Experience with **Open Ended Design**
  - Experience with **Project Management**
    - Manage a **Budget** and a **Schedule**
    - Work with a **Client** and manage a **Deliverable**
  - Consider **safety** and **health** aspects of their device
- Soft Skills for engineering students
  - Learning to **communicate** (orally and written)
  - Experience with working in a **team environment**
  - Potential to work on **international** team
- Life Lessons for engineering students
  - Appreciate the **challenges** faced by the individuals with disabilities
  - Understand that engineers have **impact on societal issues**
- Recruit students to STEM majors
- Satisfy engineering accreditation criteria



# Two Sample Projects: Low Tech & High Tech

## Hourly Rounds Timer



- Simple aid for nurses in hospital setting
- Developed for Lawrence Friends Hospital
- LED Timer box mounts on outside of room
- Eliminate use of hourly rounding paper forms
- Visual indication of the need to visit patient
  - 1 or 2 Hour Expired Light Emitting Diode-*Green*
  - 10 minute warning Light Emitting Diode-*Yellow*

- Headband with embedded sensors
- EMG signals to control a device (e.g., computer)
- ALS and locked-in patients can type

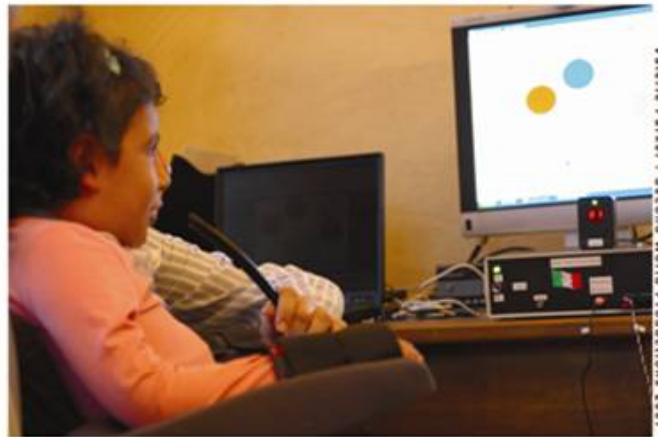
## Mind Mouse





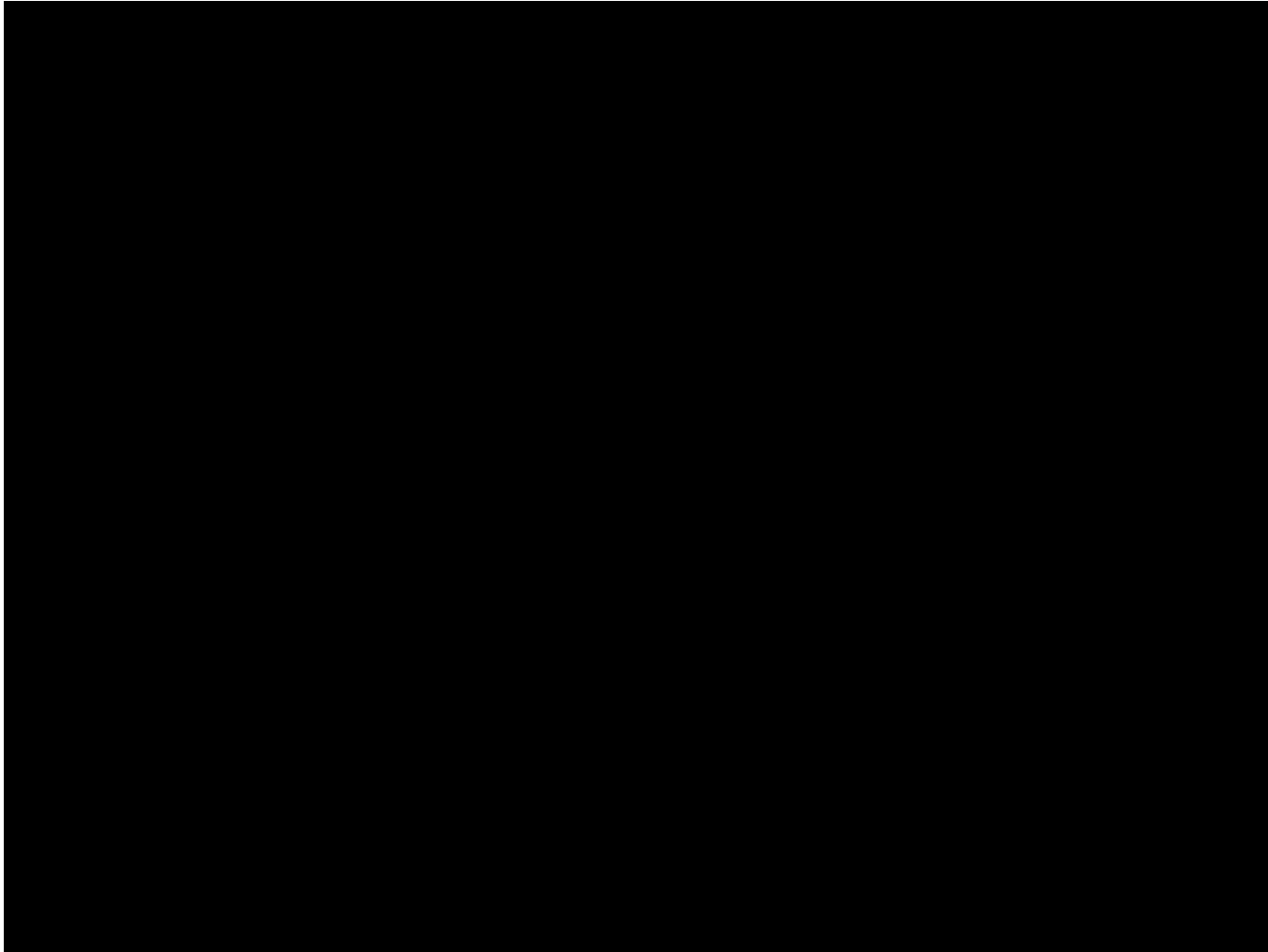
# Helping International Clients: Anna

- AT staff received a request from a family in Italy to help their 5 year old daughter
  - Anna was crippled (from the neck down) in a car accident
- Parents wanted Anna to be able to use a computer
- A student devised a voice recognition system to enable Anna to control her computer and electronic toys
- Student delivered the device and trained the family in its' use

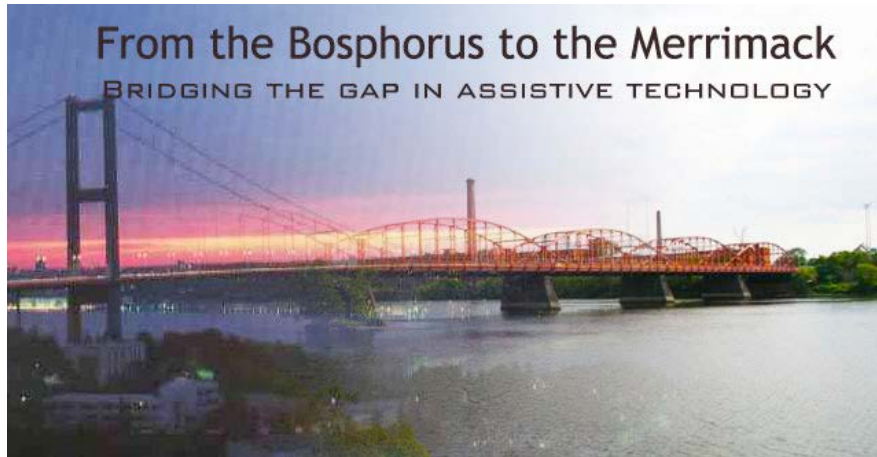


See video at: <http://www.youtube.com/watch?v=4KYtyYtAcvg>

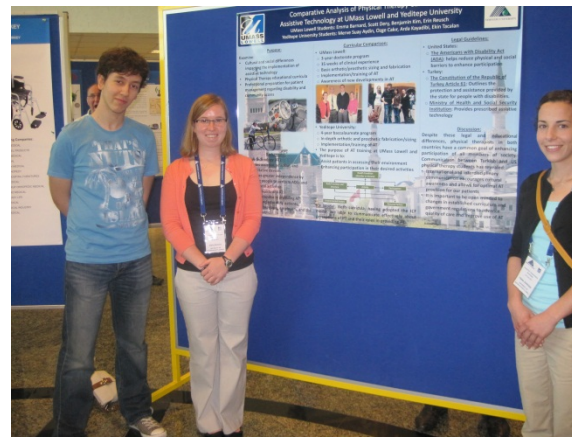
# Anna's Story



# International AT Workshop in Istanbul



- NSF Funded
- International Group of AT Researchers
- Student Posters





# Establishing AT Programs in India

Our AT program has been exported to two Indian institutions where the need is significant. Labs have been established and faculty have been trained. This was implemented by a 3 week exchange program by AT staff such as Alan Rux (see below) and various UML students.



**B.V. Raju Institute of Technology**  
Hyderabad, India  
40 Students  
Established an Assistive Tech Laboratory



**Shir Vishnu Engineering College for Women**  
Bhimavaram, India  
60 female students  
Consulting continues via video conferencing

# Recruiting Students to STEM Majors

The Assistive Technology Program has helped attract high school students to majors in **Science, Technology, Engineering and Mathematics (STEM)**

*High School Assistive Technology Design Fair* has attracted 20 high schools and over 100 students every year (for 8 years) to work on Assistive Technology projects (each team picks a disabled student from their high school)

*TEAMS Academy* (Technology, Engineering and Math-Science) exposes advanced high school students from 15 high schools to Assistive Technology



Many high school students discover that engineering is a profession that can be oriented towards helping people. This message seems to resonate well with young women.

# AT Research Center

- The newly formed ATRC will exploit emerging technologies in an interdisciplinary environment to enable advanced solutions
  - Exploit emerging technologies such as printed electronics, embedded sensors, robotics, mobile devices, etc.
- Interdisciplinary research team with faculty from:
  - Get health care practitioners and engineers in the same room!
  - Members are faculty from:
    - Engineering (Electrical, Computer, Mechanical and Plastics)
    - Computer science/robotics
    - Nursing
    - Physical therapy
    - Psychology
    - Education
    - Business school



# AT Research Center (Continued)

- Develop licensing opportunities and spin-off companies
- Expand the scope of projects to include the elderly and the education market
- Continue to expand the program internationally
  - Promote the AT concept of service learning as a part of engineering education
  - Pick international projects where the need and potential impact is greatest
- Activities directed at projects that impact large problems
  - We welcome your suggestions!

# Small Group Discussion

Opportunities to support interdisciplinary  
development of AT

# Discussion Questions

- Can you describe how you the industry that develops assistive technology and wheelchairs develops their materials? Would you call that translational research?”
- There are significant differences in how professionals may approach the same ‘problem’. How do you think that might help or hinder translational research?
- How do we create the opportunities for dialogue between stakeholders?
- How can we use the CCTS networks to facilitate translational research in the area of AT?