Design and Deployment of Technology to Support Healthy Aging

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• From ~2005 thru 2010
• Collaborated on research funded by Deere & Company
• Understanding predictors of technology acceptance
• Hoping to start new collaboration related to older consumers
Demographic Trends

World Population

Source: Population Reference Bureau
Percentage of population aged 65 and over in 2010 across the EU

Percentage of population aged 65 and over in 2035 across the EU

Percentage of population aged 60 years or over living independently

From www.un.org
Support Healthy (Successful) Aging

• Allow individuals to function effectively and independently as they age.

• Maintain personal autonomy.

• Retain and enhance ability to function in later life.

• Manage chronic conditions.

• Support preventive health (wellness).
My Inspirations
The Human Factors and Aging Laboratory Goals:

- Determine abilities, limitations, needs, preferences of older adults
- Contribute to the successful design of technology for older adults
  - usable and useful products and systems
  - effective training & instruction
  - optimized deployment and introduction

Human Factors is:

- the study of characteristics of people and interactions with products, environments, and equipment
- considering needs and capabilities of users in the design of systems, devices, training, instructions, and environments.
- “Designing for human use.”
Know thy User

• Who is **THE** older adult?
  – No such thing
  – Older adults vary widely in:
    • Experiences
    • Attitudes
    • Abilities
    • Goals
    • Limitations
    • Needs
  – Think in terms of sub-groups and categories of need
Needs Assessment

• Activities of Daily Living (ADLs)
  • Bathing, eating, drinking, mobility

• Instrumental Activities of Daily Living (IADLs)
  • Preparing meals, paying bills, managing medications, maintaining the home

• Enhanced Activities of Daily Living (EADLs)
  • Social communication, hobbies, new learning, work, volunteering, community participation
What changes as people age?

- health
- mobility
- vision, hearing
- cognitive functions
- social interaction
- support needs
For adults over age 80, the chance of having a disability is 75%.

Percentage of People Age 65 and Over Who Reported Having Selected Chronic Health Conditions, 2009-2010 (many individuals have multiple chronic conditions)

- Heart Disease: 30.4%
- Hypertension: 55.9%
- Stroke: 8.6%
- Emphysema: 6.2%
- Asthma: 11.3%
- Chronic Bronchitis: 6.2%
- Any Cancer: 24.0%
- Diabetes: 20.5%
- Arthritis: 51.2%

From: *Older Americans 2012* by Federal Interagency Forum on Aging Related Statistics (Indicator 16)
Complexity of Health Self-Management

Making Healthy Decisions
Chronic Conditions
General Wellness

Mitzner, McBride, Barg-Walkow, & Rogers (2013)
Opportunity for Technology Supports

• **Potential** and **Challenges**
  - Wellness management technologies
  - Apps
  - Exergames
  - Robotics

• Sampling of our research in these areas

• Theme:
  - Need to design for older adults’ capabilities, limitations, and preferences
Wellness Management: Potential

71% of older adults track weight, diet, or exercise*
  44% keep track in their head
  41% use paper
  12% use a medical device
  2% use a computer program
  1% use an app or mobile tool
  Less than 1% use a website or other online tool

Wellness management technologies can support these activities:

• to set and monitor health-related goals
• manage diseases
• maintain health

*Fox & Duggan, (2013)
Acceptance Over Time

• Predictors of wellness management technology use for older adults
  • Change over time
  • Assessed older adults usage over 28 days for two devices
  • Diaries and surveys pre and post

• Participants
  • 16 (8 males, 8 females)
  • Ages 65-75 ($M=70.06$, $SD=3.09$)

• Assigned either:
  • Fitbit One
  • myfitnesspal.com
  • (usage and attitude data were similar)
Intent to Adopt

Initial

Final

Total Score

Participant

Adopters

Non-adopters
Perceived Usefulness

![Graph showing perceived usefulness over time for adopters and non-adopters.](image-url)
Perceived Ease of Use

![Perceived Ease of Use Chart]

- **Mean Score**
  - Initial: Adopters vs. Non-adopters
  - Final: Adopters vs. Non-adopters

* Asterisk indicates a statistically significant difference.
Wellness Management: Challenges

• Usefulness
  • Mixture of attitudes
    • potential benefits for promoting exercise and diet habits
    • not better than paper and pencil

• Usability challenges related to:
  • system status visibility
  • error prevention
  • consistency and standards

• Older adults willing to use wellness management technologies, but better design and training required.
Exergames: Potential

Video games to promote physical activity...may provide physical, cognitive, and emotional benefits
Evaluated two exergame programs for Microsoft Xbox 360 with Kinect
Perceptions generally positive
“good for physical activity”
valuable as a way to “keep active”
Exergames: Challenges

• Current exergames are not developed with consideration of older adult users’ physical and cognitive abilities
  • Difficulties:
    • learning to use gestural controls
    • navigating menus and instructional screens
    • on-screen instructions insufficient
    • not sure when to perform actions
    • perceptual, motor, and cognitive errors

• Need to design games for older adults

• Provide better instruction and training
  • Quick-start guide
  • Evidence-based
Managing Chronic Pain

Small Business Innovative Research Grant with Aptima, Inc. (Camilla Knott)

Collaborators: Pat Parmelee, Terry Fairbanks
Osteoarthritis

• Management is complex

• Many resources for osteoarthritis management exist, but...

...overwhelming amount of information
  • Difficult to personalize from general disease model
  • Current tools are limited
Stages of Research

- Knowledge requirements
- Available support
- Beliefs about pain factors
- Current approaches
- Prototype system
- Heuristic analysis
- Refine prototype
- Efficacy of system
- Large-scale user testing
- System dissemination

Next Steps

SBIR Grant Phase I

McBride, et al. (2011)

Barg-Walkow, et al. (2013)
<table>
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<tr>
<th></th>
<th>Morning/Breakfast</th>
<th>Afternoon/Lunch</th>
<th>Evening/Dinner</th>
<th>Overnight/Bedtime</th>
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<tr>
<td><strong>Pain</strong></td>
<td>Enter Pain</td>
<td>Enter Pain</td>
<td>Enter Pain</td>
<td>Enter Pain</td>
</tr>
<tr>
<td><strong>Physical Activity</strong></td>
<td>Enter Your Physical Activity Today</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Mood</strong></td>
<td>Enter Your Mood</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Sleep</strong></td>
<td>Enter Your Sleep</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Weather</strong></td>
<td>62°F average temperature</td>
<td>28.54 in average pressure</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Medications</strong></td>
<td>Enter Your Medications Today</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
April 2013

Press on a day to see more details

Average Pain

- No pain: 0
- Mild: 1-3
- Moderate: 4-6
- Severe: 7-10
How physical activity time and pain are related over the last 3 months

How to read this graph

- My average pain on days when I exercised that amount
- My pain was within this range when I exercised that amount

Average pain

Minutes of Exercise

0 5-15 16-30 31-45 46-60 60+
Prototype System with Simulated Data

- Improved older adults’ understanding of pain triggers

Judgments about Pain Relationships with Other Variables

- Next step: large scale trial of whether STAMP reduces pain
Apps: Challenges

- Most available apps not developed with consideration of older adult users’ physical and cognitive abilities or needs in mind

- Need to understand
  - Information requirements
  - Test comprehension of information displays
  - Assess efficacy of using the apps for health management (e.g., reducing chronic pain)
Human-Robot Interaction (HRI)

“dedicated to understanding, designing, and evaluating robotic systems for use by or with humans” (Goodrich & Schultz, 2007, p. 204)
How do we design robots to support successful aging?

• What do robots need to do?
  • Communicate with humans
    • Show emotions
  • Perform tasks for the person
  • Be trustworthy
  • Have an appearance people like
  • Provide social support

• Categories of Robots
  • Personal Service Robot
  • Social Robot
  • Telepresence Robot
GATSBII
(GATechServiceBotwithInteractiveIntelligence)

Collaboration with Dr. Charlie Kemp Director of the Healthcare Robotics Lab
Video of GATSBII’s Functionality
Assistance Preference Questionnaire

- Imagine you need assistance – would you prefer a human or a robot?
- 48 home-based tasks

<table>
<thead>
<tr>
<th>If I needed assistance with...</th>
<th>If I needed assistance, I would prefer help from...</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Only a human&lt;sub&gt;1&lt;/sub&gt;</td>
</tr>
<tr>
<td>a. Bathing</td>
<td>1</td>
</tr>
<tr>
<td>b. Being entertained (e.g., playing games, dancing)</td>
<td>1</td>
</tr>
<tr>
<td>c. Being reminded of appointments</td>
<td>1</td>
</tr>
</tbody>
</table>
Activities of Daily Living

Instrumental Activities of Daily Living

Enhanced Activities of Daily Living
Assistance Preference – Robot vs. Human?

Activities of Daily Living

- Shave
- Haircare
- Bathe
- Eat
- Dress
- Brush teeth
- Walk

Only Robot

No pref

Only Human

1

2

3

4

5

Activities of Daily Living
Assistance Preference – Robot vs. Human?

Instrumental Activities of Daily Living

- Only Robot
- Only Human
- No pref
Assistance Preference – Robot vs. Human?

Enhanced Activities of Daily Living

- Shave
- Haircare
- Bathe
- Eat
- Dress
- Brush teeth
- Walk
- Prepare meal
- Call family/friends
- Decide medication
- Take medicine
- Call doctors/911
- Grocery shop
- Wash dishes by hand
- Remind take medicine
- Laundry
- (Un)load dishwasher
- Take out trash
- Make bed
- Change light bulb
- Clean bathroom
- Clean window
- Control pests
- Clean floor
- Clean kitchen
- Entertain guests
- Be entertained
- Exercise
- Learn new skills
- Getting hobby info
- Learning to use new technology
- Get weather/news
Delivering Medication (video)

Clearing away clutter

Learning Light Switches
Older adults were:
- Very positive about the robot
- Not at all frightened
- Excited about the potential for the future
Attitudes more Positive after Interaction Experience

**Being Reminded to Take Medication**

- **PRE**
  - $M = 2.75$
  - $SD = 0.97$

**Delivering Medication to You**

- **PRE**
  - $M = 2.50$
  - $SD = 1.24$
Personal Service Robot: Challenges

- Acceptance by older adults
  - Trust
- Design for home spaces
- Reliability, consistency, transparency
- Maintenance
- Cost
Social Support Robot: PARO

• Designed by Dr. Takanori Shibata – to elicit happiness and relaxation
  • Modeled after a baby harp seal
    • Moves and makes similar sounds

• Tactile sensors: paws, back, head, chin, whiskers
• Ability to sense light, touch, and sound
**Social Support Robots: Potential**

Reduce isolation

Minimize stress

Provide Companionship

**Study 1:**
Do *healthy* older adults’ perceive Paro as being useful in their daily lives?

*Who* might Paro be used by?

*How* might Paro be used?
Overall, participants had positive attitudes toward Paro

Of the 30 participants, most perceived Paro as being useful to themselves and beneficial to people in general.
Types of Functional Uses Mentioned

- Of the functional uses, mentions of either physical or verbal interactions were most prevalent.

### Functional Uses Mentioned

- **Physical Interaction**
- **Verbal Interaction**
- **Presence**
- **Unspecified Interaction**
- **Alarm/Security**
- **Learning**
- **Other**

*Graph showing frequency of mentions for each functional use.*

- "I'd just hold him and pet him and whatnot."
- "If you need to vent, vent to Paro."
- "I'd have it close by... it makes me know that there is somebody else or something else around."
Social Support Robot: Challenges

• Limited research on whether PARO is effective at reducing stress, providing companionship

• Characteristics of social/companion robots
  • Appearance
  • Interaction methods
  • Responsiveness
  • Learning about person
  • What makes them effective
Telepresence Robot: Potential

Facetime

Telepresence: Kubi
www.revolverobotics.com

Henry Evans with his BeamPro
Telepresence Robot: Challenges

• Ease of Use
  • Usability of interface
  • Control methods

• Usefulness
  • Rehabilitation support
  • Group exercise
  • Social communication
Conclusion

• Current technologies can support health and well-being of older adults
  • Design adaptations
  • Training
  • Proper introduction into everyday lives

• Emerging technologies have tremendous potential but success depends on:
  • understanding older adults’ capabilities, limitations, needs, preferences, attitudes, and goals
  • involving older adults in process of development and testing
In development:
Transportation Systems; Home Modifications; Technologies for Assisted Living Communities
Human Factors and Aging Laboratory
Current Projects

**Home**
- Human Factors of Home Health Care
- Support for Social Communication
- Needs Assessment – ADLs, IADLs, EADLs
- Exergames

**Technology**
- Memory Support
- Usefulness & Ease of Use
- Acceptance & Long-term Adoption
- Pain Management
- Wellness Management
- Human-Robotic Interaction

**Health**
- Communication with Health Care Providers
- Motivation and Self-Efficacy
- Subjective Well-being
- Telewellness Technologies

**Robotics**
- Trust and Reliance on Automation
- Social Robotics
- Personal Robots

**Social Connectedness**

**Wellness Management**

**Telewellness Technologies**