Pervasive Technologies for Health: a Focus on the Human

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“The groundwork of all happiness is health.”

-- Leigh Hunt
1784-1859, British Poet, Essayist
Pervasive Tech for Health

- Current health infrastructure becoming overloaded
  - Formally terminal diseases are now chronic diseases
  - People are living longer
- People are becoming more proactive about their healthcare
  - Doctor/patient roles changing
- New opportunities for technology to support health-related behaviors
Outline

• Motivation
• Indiana University Projects
  – DIMA
  – Chick Clique
  – ETHOS
• Looking Towards the Future
Design Process

• User-centered
  – Consult experts
  – Verify assumptions with target population

• Iterative design
  – Obtain user feedback, early and often
  – Incorporate into designs
“To safeguard one's health at the cost of too strict a diet is a tiresome illness indeed.”

-- Francois De La Rochefoucauld
1613-1680, French Classical Writer
Hemodialysis Patients

- Daily Limits:
  - 1 liter water
  - 1 gram sodium

- 80% cannot adhere to diet
Hemodialysis Patients

- 1/3 cannot perform conversion calculations
- Urban population: low literacy rates
Hemodialysis Patients

- Paper diaries have 11% compliance rate
- Electronic diaries have up to 94% compliance
DIMA Approach

Dietary Intake Monitoring Application

- Portable device to track nutrition anywhere
- Bar code scanner for easiest input
- Icons for foods without bar codes
- Real-time feedback
Iterative Design Process

• Study #1: Can they physically use PDAs? *(Interact ‘05)*
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- Study #2: Can they scan barcodes at home? (*PervasiveHealth '06*)
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- Study #2: Can they scan barcodes at home? *(PervasiveHealth ’06)*
- Study #3: Voice v.s. scanning *(Chapter in Mobile Health Solutions 2008)*
Iterative Design Process

- Study #1: Can they physically use PDAs? *(Interact ‘05)*
- Study #2: Can they scan barcodes at home?  *(PervasiveHealth ‘06)*
- Study #3: Voice v.s. scanning  *(Chapter in Mobile Health 2008)*
- Study #4: Icon interface
  - #4A: Icon choices  *(CHI ‘06)*
  - #4B: Navigation
Emergent Themes

- Integration into daily routines very important
- Showing off to others
  - Technology is a status symbol
- Domain experts didn’t always have it right
- Patients lie to their caregivers
  - Need to support that
DIMA Prototype

- 6 week pilot study
  - 20 participants using DIMA
  - 20 control participants, tracking physical activity
- Clinical trial if initial results are promising
Behavior Theories

- Ground Designs in existing behavior theories
  - Social Cognitive Theory

  Prior experience
  Observing others
  Social Persuasion

  Outcome expectations and expectancies

  Behavioral Capability

  Self-Efficacy

  Simplify target behavior

  Reinforcement experience consequences self-reward vicarious, through others

  Health Behavior

Forthcoming book chapter in *Informatics of Diabetes.*
“We are under exercised as a nation. We look instead of play. We ride instead of walk. Our existence deprives us of the minimum of physical activity essential for healthy living.”

-- John F. Kennedy

Thirty-fifth President of the USA
Teen Obesity

- Overweight adolescents in US have tripled in past 20 years
Teen Obesity

- US Surgeon General says adolescent obesity primarily attributed to
  - Inactivity
  - Poor dietary habits
Teen Obesity

Teenage girls, when compared to boys:
1. Become increasingly inactive during adolescence
2. More likely to use unhealthy weight control methods
3. More receptive to health behavior modification
Chick Clique

Modeling  Social support

Verbal persuasion

CHI Student Design Competition winner, PervasiveHealth '08
Chick Clique: Step and Share

- Girls wear pedometers
- Enter step count periodically throughout day
- Can monitor progress of the entire group
Chick Clique: Texting

- For our user study, we recorded all texts between girls, even if sent outside of Chick Clique
Emergent Themes

• Need scaffolding for text messages
  – Templates
• Modeling is positive, but competition could be perceived negatively
  – Short interventions, or
  – Share progress in game, but no direct comparison
• Reciprocity is necessary when relying on social support
  – Prompt non-participating users to enter step count
• Group composition
  – Small groups of close friends
In-Situ Evaluation

- People’s attitudes about technology are often very different before/after experiencing the technology
- Usage often declines over time after “wow” factor has subsided
“Health is a state of complete physical, mental and social well-being, and not merely the absence of disease or infirmity.”

-- World Health Organization
In the US, 13% of the population is over 65. By 2030, it will be about 22%.

Those over 85 are the fastest growing age segment of the population.

Technology holds great promise for maintaining and improving the health and well-being of the growing older adult population.
Technologists and caregivers are eager to use technology to monitor elders, but everyone is punting on more ethical issues, such as privacy:

- Hobson’s choice: an elder can either give up all of their privacy by moving into an assisted living facility, or some of their privacy to the technology.
Privacy Paradigms

• Seclusion
  – Right to be left alone
• Autonomy
  – Right to do what you want
• Property
  – Ownership of data
• Spatial
  – Boundaries

Neither designers nor elders are well versed in privacy.
**ETHOS Approach**

- Toolkit to assist in privacy-enhancing design:
  - Tools to facilitate communication between designers and elders
  - Tool to ease implementation of design
Living Lab

- 1 bedroom apartment, with living room, kitchen and bath
- Intermediate testing of prototypes in realistic setting
Ambient Plant

- Awareness of remote presence
- Embedded in existing home object
- Attitudes change after experience
Mirror Motive

- Embedded in everyday object
- Reminders and monitoring
- Inherent trust of system to protect their data
Portal Monitor

- Focus on physical security a positive
- Often more comfortable with pictures taken than motion sensed in ambient plant
Initial Results

• Reciprocity not important for many
• Data as property was a foreign concept, even though that is the legal reality under which they live
• Data granularity not deciding factor (though video was almost universally disliked)
• Longitudinal, in-situ studies
ETHOS Team

• Faculty:
  – Jean Camp -- privacy specialist
  – Kay Connelly -- technology
  – Lesa Huber -- elder specialist
  – Kalpana Shankar -- social scientist

http://ethos.indiana.edu
• Iterative, user-centered design
• Grounded in behavior theories
• In-situ, longitudinal testing
• Develop new methods for eliciting privacy concerns
Announcing....

Institute investigating privacy and security of pervasive health applications

Funded by the Lilly Endowment

University of Washington, August 20th 2008.
Grand Challenges Workshop

• IU will host a workshop
  – Leading researchers around the country
  – To identify the major challenges, and
  – Formulate research agenda for
  – Privacy and security of pervasive health applications

  – Look for it next year