Creating Proactive Environments for Healthy Living

Research and Technology for Aging, Disability and Independence
June 26-27, 2003 London, UK

Kent Larson  kll@mit.edu
Director, MIT Changing Places Consortium (Department of Architecture + Media Laboratory)
MIT Changing Places Consortium

Architecture:

Places ➔ Technology

Media Lab / AI Lab:

Technology ➔ Places
Architecture:

Places \rightarrow Technology

Media Lab / AI Lab:

Technology \rightarrow Places
Buildings:
Permanent

Life & Technology:
Change
Buildings:
Permanent

Life & Technology:
Change
The MIT Open Source Building Alliance (OSBA)

Toward standards for creating

low cost
high performance
responsive
agile
buildings
Grants:
NSF (2)
Robert Woods Johnson Foundation
AARP Andrus Foundation
Center for the Integration of Medicine and Innovative Technologies (2)
IBM Research
GE Global Research (DOD sub)

Consortium Sponsors:
Motorola
British Telecom
Intel
Hewlet Packard
Samsung
State Farm Insurance
Salt River Project

Health-related Partners:
Harvard School of Public Health
Boston U. Medical
What is Proactive Health?

Recognizing activities of daily living:
the portable environmental sensor kit

Scenario:
One possible proactive health service

PlaceLab: a “microscope” to study technologies and interventions in the context of life.
1
What is Proactive Health?
What is Proactive Health?

Environments, technologies, and services that help people stay:

- Autonomous
- Comfortable
- Engaged in Life
- Healthy
Three levels of health at home (in increasing order of difficulty and importance):

1. Responding to crisis (requires a few good sensors)
Three levels of health at home (in increasing order of difficulty and importance):

1. Responding to crisis (requires a few good sensors)

2. Early warning of emerging problems (requires ubiquitous sensors)
Three levels of health at home (in increasing order of difficulty and importance):

1. Responding to crisis (requires a few good sensors)

2. Early warning of emerging problems (requires ubiquitous sensors)

3. **Proactively keeping people healthy** (requires ubiquitous sensors and communication media)
What is Proactive Health?

Proactive health involves maintaining the three rings of social performance.

Activity in the community

Activity in the household

Activity related to body

The problem involves more than just the health of the body alone.
Proactive Health

Proactively encouraging healthy behaviors:

diet
exercise
medication adherence
stress reduction
smoking cessation
social contacts

could have a profoundly positive societal effect.

Figure 106-1  A model of social performance levels in older people. (From Williams EI: A Model to Describe Social Performance Levels in Elderly People. Br J Pract; 36:422–3.)
Proactive Health

Encouraging healthy behavior

Intervention at the point of decision can have a dramatic and positive effect:

Result = 3x use of stair over escalator

Now installed at 3 Boston subway stations
Empower with information

Information at the point of decision can have many applications

(such as energy conservation)
Current proactive health research at MIT

Switch/bend sensors
1. Doors
2. Cabinets
3. Drawers
4. Thresholds
5. Appliances
6. Objects

Wearable sensors
1. Accelerometers
2. Heart rate monitor
3. Self report

Multi-purpose sensors
1. People-locator tags
2. Auditory sensors
3. Optical sensors

Activity recognition
- Eating meals
- Talking
- Sleeping patterns
- Taking medications
- Cleaning
- Cooking
- ...

New algorithms

1. Detect change in activity
2. Motivate behavior changes

Health applications
Best bet: link advice with activity

Simple messages:
- Right time
- Right place
- Non-disruptive

- Requires computational sensing
- Requires “pixels where you are”
- Requires attention to UI design

Big impact
- 1.20% shown for energy
- Substantial gains for preventative medicine
2
Recognizing activities of daily living: portable environmental sensor kit
Data collection board with swappable sensors (2 weeks time stamped data)

On | Off
Open | Closed
Identity of People
Position of People
Self labeled data
Sensors to study behavior in context

Being used to develop algorithms to detect activities of daily living

Studies complete in four homes of non-researchers
One subject’s home

3 hours with small team
Install: tape-on

150 sensors in 4th subject’s home
(family of four)

On | Off
Open | Closed
Position | Identity
MIT Changing Places Consortium
MIT Changing Places Consortium
Fixed interval queries – PDA experience sampling
MIT Changing Places Consortium

Image-based experience sampling
Position-base context-aware experience sampling
Heart rate/accelerometer-based context-aware experience sampling
Patterns of movement
3

Scenario: One possible proactive health service
ActivityLink: Providing peace of mind communication
The family: adult children and kids
The single aging parent
First a broken ring

Less involvement signals health downturn in older adults

Experts talk about 3-rings that describe an individual’s healthy life activities.

By Megan Carrigan

When her mother stopped attending church every Sunday, Linda knew that something was wrong. Her commitment to community service was a cornerstone of her life.
Neighbor tells adult son that she hasn’t noticed his mother gardening lately, and son sees that garden is untended... and then neighbor concerns
Lots of gadgets to pick from???????????
WATCHING OUT FOR EACH OTHER

NEW PRODUCT GIVES SANDWICH GENERATION PEACE OF MIND

By: Anna Crawford, AP Reuters

Most adults see themselves living out their lives in their own homes, but for the children that care for and worry about them, independent living may seem too difficult to achieve.

The sandwich generation, adults who are caring for both their children and their parents, are having face tough decisions: the stress of moving in together, the heartbreak of assisted living, or the danger of accidents and depression that comes with older adults living alone.

A new product now available, ActivityLink, has its roots in research conducted at the MIT PlaceLab. Unlike other products which are stigmatizing and fragile, ActivityLink benefits from a thoughtful approach to issues such as privacy, flexibility, and personal control.

ActivityLink consists of a kit of simple sensors that are easily installed on furniture, appliances, and household fixtures.

These sensors only record open and close events, but come, stay, too.
ActivityLink available at home stores
Hundreds of sensors: a kit of parts

Cost: Just a few hundred dollars and $20 a month
Installation elder’s home
Stick-ems easy, wireless
... everyone helps.
Sensors installed in home of adult children
Devices are invisible

Install in just a few hours
Wearable devices for all in the family are also available.
System models overall activity

<table>
<thead>
<tr>
<th>Thursday, 3/27/2003</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kitchen Freezer</td>
</tr>
<tr>
<td>Kitchen Refrigerator</td>
</tr>
<tr>
<td>Kitchen Cabinet</td>
</tr>
<tr>
<td>Kitchen Cabinet</td>
</tr>
<tr>
<td>Kitchen Drawer</td>
</tr>
<tr>
<td>Kitchen Cabinet</td>
</tr>
<tr>
<td>Kitchen Cabinet</td>
</tr>
<tr>
<td>Kitchen Cabinet</td>
</tr>
<tr>
<td>Kitchen Dishwasher</td>
</tr>
</tbody>
</table>

1.1 hour

Software detects “important” (3-ring) changes
“Something’s changed ... you might give her a call”
System lifestyle benefits

Conversations don’t always start with…

“Are you still getting exercise?”

Not stigmatizing

Both households use system
Infrastructure enables other applications

Fun
Communication

New proactive applications for keeping people:

1. Active
2. Mindful
3. Empowered
Technology development is the “easy part.”

Big Question: How can we develop effective strategies that people will accept into their lives.

Needed: A shared research facility to study people and their use of technology in natural environments.
Testing of Infrastructure
“Plug and Play” Architecture
Digital Infrastructure
Fine grained sensing of people, objects, and activity
Ubiquitous displays

Testing with People
Proactive Health.
Interface (Single Mental Model)
Models of Behavior
Technology in Context
Just-In-Time Information
Not a prototype
Not a demonstration
The PlaceLab is a “microscope” to study people and their relationship to:
new technologies
and
new approaches to design
in natural settings . . .
with occupants going about their real life activities
Location

The PlaceLab is at 369 Franklin Street in Cambridgeport, Cambridge (between Harvard and MIT)
A lower floor unit of full-service condominium building, now under construction.

The apartment can be entered both from the lobby and from the side yard.
MIT Changing Places Consortium

PlaceLab Infrastructure:
Modular interior cabinetry with embedded technologies

removable panel: microcontroller, CO2 sensor, barometric pressure sensor, humidity sensor, smoke detector (not visible)

IR and visible light sensors, motion sensor

IR illuminator

IR transmitters (4) and microphones (2)

Switches to detect “open/close”

1-wire network connection and Ethernet connection

power connection
PlaceLab Infrastructure: Modular interior cabinetry with embedded technologies
PlaceLab Infrastructure:
Interior cabinetry with embedded technologies
PlaceLab

Agile facility to develop and test – in a natural environment – tools for:

- identity of people
- location of people
- what they are doing
- their physiological state
- their psychological state

and

- A suite of tools to test communication - in non-irritating and effective ways - at just the right time.
PlaceLab Infrastructure:
State of fixed things

Switch sensors in cabinets and appliances
PlaceLab Infrastructure:
State of movable things

Wireless sensors in movable furniture
MIT Changing Places Consortium

PlaceLab Infrastructure:
Location/identity of People

IR transmitters
PlaceLab Infrastructure:
Environmental conditions

Locations of temperature, humidity, CO, CO2, and smoke sensors
PlaceLab Infrastructure:
Optical sensors (IR and visible light)

IR and visible light sensors
PlaceLab Infrastructure:
Communicating with directed audio

Speakers and microphones
PlaceLab Infrastructure:
Communicating with ambient light, pixels

Addressable LED 24bit lighting
MIT Changing Places Consortium

PlaceLab Infrastructure:
Local sensor networks (also for communication with wearables)

Sensor networks located in prefabricated cabinetry
PlaceLab Infrastructure:
Pixels everywhere
(initially lab demo only)
PlaceLab Attributes

1) Common Infrastructure
Sensing, communication, and recording infrastructure used by all researchers.

2) Smart occupants (not smart homes).
Give people information and control rather than automate.

3) Context of Life
Evaluate technologies in natural settings (not lab).

4) Agile
Allow for change.

5) Shared Research Facility
Any sponsor or academic researcher may apply.
PlaceLab research possibilities (a few)

1) Techniques to encourage healthy behaviors

2) Viability and acceptance of wearable systems

3) Novel sensors and low-cost sensor networks

4) Activity recognition

5) Lighting and energy management

6) Privacy and trust

7) Learning at home

8) Indoor air quality
Submit proposal

Non-profit (research) or CP/OSBA members

Academic review (scientific merit)  Industrial review (societal impact)

Project directors (MIT+TIAx) (selection, scheduling)

PlaceLab study runs (overlapping studies when possible)
PlaceLab
A Shared Research Facility
Opening Fall 2003
Research Proposals Now Being Accepted

Kent Larson  kll@mit.edu