Smart/Aware Homes

Scenario

- Past: "You hear a strange noise in the night, you get out of bed, stumble to the wall switch, and turn on the light. It's just the cat." (Bruce Sterling, "The Sensitive House")
- Future: You hear a strange noise in the night, the "house" realizes that you are awake and assumes it is because of the noise. It quickly checks all security systems, doors, and windows, turns on the outside lights, while it analyzes the sound it recorded and where it was recorded. The "house" identifies the cat as the culprit and "informs" you (e.g., voice, shining a light on the cat, etc.)

Scenario

1. Power up Windows-for-House
2. Wait for system boot-up
3. Grasp mouse, click "Start"
4. Go to "Programs"
5. Select "House Lighting System"
6. Wait for application to load
7. Pull down menu for "Bedroom"
8. Click "Illuminate"
9. Get error message: "No bulb installed."
10. Click over to the automated "help" web site.
11. Light-bulb manufacturer incompatibility requires a patch.
12. Select nearest downloading site and begin download.
13. Receive banner ad for light-bulb e-tailer.
14. Receive pop-up screen demanding you upgrade your browser.
15. ...

When Smart Homes Go Bad

"Remove a quart of milk. There's a Chernobyl-like chain reaction. The fridge scans the bar code as the carton leaves. It e-mails the grocery dot-com and a delivery service. The broken coffee maker, misinterpreting a burst of e-mail, jumps into action with a vague burning stench."

- Bruce Sterling

What Are Smart Homes Good For?

- According to research by anthropologists watching people live, it is predicted that key areas for innovation will relate to:
  - Child care
  - Cooking
  - Group entertaining
  - Family coordination
  - Learning
  - Home management
- But also:
  - Personal Health
  - Home security
  - Entertainment
  - All boring stuff
- Houses are part of a bigger picture
  - Part of the local neighborhood and community
  - Part of the local environment

What Are Smart Homes Good For?

- Value proposition: safety for you and your family
- Safety from intruders already well-established
- Sensor-based systems enable new areas:
  - "Is the gas leaking?"
  - "What's in the water?"
  - "Is the oven off?"

What Are Smart Homes Good For?

- Value proposition: great fun
- Again, well-established market
  - Smart toys, home theaters, video games
- New twists:
  - How about make it easier to find neighbors and compete?
  - Games where you learn something "useful"?

What Are Smart Homes Good For?

- Value proposition: stay in touch, know your neighbors
- Carpooling
- Always on connection with close friends
- Wi-Fi NeighborNode
- "How much is our community recycling?"

What Are Smart Homes Good For?

- Value proposition: stay in better health
- Suite of mobile and fixed wireless devices
- "Great weather outside, how about walking today?"
- Intel Research Seattle – Group coordination
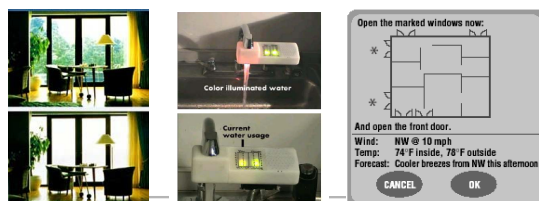- Smart toilets

What Are Smart Homes Good For?

- Value proposition: We'll warn you before it's too late
- "Are ants/termites/roaches invading?"
- "Are my sewer pipes okay?"
- "Your plants need water…"

What Are Smart Homes Good For?

- Value proposition: save energy and money
- Add "smarts" that also encourage sustainable behavior
  - "Are my windows leaking warm air in winter?"
  - "Did you know you can save water if…"
  - "Opening up the windows could increase sunlight."

Open the marked windows now:

And open the front door.
Wind: NW @ 10 mph
Temp: 74°F inside, 78°F outside
Forecast: Cooler breezes from NW this afternoon

CANCEL   OK

Research Issues with Smart Homes
Computer Security

- Problem:
  - Few people can make their home Wi-Fi networks secure
  - Security will only get worse as more devices and homes are wirelessly networked

- Some ideas:
  - Better user interfaces for configuration
  - Simpler and understandable security models
    - E.g., physically limited channels

- Prognostication:
  - Will remain very messy for a <u>long</u> time
  - Huge risks in accidentally sabotaging the market

Research Issues with Smart Homes
Unified Interaction Experience

- Problem:
  - #1 – "How do I get my home to…"
    - Some houses so complex, have to hire someone to set temperature
  - #2 – "Why did my house do that?"
    - Complexity, emergent behavior, e.g., temperature oscillates

- Some ideas:
  - Design patterns for the home, e.g., power cycle
  - Simplicity: tech-heavy features favored by engineers, again focus on key activities

Prognostication:
  - De facto standards (Microsoft, Sony, Krupps, etc,)
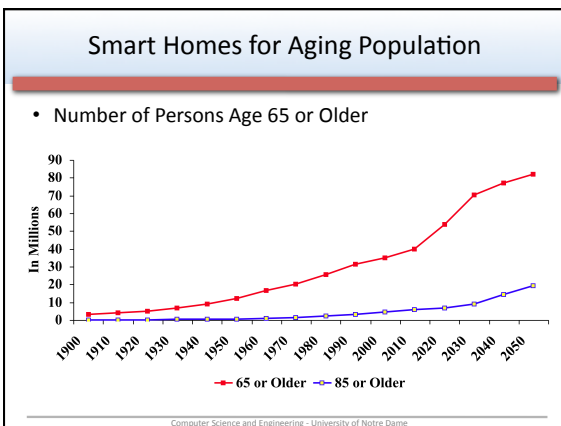 - Will remain ugly for a <u>long</u> time as contenders fight

Research Issues with Smart Homes
Deployability

- Problem:
  - How to move from research concept to real homes?
- Some ideas:
  - Incremental deployment, can add new toaster, just works
  - Managing power, can't replace hundreds of batteries a day
  - Maintenance, needs to just work
  - Marketing
    - People don't want to be green, they want to save money

Prognostication:
  - Insurance companies will advocate (e.g,. the Club or Lojack)
  - Bundled with entertainment (XBox) and media (Apple)

Smart Homes for Aging Population

- Number of Persons Age 65 or Older

Computer Science and Engineering - University of Notre Dame
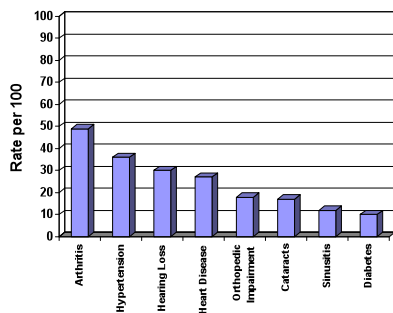
Independence Is Important

- A primary goal of many older individuals is to maintain an independent lifestyle in their own home (Willis, 1996)

- Aging successfully will be difficult in homes not designed to meet changing needs and without access to appropriate technologies (Coughlin, 1999)

- "Staying put is contingent on the livability of the dwelling unit" (Lawton, 1997, p. iii)
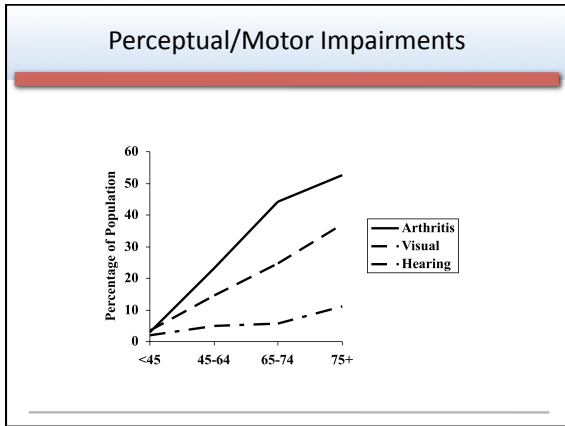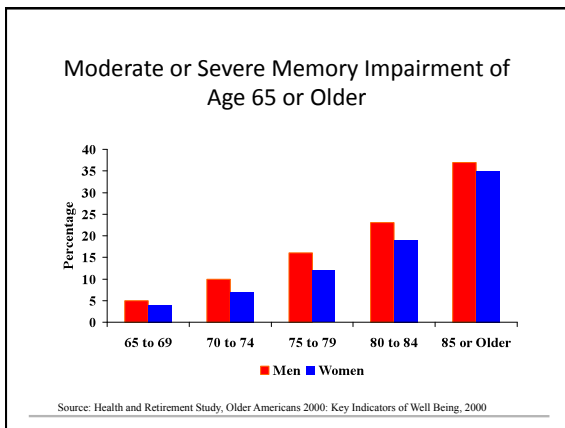
How To Fix/Build A Home?

- Need to understand: (1) perceptual, (2) cognitive, and (3) movement control capabilities and limitations

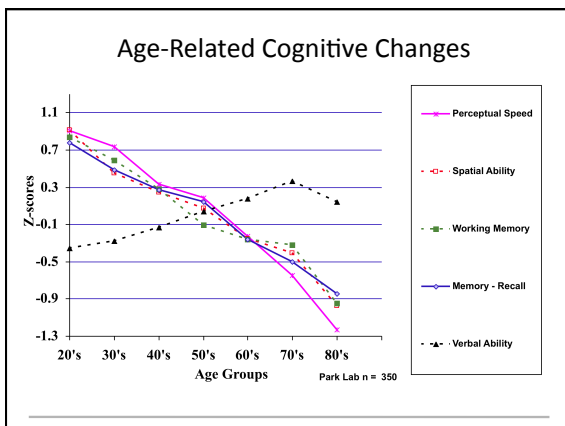### Chronic Conditions (adults over 65)

Perceptual/Motor Impairments

Moderate or Severe Memory Impairment of Age 65 or Older

Source: Health and Retirement Study, Older Americans 2000: Key Indicators of Well Being, 2000

Age-Related Cognitive Changes

How To Fix/Build A Home?

- What else do we need to understand?
  - Usability of products that could support functional independence

Things Are Easy To Use, Aren't They?

What about "simple" household products?

Product usage/usability survey:

Adults of all ages from 53 counties surrounding Atlanta

Usability questions concerning 73 common products

Are There Usability Problems?

	Health care Products	Over-the-counter Medications	Cleaners	Toiletries
All Ages	41%	56%	50%	42%
Young	39%	53%	49%	36%
Middle-aged	41%	57%	50%	44%
Young-old	40%	58%	50%	44%
Old	44%	50%	48%	43%

If Usage Problems, What Types?

	Young	Middle-aged	Young-old	Old
Text	27%	32%	30%	26%
Symbol	12%	22%	25%	23%
Perceptual	26%	57%	55%	51%
Memory	66%	51%	46%	48%
Motor	80%	80%	80%	94%

Human Factors Approach

- Understand the users
  - Person analysis
- Understand the products
  - "System" analysis
- Understand using the product
  - Task analysis