



# MAS 963 - Ambient Intelligence

---

Pattie Maes

# Ambient Intelligence: Vision

---

- Ambient Intelligence envisions a world where people are surrounded by intelligent and intuitive interfaces embedded in the everyday objects around them. These interfaces recognize and respond to the presence and behavior of an individual in a personalized and relevant way.
-

# Merging of different bodies of work

---

- Ubiquitous Computing
  - Intelligent Interfaces
  - Context-aware Computing
-

# Some Scenarios

---

- **Ambient semantics (H. Liu)**
    - “enriching your every day experience”
    - Book tells you about friends/famous people that read/loved it
    - Book tells you about particularly interesting passages
    - Touching 2 books makes their connections appear
  - **Objects with memory**
    - Readwear/writewear
    - Objects that can tell you their relevant stories
  - **Augmented physical environments**
    - Walking around town, system points out buildings/places of particular interest to a user (based on user’s interests)
    - Books on a bookshelf can “speak out” to you (or posters in infinite corridor)
-

# Vision (continued)

---

- **Ambient Intelligence Technology is:**
    - **Invisible:**
      - Use/functions are immediately apparent
    - **Ubiquitous:**
      - Available anywhere, integrated in physical environment & objects around us
    - **Intelligent:**
      - Relevant to user & context-aware
      - Unobtrusive
      - Providing meaning (vs. knowledge vs. information)
-

# Vision (continued)

---

- **Radically rethink the human-computer interactive experience:**
    - **Integrate digital world (information & services) and physical world (physical objects/environment)**
    - **Make interfaces more responsive and proactive (objects & environment monitor user and (proactively) present information & services relevant to user's current needs/interests)**
-

# Challenges

---

- Augment objects/environments with sensing, computing & networking capability
  - Sense & model the user's behavior (offline/online)
  - Infer the user's current interests/intentions
  - Design (proactive) interfaces that offer value without being obnoxious, while being highly relevant
  - Integrate these interfaces in user's physical environment in seamless, natural way:
    - On the body: cell phones, wearables
    - In the environment: architecture, ether, objects
-

# Goals for this Course

---

- Provide an overview of this new vision for HCI
  - Read and discuss the most relevant articles in related areas: Smart Environments, Smart Networked Objects, Augmented & Mixed Realities, Ubiquitous Computing, Pervasive Computing, Tangible Computing, Intelligent Interfaces and Wearable Computing.
  - Focus on understanding enabling technologies and studying applications and experiments. To a lesser extent address the socio-cultural impact.
  - Come up with new ideas, start innovative projects in this area
-

# How does this class differ from related Media Lab classes?

---

- **Hiroshi Ishii's "Tangible Interfaces"**
    - Giving physical form to digital information so that it becomes more easily manipulable and perceivable
  - **Joe Paradiso's "Sensor Technologies for Interactive Environments"**
    - Focus on sensor technologies (& performance/events)
  - **Ted Selker's "Context-Aware Computing"**
    - Focus on context-aware systems in general (desktop as well as ubiquitous systems)
-

# Requirements for the students

---

- **Students are required to participate extensively in literature research and discussions**
    - Read required readings ahead of class & prepare questions & interesting points for discussion
    - Review & present +- 3 papers in class (from 2/25 on, see **\*\*\***)
    - Write 1 short “scenario(s)” paper (by 3/10)
    - Suggest additional papers to read
    - Suggest experiments & technologies to look at
  - **Students are required to design and implement an original project in this area and describe their project in a 3-page paper as well as make a presentation to the class (5/12)**
  - **Limited to 18 graduate students based on their interests and backgrounds. Fill out an application by 2/5 at the latest. Notification of acceptance by 2/6.**
-

# Schedule

---

- Feb 4      Class #1      Introduction to Ambient Intelligence  
Pattie Maes
- Feb 11     Class #2      Tangible & Ambient Interfaces  
Invited Speaker Hiroshi Ishii
- Feb 18     Class #3      Interfaces with Common Sense  
Invited Speaker Henry Lieberman
- Feb 25     Class #4      Software Agents & Intelligence  
Augmentation  
Pattie Maes & students
- Mar 3      Class #5      Ubiquitous Computing  
Pattie Maes & students

---

Yellow means requirements for students

# Schedule (continued)

---

- **Mar 10**      **Class #6**      **The meaning of Things**  
**Invited Speaker Judith Donath**  
**1-2 PAGE PAPER DUE:**  
**SCENARIO(S) FOR AMBIENT**  
**INTELLIGENCE**
  
- **Mar 17**      **No Class**      **(TTT meeting)**
  
- **Mar 24**      **No Class**      **(Spring Vacation)**
  
- **Mar 31**      **Class #7**      **PROJECT PROPOSAL DUE**  
**Sensor Technologies**  
**Invited Speaker Joe Paradiso**
  
- **Apr 7**      **Class #8**      **Augmented Reality/Mixed Realities**  
**Pattie Maes & students**

# Schedule (continued)

---

- Apr 14      Class #9      Intelligent Environments  
Pattie Maes & students
  - Apr 21      Class #10      **PROJECT UPDATE DUE (1 page)**  
Embedded Intelligence/Smart Objects  
Pattie Maes & students
  - Apr 28      Class #11      Pervasive Computing & Wearables  
Pattie Maes & students
  - May 5      Class #12      Location Based & Context-Aware  
Systems  
Pattie Maes & students
  - May 12      Class #13      **PROJECT PRESENTATION &  
PAPER DUE**
-

# Reading List

---

- **Ambient Intelligence (2/4)**
    - **Ambient Intelligence, Fraunhofer Institute**  
[http://www.iuk.fhg.de/embedded\\_systems\\_eng.html](http://www.iuk.fhg.de/embedded_systems_eng.html)
    - **Ambient Intelligence in Home Lab, Philips Research**  
<http://www.research.philips.com/Assets/Downloadablefile/ambientintelligence-2456.pdf>
-

# Reading List

---

- **Tangible Interfaces (2/11):**
    - **Required reading: "Tangible Bits", Ishii H., CHI97**  
[http://tangible.media.mit.edu/papers/Tangible\\_Bits\\_CHI97/Tangible\\_Bits\\_CHI97.pdf](http://tangible.media.mit.edu/papers/Tangible_Bits_CHI97/Tangible_Bits_CHI97.pdf)
    - **other papers by Ishii et. al.**
  - **Ambient Interfaces (2/11):**
    - **Required reading: "Ambient Interfaces: Design Challenges and Recommendations", Fraunhofer Institute**  
[http://www.uni-weimar.de/~gross/publ/hcii03\\_gross\\_amb\\_int.pdf](http://www.uni-weimar.de/~gross/publ/hcii03_gross_amb_int.pdf)
    - **papers by H. Ishii**
-

# Reading List (continued)

---

- **Intelligent Interfaces & Common Sense (2/18)**
    - **Required reading: Beating some Common Sense into Interactive Applications, Lieberman et. Al.**  
<http://web.media.mit.edu/~lieber/Lieberary/Common-Sense/Common-Sense-Intro.html>
    - **Selected readings on Interfaces with Common Sense (Lieberman)**
    - **Selected readings from IUI Proceedings**
-

# Reading List (continued)

---

## ■ Software Agents and Intelligence Augmentation (2/25):

- **Required reading: Intelligent Software, Maes**  
<http://web.media.mit.edu/~pattie/SciAm-95.html>
  - **Required reading: The Wearable Remembrance Agent: A system for augmented memory, Rhodes (required reading)**  
<http://xenia.media.mit.edu/~rhodes/Papers/wear-ra.html>
  - **Douglas C. Engelbart, "Augmenting Human Intellect" \*\*\***
  - **Andy Clark, *Natural-Born Cyborgs: Minds, Technologies, and the Future of Human Intelligence* \*\*\***
  - **MIT Media-Lab Software Agents work**
-

# Reading List (continued)

---

## ■ Ubiquitous Computing (3/3):

### ■ **Required reading: papers by M. Weiser**

[http://www.ubiq.com/hypertext/weiser/UIST94\\_4up.ps](http://www.ubiq.com/hypertext/weiser/UIST94_4up.ps)

<http://www.ubiq.com/hypertext/weiser/ACMInteractions2.html>

<http://www.ubiq.com/hypertext/weiser/UbiCompHotTopics.html>

### ■ "Open House", Weiser M., 1996 \*\*\*

### ■ "Designing Calm Technology", M. Weiser and J. Seely Brown <http://www.ubiq.com/hypertext/weiser/acmfuture2endnote.htm> \*\*\*

### ■ "The Human Experience", Abowd, IEEE Pervasive Computing \*\*\*

### ■ "Slow Technology", Hallnas & Redstrom, <http://civ.idc.cs.chalmers.se/projects/slowtech/papers/slowtech.pdf> \*\*\*

### ■ "Ambient Agoras" project, [www.AmbientAgoras.org](http://www.AmbientAgoras.org), Fraunhofer Institute \*\*\*

### ■ Selected papers from proceedings of Ubicomp 2001, 2002, 2003 \*\*\*

# Reading List (continued)

---

- **The Meaning of Things (3/10):**
    - **Required reading to be announced**
    - "The meaning of Things", Csikszentmihalyi
    - "The Cultural Biography of Things", I. Kopytov
    - "Culture and Consumption", "Mc Gracken, G
    - "The Social Life of Things" Apadurai, A.
-

# Reading List (continued)

---

- **Sensor Technologies (3/31)**
    - **Required reading to be announced**
    - **Sensor systems for Interactive Surfaces, Paradiso**  
<http://www.research.ibm.com/journal/sj/393/part3/paradiso.html>
-

# Reading List (continued)

---

- **Augmented Reality/Mixed Realities (4/7):**
    - **Required Reading: Augmented Reality: A New Way of Seeing, Steven K. Feiner, 2002**
    - **Introduction to Augmented Reality by J. Vallino**
    - **Presence Journal special issue on AR, 1997 \*\*\***
    - **CACM Special issue on AR, 1993, Vol 36, #7 \*\*\***
    - **Animated & Electronic Paper Experiments (e.g. Wellner) \*\*\***
-

# Reading List (continued)

---

## ■ Intelligent Environments (4/14):

### ■ Concept Homes

<http://www.research.philips.com/Assets/Downloadablefile/ambientintelligence-2456.pdf> \*\*\*

### ■ Selected papers from “Intelligent Environments”, P. Froege (ed) \*\*\*

### ■ Papers on Georgia Tech “Aware Home”

<http://www.cc.gatech.edu/fce/ahri/projects/index.html> \*\*\*

### ■ Papers on MIT Media Lab Smart Room experiments

<http://vismod.www.media.mit.edu/vismod/demos/smartroom/> \*\*\*

### ■ Papers of MIT AI-lab Smart Room experiments

<http://oxygen.lcs.mit.edu/> and <http://www.ai.mit.edu/projects/aire/> \*\*\*

### ■ Papers on Stanford iRoom <http://iwork.stanford.edu> \*\*\*

---

# Reading List (continued)

---

- **Embedded Intelligence/Smart Objects (4/21):**
    - Tutorial on RFID technology \*\*\*
    - Objects with embedded sensors, computation, & networking
    - Sensor & Actuator Networks, Special Issue of IEEE Pervasive Computing, Oct 2003 \*\*\*
    - Mobility, Service Discovery, Auto Configuration and Ad-Hoc Networking \*\*\*
    - Disappearing Hardware, R. Want et. Al. IEEE Pervasive Computing \*\*\*
-

# Reading List (continued)

---

- **Pervasive Computing and Wearables (4/28):**
    - Pervasive Computing Handbook, U. Hansmann
    - Me++, W. Mitchell \*\*\*
    - Papers from IEEE pervasive computing journal \*\*\*
    - Wearable Computing Papers, MIT, CMU, UNC, Sony CSL \*\*\*
    - Proceedings of the wearables conferences \*\*\*
-

# Reading List (continued)

---

- **Location-based & Context-aware systems (5/5):**
    - Special issue on Context-Aware Computing, IEEE Pervasive Computing, 2002 \*\*\*
    - Context-based city & museum tour guides (Abowd, Cheverst, Reinhard, Petrelli) \*\*\*
    - “Ubiquitous Systems in Interactive Museums” , Fleck et. Al. IEEE Pervasive Computing \*\*\*
    - Reminder systems (Rhodes, Pentland & Devaul, Lamming...) \*\*\*
    - “Virtual Graffiti” systems (Geonotes, HangingMessages, Ether Threads) \*\*\*
-

# Some of my work in this area

---

- **Software Agents Group (till 2001):**
    - Remembrance agent
    - Periscope
    - Impulse
    - Hanging Messages
  - **Interactive Experience Group (ongoing, since 2003):**
    - What would they think?
    - Ether Threads
    - Ambient Semantics
    - Automated annotation of photographs
-

# Remembrance agent (on Wearable)

— Bradley Rhodes (2001)

---

Context-  
specific  
reminders of  
previous notes  
taken  
(based on  
location, day,  
time of day,  
other people  
present,  
conversation  
topics, ...)

---

# Periscope: A virtual Browser for the Real World – Jim Youll (2001)

---

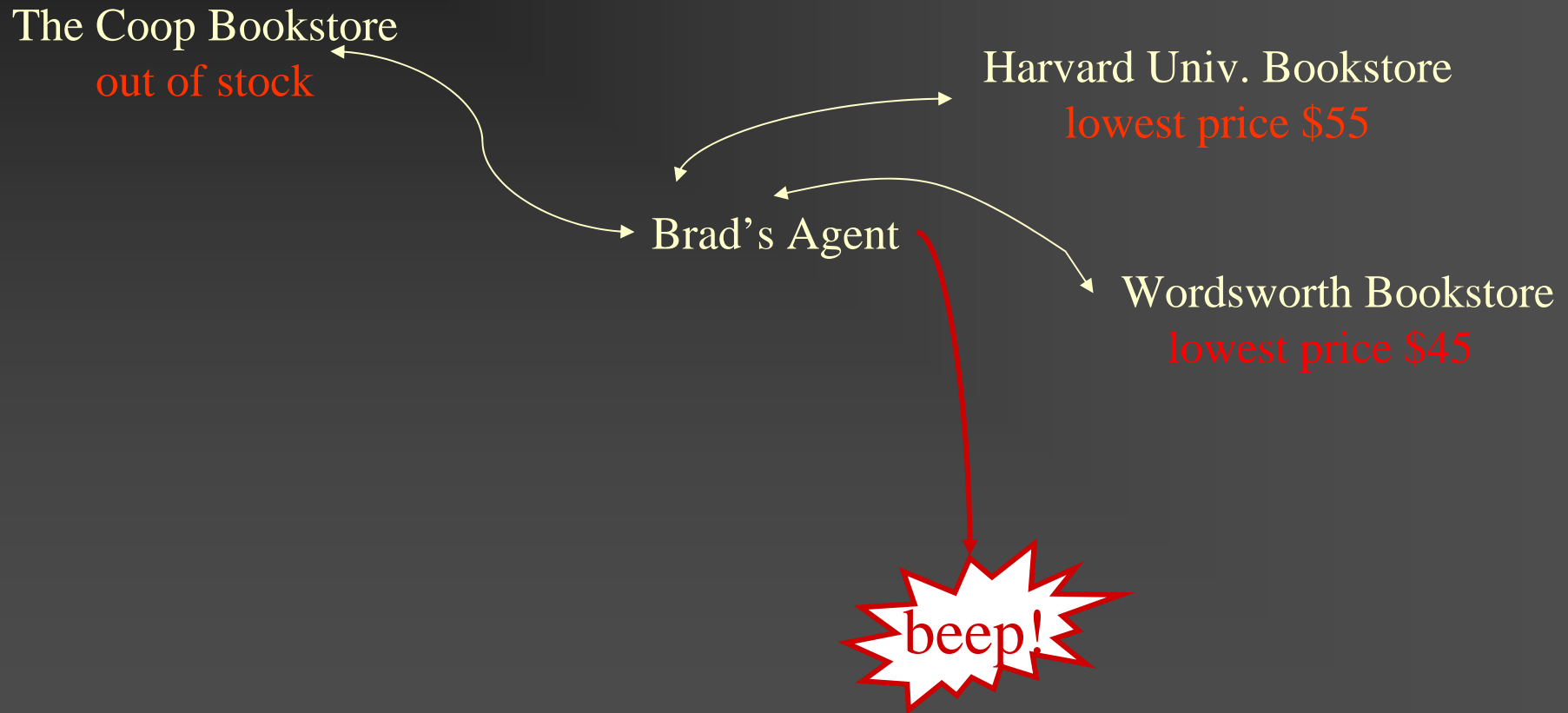
Camera with compass and range finder shows webpages about the location the user is focused on.

(currently being implemented on mobile phone with GPS & possibly compass by Dan Relihan)

---

# Impulse: Information Exchange with Entities in the Physical Vicinity - Joan Morris & Jim Youll (2000)

---



# Ether Threads

- Brad Lasseby (2003)

---

- Infrastructure for annotating the physical world (leaving location-specific messages)
- Threads and filtering mechanisms
- Can be used as personal or collective “distributed memory”

Blue-tooth and GPS data trigger location-based messages relevant to the user & thread s/he is interested in

---

# Automated Annotation of Photographs (Relihan, 2004)

---

Phone Camera communicates with GPS device via bluetooth to record location of picture taken. Phone interfaces to [www.metacarta.com](http://www.metacarta.com) to find urls about that location. Extracts and offers keywords for the picture taken (to be edited by the user).

---

# Ambient semantics (Liu & Maes, 2004)

---

- User wears RFID reader on wrist (watch/bracelet)
  - Every object that user picks up gets read (without requiring user's attention)
  - “meaningful” knowledge is presented on nearby display (eg cell phone) (based on last object read, history of objects read, personal profile of user)
-

# Impact

---

- **Always-present, pro-active, highly responsive interfaces make people more efficient, better informed. Examples:**
    - **Better memory (environment/objects around us “remember” and recall information)**
    - **More effective learning (just-in-time information is presented when user is most motivated to learn)**
  - **Traditional computer interface disappears (replaced by augmented bodies & augmented environments)**
-

# To Do's Next Two Weeks

---

- **By tomorrow: return class form**
  - **By next week (2/11):**
    - **Read Ishii and Fraunhofer paper and prepare questions**
    - **Decide which topic(s)/papers you want to research & present & email selection to Pattie**
  - **By 2/18: Read “Beating some Common Sense...” by Lieberman & Co and prepare questions**
-