

1b – Vision and Research Questions of Ubiquitous Computing

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Overview

UbiComp (Ubiquitous Computing)

- Seminal visions of UbiComp
- Historical overview of development of UbiComp
- Research questions asked in UbiComp



Designing Interactive Systems (DIS)

Learning Goals

After this lecture you should be able to

- Understand and explain what is ubiquitous computing (UbiComp)
- Understand and explain what kinds of research questions asked in the field UbiComp
- Understand and explain what is the field “designing interactive systems” (DIS)
- Understand and explain what research questions DIS asks
- Understand the relationship between UbiComp and DIS
- Discuss to what degree, in what respect, the original visions of UbiComp have been realised or not

WHAT IS UBIQUITOUS COMPUTING?

Weiser 1991, Scenario: Sal's Day

- Coffee on Wake-Up
- Digital traces of neighbours' coming and going
- Awareness of others in the house (who is awake?)
- Finding a lost manual

- Most profound technologies are those that disappear

The most profound technologies are those that disappear

Weiser, 1991: Computers everywhere

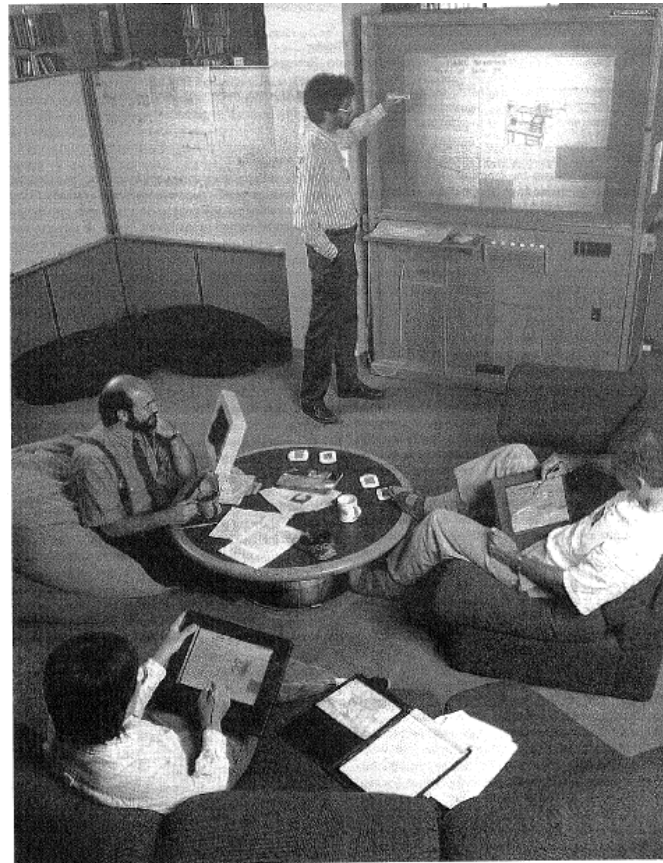


Figure 1: **UBIQUITOUS COMPUTING** begins to emerge in the form of live boards that replace chalkboards as well as in other devices at the Xerox Palo Alto Research Center. Computer scientists gather around a live board for discussion. Building boards and integrating them with other tools has helped researchers understand better the eventual shape of ubiquitous computing. In conjunction with active badges, live boards can customize the information they display.

Weiser, 1991: Location and Scale

Location: Computers should know: Where am I?

- Scenario: Active Badges keep track of their owner

Scale: Displays will come in different sizes: Post-It Notes, Paper Sheets, Whiteboard-Sized

- Scenario: Transfer computer window to badge, “animate” inanimate objects, e.g., books, in order to locate them
- Scenario: Spread “pads” (paper sheet-sized) across a huge physical space (real desk, office, wherever...)
- Scenario: Boards can be used for remote collaboration

Weiser, 1991: Challenges

Hardware

- Low-power computers
- Display technology (large! flexible! cheap! energy-efficient!)
- Data storage (a lot! energy-efficient! small physically!)

Network

- Network infrastructure (low-power! high bandwidth! different ranges!)
- Networking software/usage (transparent to the user!)

Software

- Operating systems (configurable at runtime! adaptable to significantly different devices! distributed over multiple devices!)

Roger 2006: Moving on from Weiser's Vision of Calm Computing: Engaging UbiComp Experiences

Understanding people (their intentions, goals, rationale...) is a very hard challenge

Is it desirable that proactive intelligent computers take over our day-to-day decisions and plannings?

- Privacy? (also in assisted living solutions for elderly, handicapped, ... persons!)
- Who takes responsibility?
- Will our own intelligence suffer?

Rogers, 2006: Engaging Users

“From proactive computers to proactive users”:
Computers need not disappear; they should engage users

Examples:

- Playful learning technology – PicoCricket (Lego MindStorm)
- Collaborative visual interaction with scientific data in environmental sciences
- Persuasive technology – Pocket Pikachu with pedometer to motivate kids to walk regularly

Ubiquitous Computing is...

Computers in abundance: in many places and at many times

Many computers instead of a single one!

Computers are

- interconnected
- aware of their location, of users (monitoring, tracking), of each other, of environment (ambient intelligence)
- Intelligent (artificial intelligence)

A continuation of computer technology : from mainframe, to personal, to ubiquitous computers...

UBICOMP RESEARCH QUESTIONS

Ubiquitous Computing as Research Field is hugely heterogeneous

Hardware and software research

From human factors, to network protocols, to machine learning....

Systems: How to build software for ubicomp systems?

Experiencing UbiComp: How do humans experience existing / prototyped ubicomp systems? How could/should humans experience ubicomp systems?

Sensors – making UbiComp systems adaptive:

Sensor technologies, data analytics incl. statistical and machine learning methods, adaptive systems.

Systems View Research Questions

How to **design hardware, communication protocols, operating systems** for UbiComp?

- How to do computing in resource-constrained, volatile (nearby devices come and go) and heterogeneous (every device may be different) environments?
- How to organise communications between computers (networks of things, self-configurable networks, in different ranges...)
- How to preserve privacy of users, and secure systems (confidentiality of data, authenticity, integrity?)
- How to move information and computation, transparent to the user, across devices? (distributed systems)

Experiences/HCI View Research Questions

How to **design and evaluate ubiquitous systems** (highly dependent on context)?

How to **interact with information via different surfaces, devices and tools?**

- How to make interaction / representation persuasive?
- How to make the many available data recordings intelligible, useful, and usable?
- Also: How to design devices with a dedicated functionality?

How to **create value for users from context-awareness?**

How to let **non-computer scientists assemble UbiComp systems** (combinations of sensors, interface and computational devices)?

Sensors' View Research Questions

What to sense? (human-computer interaction, cognitive psychology)

How to sense? (radio technology, measurement engineering, signal processing...)

What information to infer from sensor data? (artificial intelligence, data analytics)

How to represent information? (knowledge representation, artificial intelligence)

How to use such information to **augment activities of system users?** (artificial intelligence, human-computer interaction, cognitive psychology)

DESIGNING INTERACTIVE SYSTEMS

Designing Interactive Systems

Designing in the sense of conceptualising, prototyping, implementing and evaluating (iterative!)

- Functionality of an interactive system
- Interaction paradigms to be used (what kinds of input, output modalities?)
 - Visual design in case visual input/output modalities are used as subfield
- Focus on designing the interaction pattern
 - Interaction between human(s) and computers
 - Computer-mediated interaction between humans

READING MATERIAL

Reading Material

Krumm, Ubiquitous Computing Fundamentals – Ch. 1

Weiser, 1991: Computer of the 21st Century

Rogers, 2006: Moving on from Weiser's Vision of Calm
Computing: Engaging UbiComp Experiences