Interaction Design for Future Smart Environments
Dr. Dr. Norbert A. Streitz

Overview
- AMBIENTE – Smart Environments of the Future
- Cooperative Buildings and Roomware®
- EU-Initiative „The Disappearing Computer“ (DC)
  - Overview over DC-projects
- The DC-Project „Ambient Agoras“
  - Augmenting the Social Architectural Space
  - Smart Artefacts
  - Ambient Displays and Mobile Devices
  - Connecting Remote Sites and Personal Aura
- European Disappearing Computer Privacy Guidelines

Approach of the AMBIENTE division
Interdisciplinary Team
- Computer Science
- Electrical Engineering
- Psychology
- Design
- Architecture
- Sociology

Examples of AMBIENTE-Projects
Future Office Dynamics (since 1999)
- R & D consortium with industrial partners
- 2nd generation of Roomware and software
- Pilot installations

Ambient Agoras: Dynamic Information Clouds in a Hybrid World

InterSpace: Novel Group Interaction with Heterogeneous Displays and Devices (Microsoft Research USA, 2002-2003)

InterSmArt: part of the cluster "Living in a Smart Environment - Implications of Ubiquitous Computing" (Daimler-Benz, 2002-2005)

and more recent projects
AMIGO
- Ambient Intelligence for the Networked Home Environment
  - Three Application Domains
    - Home Care and Safety
    - Home Information and Entertainment
    - Extended Home Environments
- Interactive Hybrid Games (table-top games, board games, ...)

Preface - 1
- Workshops on RFID: Information Sharing, Privacy, New Paradigm
- A new paradigm for Information Sharing and Privacy: RFID and other technologies
RFID is one very important and prominent example ... but the issues are more general and apply to all kinds of sensor-based / enriched / "polluted" environments
Preface - 2

Human Technology

Human
Interface Services, Functionality Middleware, Infrastructure Sensors, S-Networks

Preface - 3

Inferencing Decision making Aggregation Communication Distribution Action

Processing Aggregation Communication Distribution Infrastructure

Human Sensors looking at the world

Technology Sensors looking at the world

Looking view of the world

Tricky Trade-offs

There is an interaction and balance/trade-off between being able to provide support for people based on collecting and using sensor data and using them for deciding, selecting and tailoring system functionality and the right of people to be in control over which data are collected and by whom and how they are used.

People are willing to comprise their data for certain benefits (example of payback cards, ...)

Issue/Question:
How can people know about being monitored when they are not aware of it, when they don’t “see” the computer, the sensors, ...

Why does/should the computer disappear?

- Information technology changed the processes and contents for the creation and processing of information in a dramatic way.
- Turning away from the real environment to computer screens as the “interface” to information => Human-Computer-Interaction

But: is Human-Computer-Interaction the goal?
- isn’t it Human-Information-Interaction and
- Human-Human-Interaction and Cooperation?

Shouldn’t the computer “disappear” as a device?

The Computer Disappears ...

Everyday objects (household, leisure, work, ...) with integrated processors and sensors => Smart Artefacts
Disappearance of the Computer

Computers used to be “primary artefacts”, now they become “secondary” artefacts, e.g., in terms of compound artefacts and move into the “background” in several ways

- Physical Disappearance
- Mental Disappearance

Disappearance and Interaction

- How can people interact with “invisible” devices?
- How do people migrate from explicit interfaces/interactions to implicit interfaces interaction?
- How can we design for transparency and make people “understand” the interface?
- How can we design for a coherent experience?
- What should happen in case of errors or malfunctioning which are not explicitly perceived?
- How can we design for user’s control and address the resulting privacy issues in sensor-enriched (or “polluted”) environments?

The example of Cooperative Buildings

Cooperative Buildings

- are serving the purpose of cooperation and communication by providing facilities and appropriate computer-supported functionality
- and at the same time
- they are “cooperative” towards their inhabitants, visitors, users, ...
- via attentive, active, adaptive environments based on wide range and multitude of sensors

=> Smart Environments

Roomware®

Roomware components result from

- integration of room elements with information and communication technology

Roomware components are

- interactive and networked
- mobile (some) with independent power supply and wireless networks
- provided with sensing technology

Roomware components are the constituents of Cooperative Buildings

i-LAND - an interactive landscape for creativity and innovation

Vision Scribble of i-LAND (1997)

2nd Generation of Roomware® (1999)

DynaWall® CommChair® InteracTable® ConnecTable® Passage
Software for Roomware®

- BEACH: cooperative hypermedia system providing gesture-based, modeless interaction
- MagNets: card-based creativity tool (Metaplan)
- PalmBeach: mobile work “on the road” integrated with team work in the building
- Sounds@Work: audio-based awareness for groups
- Passage: ephemeral binding between virtual and physical objects

Passage: Passenger and Bridge at DynaWall

Simple, intuitive, gesture-based assignment of real physical objects to virtual objects (sensing initially based on a non-RFID approach)

Passage at the InteracTable®

Transporting virtual objects: Retrieval via physical objects
InteracTable: accommodating different view perspectives

ConnecTable®

Connecting and sharing workspaces in the virtual world by simply moving smart artefacts in the real world based on integrated sensing technology

The Disappearing Computer - Initiative

5th Framework Programme of the European Commission
Information Society Technology (IST)
Future and Emerging Technology (FET)

Goal of “The Disappearing Computer”

To explore how everyday life can be supported and enhanced through the use of collections of interacting artefacts.
Together, these artefacts will form new people-friendly environments in which the “computer-as-we-know-it” has no role.
Specific Objectives of the DC-initiative

- Developing new tools and methods for the embedding of computation in everyday objects so as to create artefacts.
- Research on how new functionality and new use can emerge from collections of interacting artefacts.
- Ensuring that people's experience of these environments is both coherent and engaging in space and time.

Privacy became an important aspect in several projects.

Overview

- 17 projects accepted for funding
- 55 institutions from academia and industry, 21 universities, 16 research institutes, 18 companies in 15 countries
- Start: 1.1.2001, duration: 2.5-3 years; end: 31.12.2003
- Total EU funding: 23 million € => total effort ~ 40 million €

Steering group of the DC-Network

Chair: Norbert Streitz (Fraunhofer-IPSI, Germany)

DC website: http://www.disappearing-computer.net

DC-Projects: Overview

- 2WEAR: A Runtime for Adaptive and Extensible Wireless Wearables
- ACCORD: Administering Co-Operation Residential Domains
- AMBIENT AGORAS: Dynamic Information Clouds in a Hybrid World
- ATJUGER: Architecture and Technologies for Inspirational Learning Environments
- e-GADGETS: Extrovert Gadgets
- FEEL: Non-intrusive Services to Support Focused, Efficient and Enjoyable Local Activities
- GLOBA: Global Smart Spaces
- GROKHER: Grocery Store Commerce Electronic Resource
- INTERLIVING: Designing Interpersonal Interoperable Services for Living Together
- MARK: Multiple Intimate Media Environments
- MIME: Multiple Intimate Media Environments
- ORESTEIA: Modular Hybrid Artefacts with Adaptive Functionality
- PAPER++: SMART-ITS: Interconnected Embedded Technology for Smart Artefacts with Collective Awareness
- SHAPES: Situating Hybrid Assemblies in Public Environments
- SOB: The sounding object
- WORKSPACE: Distributed Work Support through Component-based Spatial Computing Environments

Ambient Agoras: Goals

- to transform places into social marketplaces of ideas and information ("agoras")
- to add layers of situated services and place-relevant information
- to provide a spirit of the place ("genius loci")
- to exploit the paradox of ubiquity vs. place-dependency
- to provide the environment with memory accessible to the user
- to support collaboration, social awareness, and to enhance quality of life in the working environment
- to address privacy issues in sensor-based environments

Ambient Agoras: Dynamic Information Clouds in a Hybrid World

- Fraunhofer-IPSI (Darmstadt, D) (coordinating partner)
- Electricité de France (EDF) (Paris, F)
- Laboratory for the Design of Cognition (LDC)
- DALT (design consulting firm, Brussels)
- Wilkhahn (Bad Münster, D)
- POD business unit and production unit
- Wiege design


Website: www.ambient-agoras.org

Augmenting the Social Architectural Space

- Going beyond the PC-based workplace and traditional productivity tools
- Acknowledging the role of informal communication and social awareness for creativity and innovation in organisations
- Increase of temporary project teams and nomadic workers with irregular presence in the office building
- Interruptions and loss of continuity in social relationships and deficit in social cohesion
- Need for transparency of relationships and light-weight means for communication
Ambient Agoras: Lounge Area

Accessing the InfoRiver at the InforMall

Ambient Displays (Hello.Wall) combined with Mobile Devices (ViewPort)

From Bits-of-Life to Prototypes

Overview over Artefact Versions - 1

Overview over Artefact Versions - 2
InfoRiver at the InforMall

Hello.Wall – Ambient Display

ViewPort: model (left) and prototype (right)

Communication using Ambient Displays

"Connecting Remote Sites" Scenario

Hello.Wall in Lounge Area
Privacy via the “Personal Aura”

Goals
- design of an easy and intuitive interface which puts users in control of their “sensed” appearance within a smart environment
- avoidance of privacy infringements

Modeled according to “Real Life” Behavior
- every person takes up different social roles, depending on the present situation and current social environment
- example: an individual can take up the roles of a family father, project manager, supermarket customer, and member of a sports club during his daily routine

Personal Aura: Prototype
- two matching parts:
  - ID stick (contains a unique identity and optional personal information)
  - reader module (“broadcasts” different identities)
- each person has multiple ID sticks symbolizing different roles
- if people want to signal their current social role they do so by simply connecting a specific ID stick to the reader module or they stay “invisible”

European Disappearing Computer Privacy Design Guidelines
- Think before doing
- Revisit classical solutions
- Openness
- Privacy razor
- Third party guarantee
- Make risky operations expensive
- Avoid surprise
- Consider time
- Good privacy is not good enough
Summary

- Tradeoff between functionality and privacy concerns
- The Disappearing Computer
- Cooperative Buildings and Roomware®
  - New forms of interaction based on sensor technology
- EU-funded Disappearing Computer Initiative and its Projects
- DC-Project “Ambient Agoras”:
  - Support for Informal Communication and Social Awareness
  - Personal and Ambient Displays
  - Patterns for communicating information, Informative Art
  - Connecting Remote Sites and Personal Aura
- European Disappearing Computer Privacy Design Guidelines

Acknowledgements

Funding from EU-initiative “The Disappearing Computer”

Shin’ichi Konomi
Carsten Magerkurth
Christian Müller-Tomfelde
Daniela Plewe
Thorsten Prante
Carsten Röcker
Richard Stenzel
Peter Tandler
Daniel van Alphen

... and many more from our partners in the different projects

More Information …

www.ipsi.fraunhofer.de/ambiente
www.roomware.de
www.disappearing-computer.net
www.ambient-agoras.org

contact: streitz@ipsi.fraunhofer.de