

# Instrumented Environments

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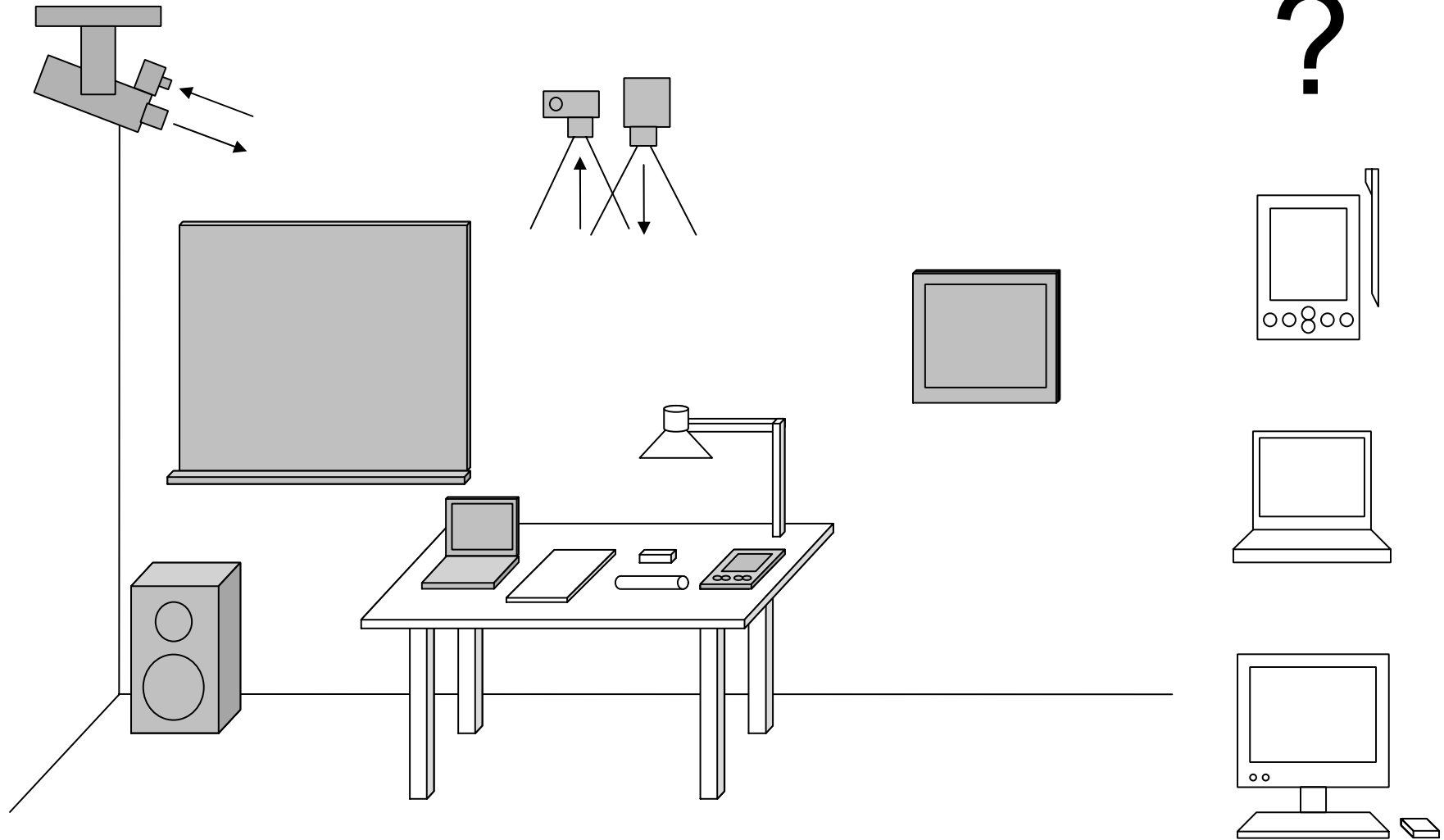
Mon, 10-12 Uhr, Theresienstr. 39, Room E 46



# Topics today

- What are (intelligent) instrumented environments?
- What disciplines do we need to look at?
  - Mobile computing
  - Ubiquitous computing
  - Wearable computing
  - Augmented reality
  - HCI
  - AI techniques, knowledge representation
- Two examples
- Formal things about this lecture

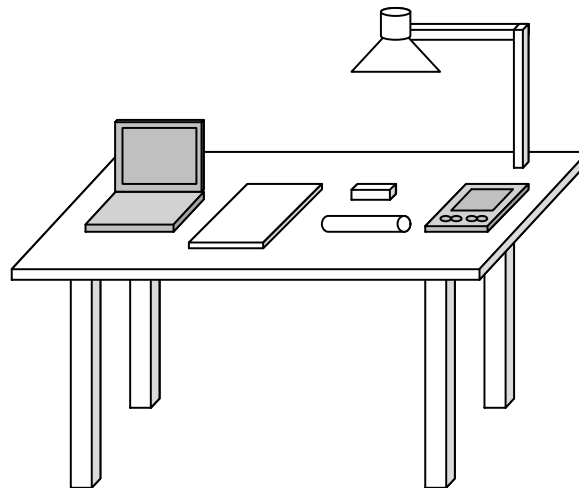
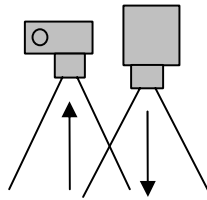
# Instrumented Environments



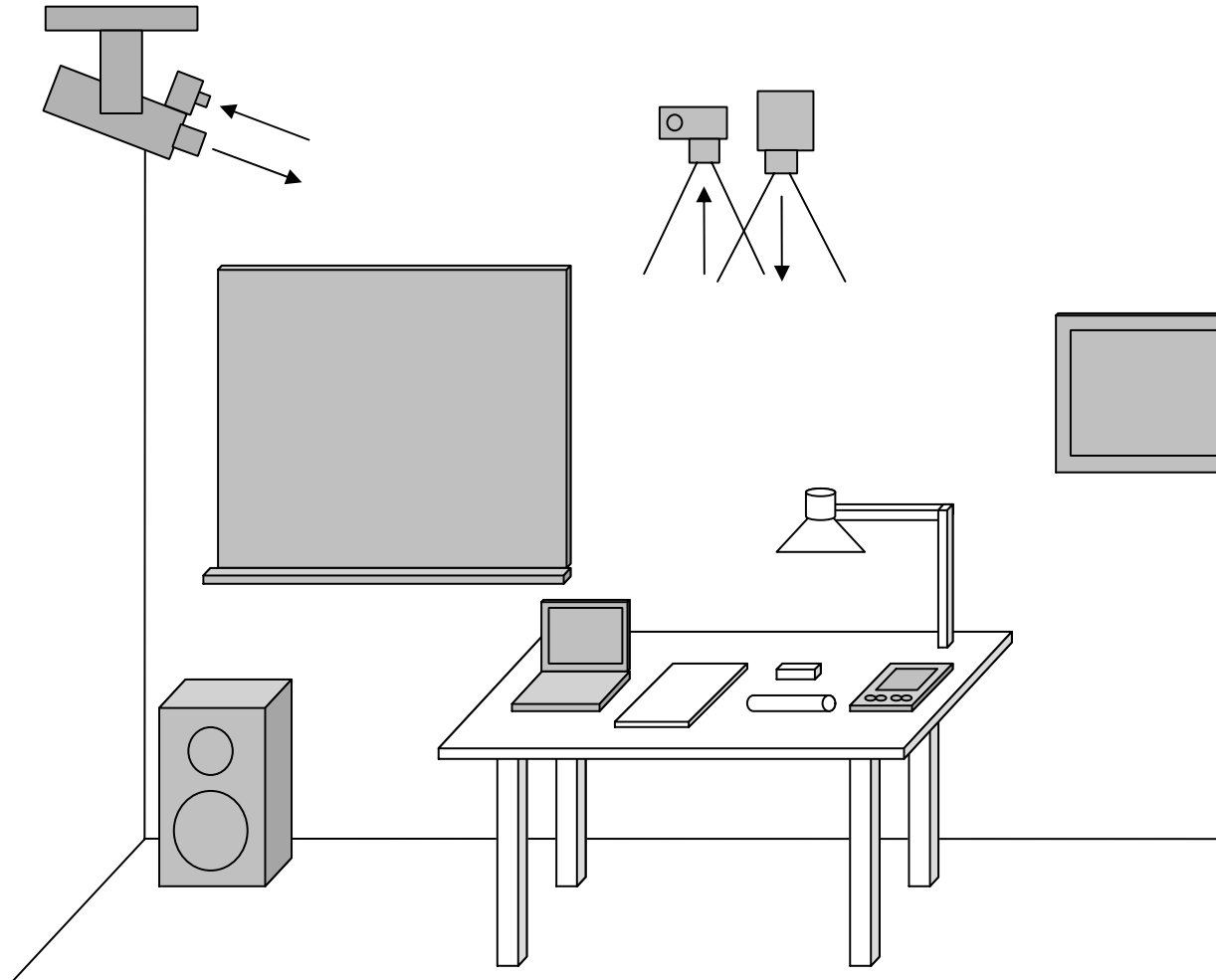
# Instrumented desk

Research Topics:

- Borders between phys. and virtual world
- Interaction objects
- Physical tools for virtual media



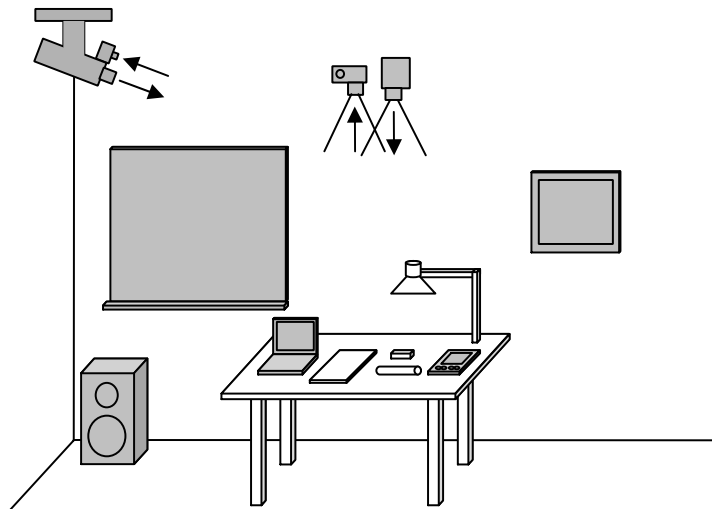
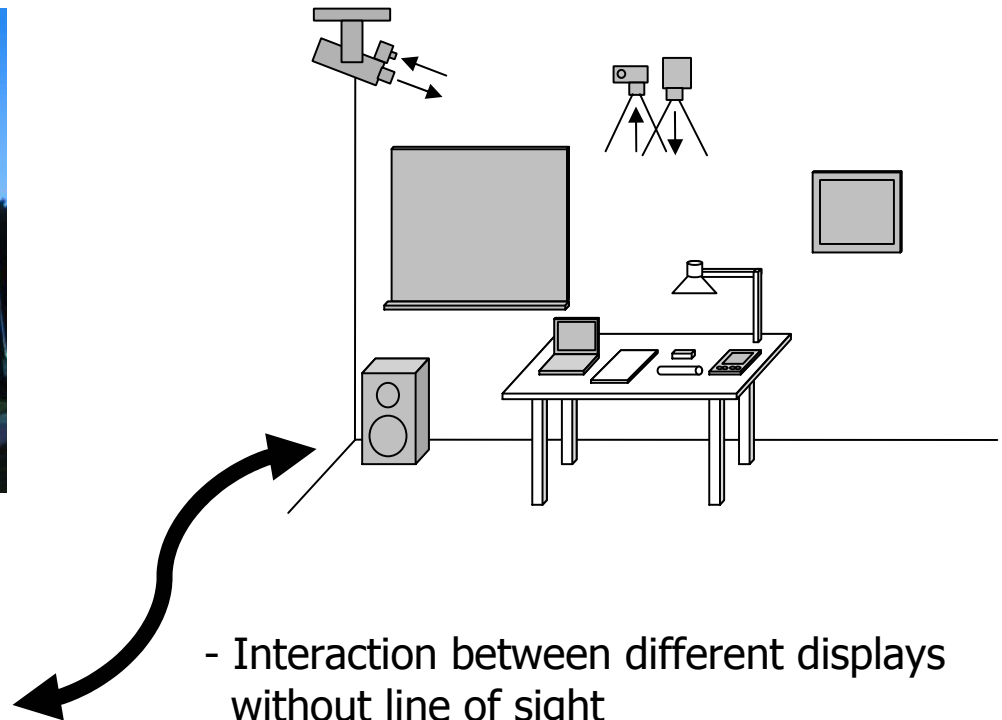
# Instrumented room



## Research Topics:

- Borders between phys. and virtual world
- Interaction objects
- Physical tools for virtual media
- Environment as display continuum (+ audio)
- Interaction with large displays
- Interaction with many different displays
- Ambient displays

# Instrumented building



- Interaction between different displays without line of sight
- place holder objects, transport metaphors
- interaction over distance

# Instrumented city



# Instrumentation of environments

- Sensors
  - Cameras
  - Microphones
  - Antennas
  - Light barriers
  - IR sensors
- Actuators
  - Mechanical, vibration
  - Force feedback
  - Lamps, gobos
  - ...
- Output/Displays
  - PC screens
  - Tablet PCs, PDAs
  - Wall size displays
  - Steerable projectors
  - Spatial audio
- Input devices
  - Keyboards, mice
  - Optical markers
  - Tangible interfaces
  - ...



# Instrumentation of users

- I/O Devices
  - Head-mounted displays
  - Retina displays
  - Data gloves
- Bio sensors
  - Heart rate sensors
  - Skin conductivity
  - EEG, EKG, EMG
  - Eye trackers
  - Acceleration sensors



# Sci-Fi version of Instr. Env.

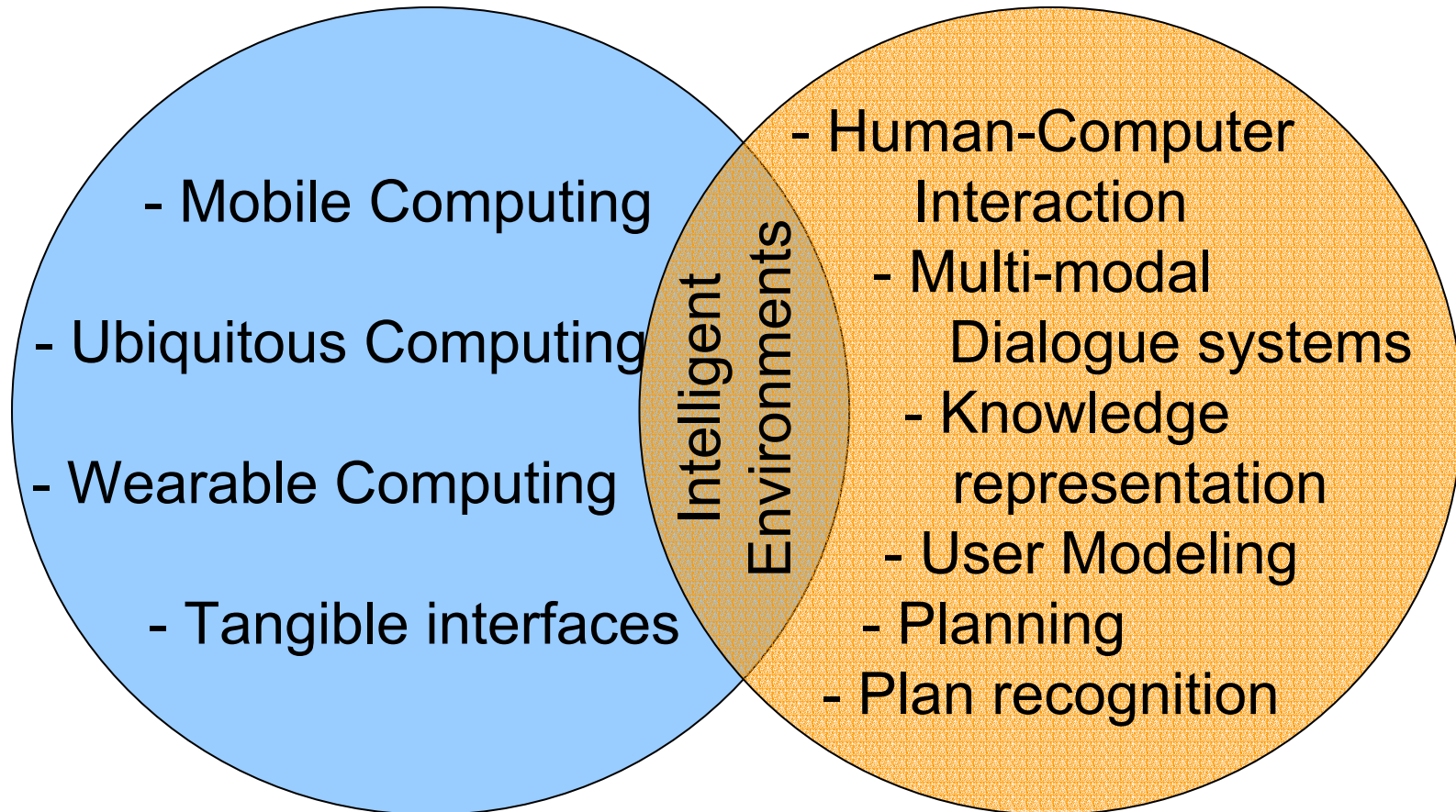


# Disciplines we need to look at

- Some aspects of:
  - Ubiquitous Computing
  - Wearable Computing
  - Mobile Computing
  - Augmented Reality
  
- ...but also bits and pieces from:
  - Human Computer Interaction
  - Multi-modal information presentation
  - Knowledge representation and reasoning
  - Context/User adaptivity

## Instrumented Environments

## Intelligent User Interfaces



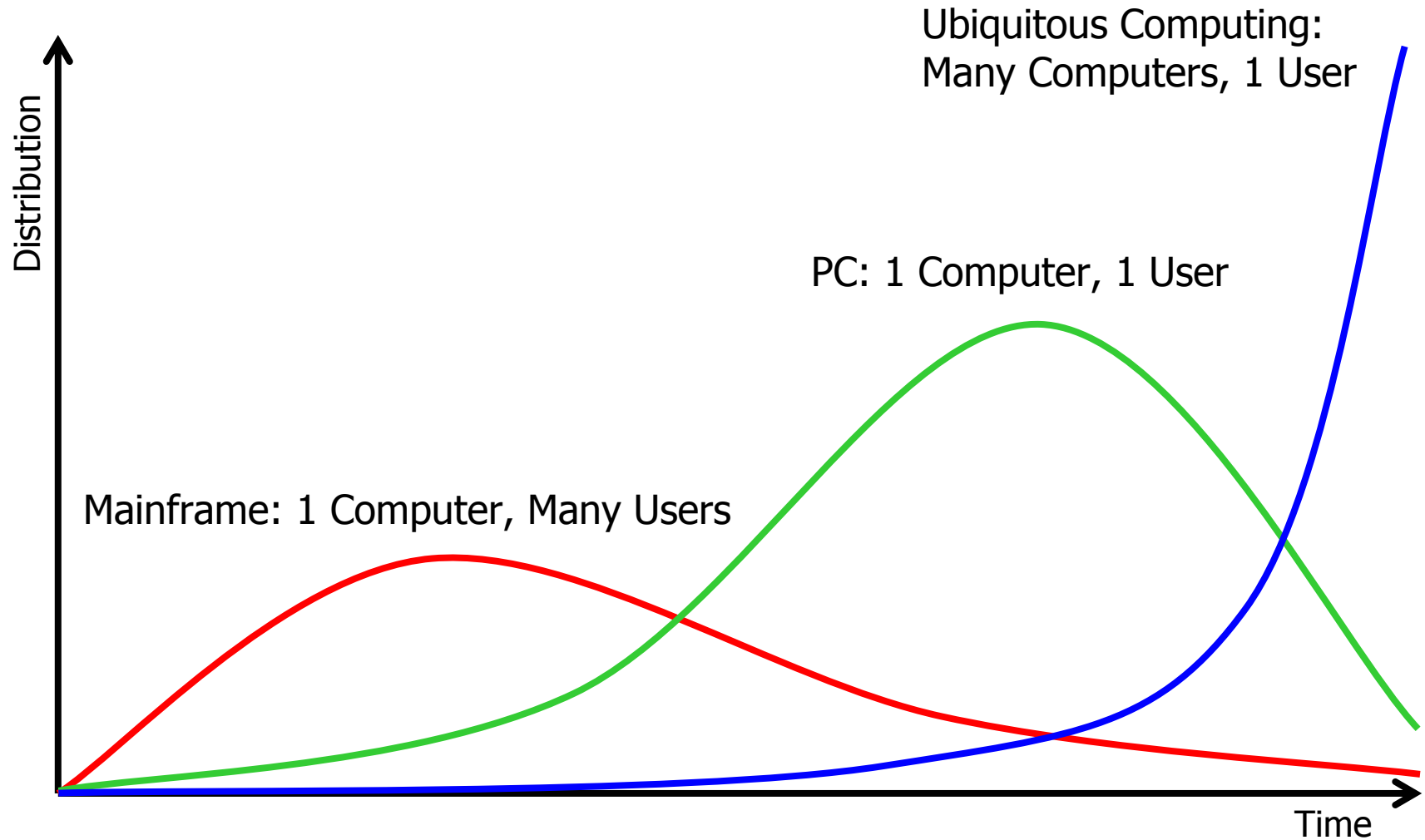
# Some related conferences and workshops

- International Conference on Ubiquitous Computing (UbiComp, Springer)
- International Conference on Pervasive Computing (Pervasive, Springer)  
**2005 in Munich!!!**
- IEEE International Conference on Pervasive Computing and Communications (PerCom, IEEE)
- Mobile Human-Computer-Interaction (mobileHCI, Springer)
- Computer-Human-Interaction (CHI, ACM)
- Intelligent User Interfaces (IUI, ACM)
  
- AI in mobile Systems (AIMS, ECAI/IJCAI-Workshop notes)
- Multi-User Ubiquitous User Interfaces (MU3I, IUI workshop notes)
- Smart Graphics Symposium (SG, Springer) **2005 in Munich!!!**
- User Modelling (UM, Springer)

# Some Journals and Digital Libraries

- IEEE Pervasive Computing
- Ubiquitous and Personal Computing, Springer
- ACM Transactions on Computer-Human Interaction
  
- ACM Digital Library <http://portal.acm.org>
- Springer Online <http://link.springer.de/ol/csol/>
  - Lecture Notes in Computer Sciences Series

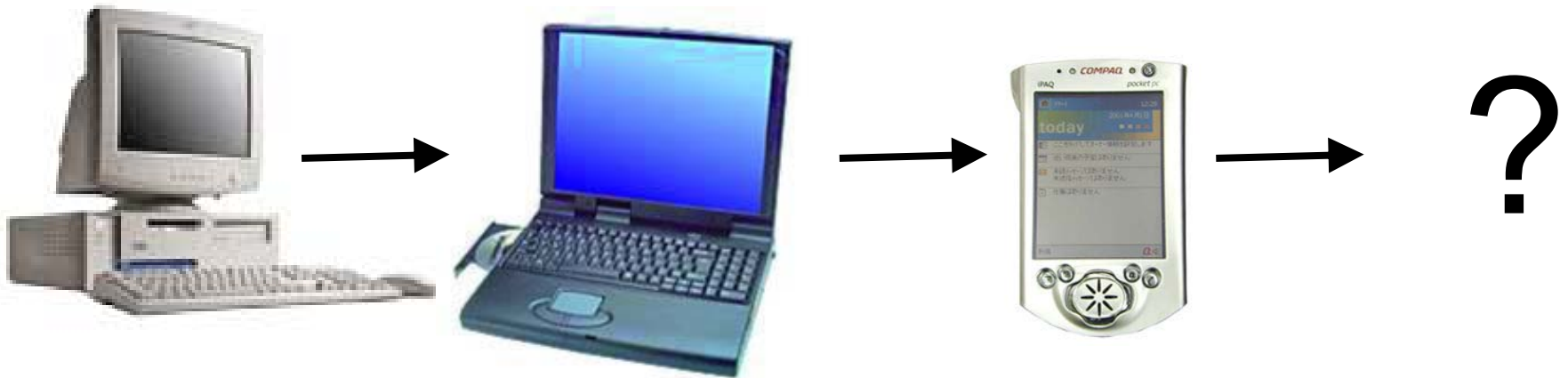
# Post-PC Era



Source: Mark Weiser

# Mobile Computing

- Evolution from fixed to mobile devices





# Ubiquitous Computing

- Computers everywhere
- The real world contains virtual information

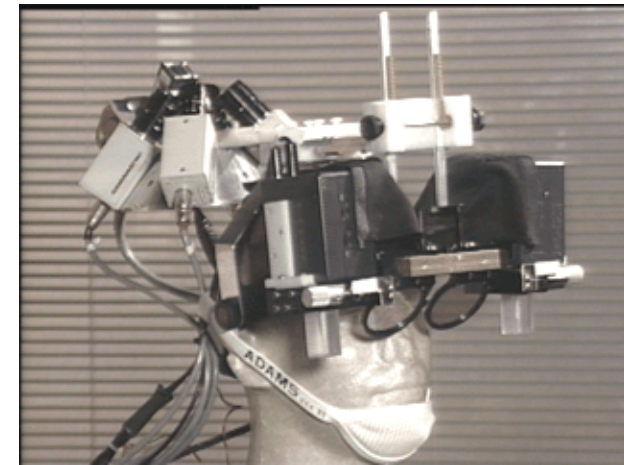
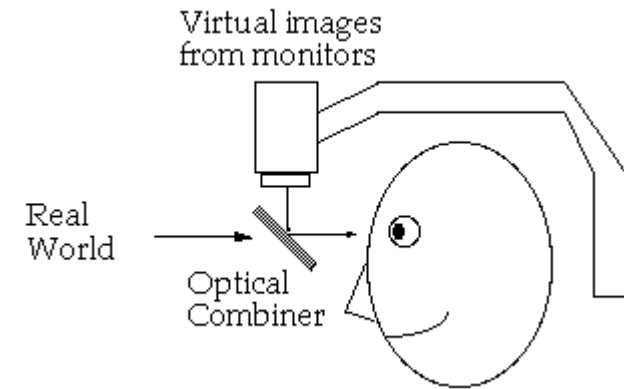
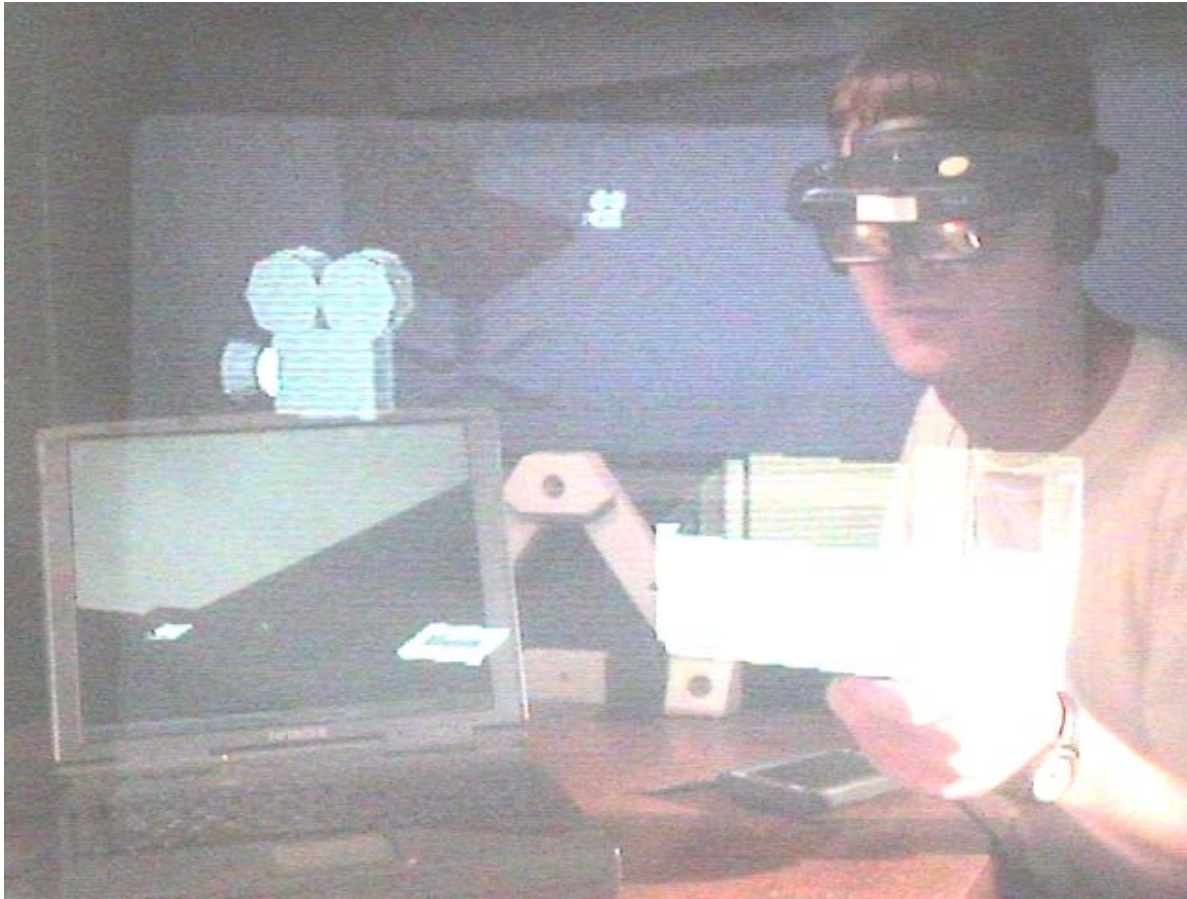


## **Mark Weiser: What Ubiquitous Computing Isn't**

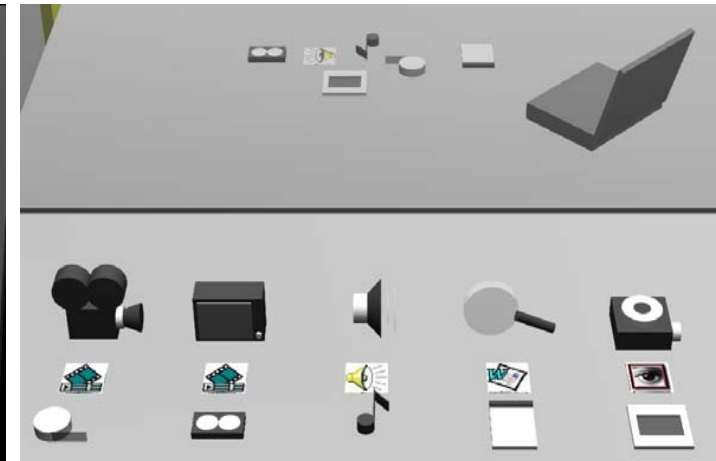
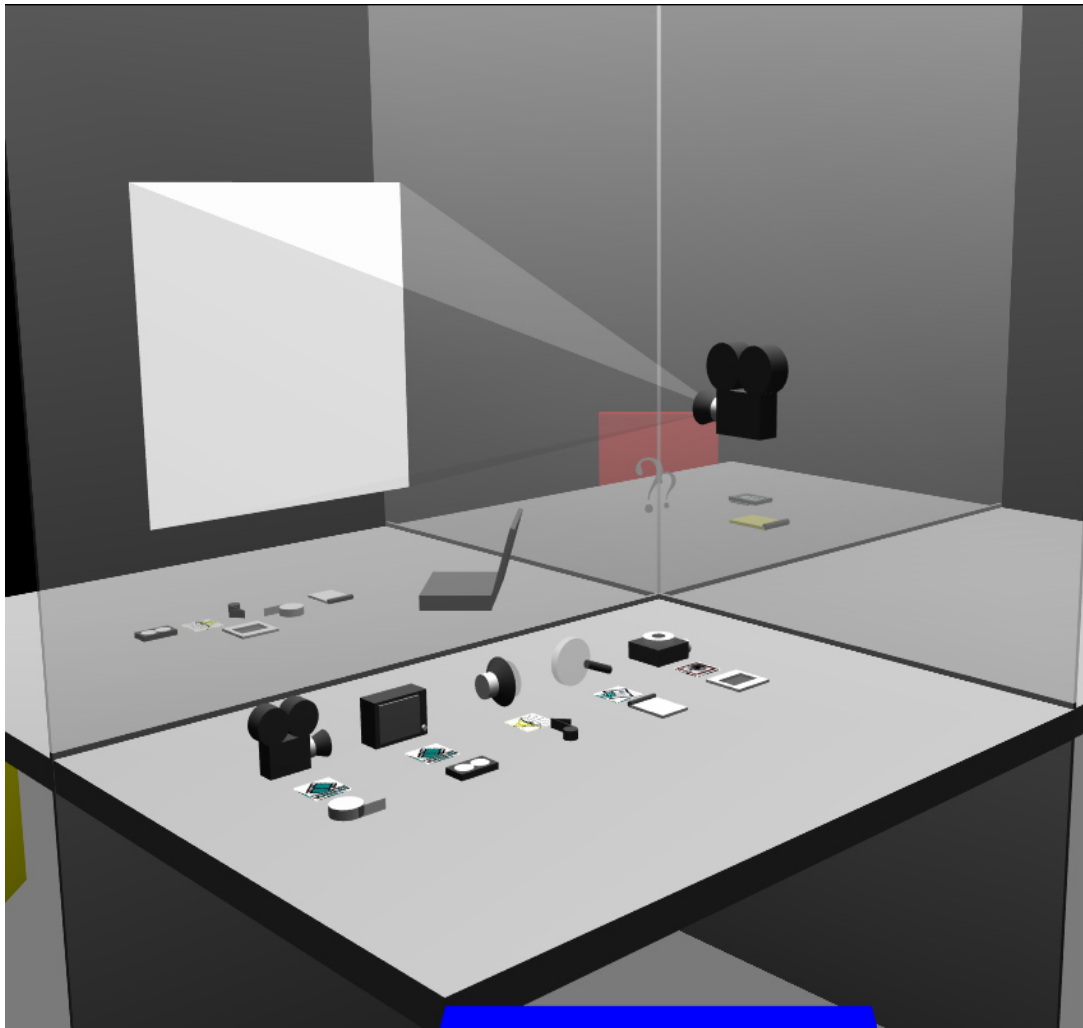
Ubiquitous computing is roughly the opposite of virtual reality. Where virtual reality puts people inside a computer-generated world, ubiquitous computing forces the computer to live out here in the world with people.

- Out of sight and senses
- All devices are highly connected

# Augmented/Mixed Reality



# Hybrid UI for AR/MR



- AR with see-through HMD
- meeting scenario
- 3D icons, menus, pointer
- 3D applications
- Drag & drop between 3D world and 2D displays
- 3D search function on 2D displays
- heterog. displ. (PDA, PC, Wall)
- multi user env. → Privacy

# Wearable Computing

- New types of clothing
  - Jackets, trousers, shirts
  - Glasses
  - Jewellery
  - Shoes



# Human-Computer Interaction

- Human-centered engineering
  - More intuitive communication modes
  - Put the human into focus
- Image and natural language understanding
- Intelligent dialogue systems
  - The computer “understands” my problem
  - The computer takes into account both technical and cognitive resources

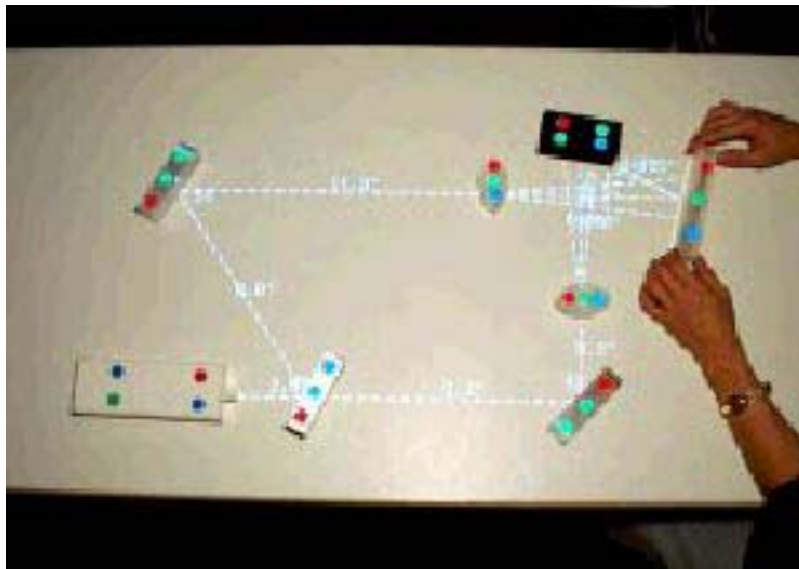
# Multi-modal presentation/interaction

- Use different media
  - Large and small displays, Head-mounted displays, 3D-Audio, cameras, microphone-arrays
- Use different modalities
  - Graphic
  - Speech
  - Gestures



# Tangible Interfaces

- physical artifacts that act as representations and as controls for digital information
- seamless integration of representation and control



Example:  
A TUI for optical design  
and layout

# Interaction with IE, some visions

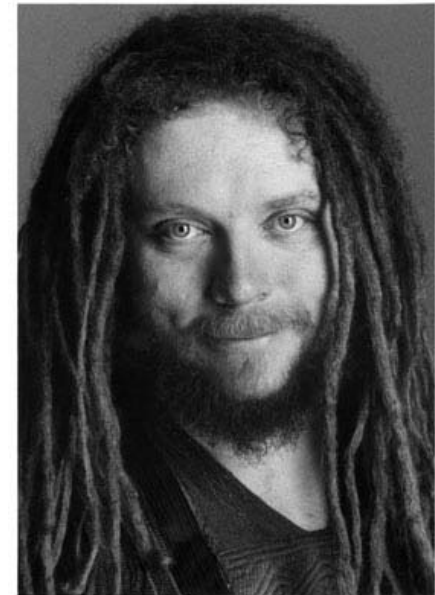


Electronic Ink, Ubiquitous displays



Interaction, multiple heterogeneous displays

Source: "Minority Report"  
(Steven Spielberg, USA 2002)  
Consulting by  
John Underkoffler (gestures),  
Jaron Lanier (VR)





# Knowledge representation

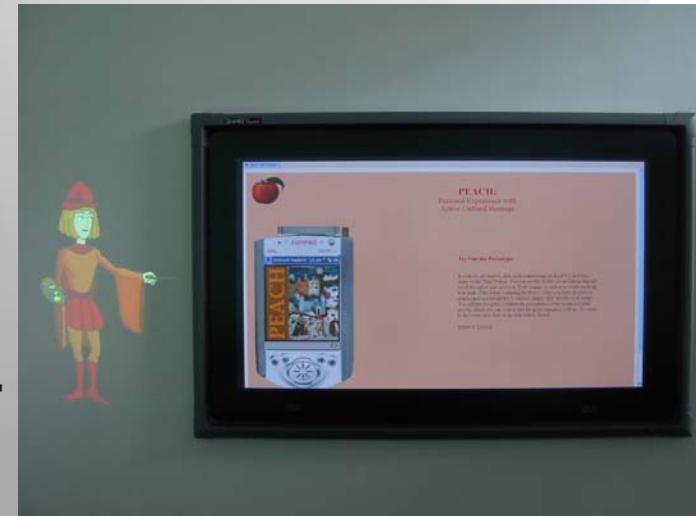
- Type of knowledge
  - Domain and tasks
  - Users
  - Location
- Representation formalisms
  - Semantic networks, rules, analogue repr.
- Inference
  - Work on representations

# Use of AI-Techniques in Intelligent Environments

- AI-Techniques help to
  - describe a computational context in an intelligent environment (representation)
  - evaluate the context (sensing)
  - extend the context (inference)
- AI-Techniques improve
  - the communication with the intelligent environment
  - the user adaptivity

# Instrumented Environment SUPIE

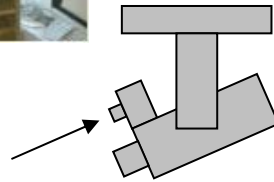
Saarland University Pervasive Instrumented Environment



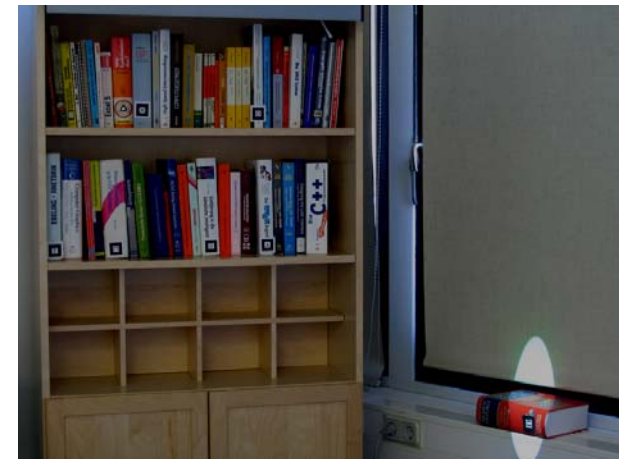
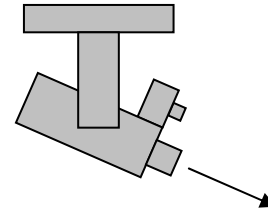
# Physikalische Suchfunktion



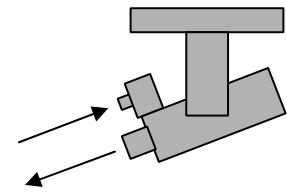
**Indexerstellung:** Abscannen des Raums mit Kamera  
Marker-Erkennung ( $\geq 1\text{cm}$ ) mit AR-Toolkit  
Abspeichern der Pan/Tilt Werte zu jeder Marker ID  
Dauer: ca. 1h für gesamten Raum



**Suchanfrage:** Marker ID  
Ansteuern der gespeicherten Pan/Tilt Werte  
Anleuchten des Objektes  
Bei ungenauer Position: Bereich ausleuchten



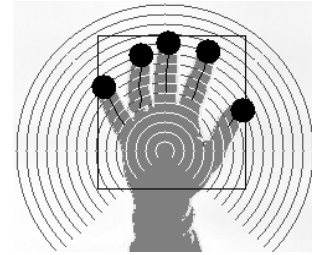
# Annotating physical objects



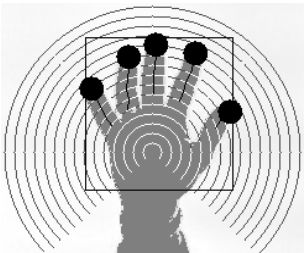
- Idea:
  - Environment should be able to „label“ objects
- Approach:
  - Describe possible display surfaces in the 3D model
  - Position annotations acc. to:
    - Proximity to objects
    - Uniqueness of position
    - Grouping of annotations
    - Main axes of objects



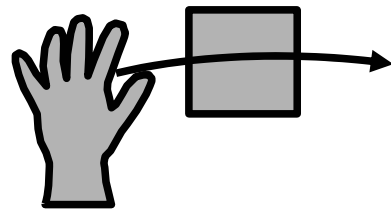
# camera-based interaction



projection widgets



finger  
gestures



hand  
gestures



# Example: Intelligent Pedestrian Navigation System

- Systems IRREAL and ARREAL
  - Pedestrians receive information according to their locations, goals, presentation media and speed
  - Combine stationary large display (Info kiosk) with a mobile display (PDA).
- IRREAL: Indoor Navigation
- ARREAL: Outdoor Navigation



# Information Booth: Adaptation to Time Pressure



Presentation from a **birds-eye view**  
with **higher speed** and **without** presentation agent



# IRREAL: Indoor Navigation Example



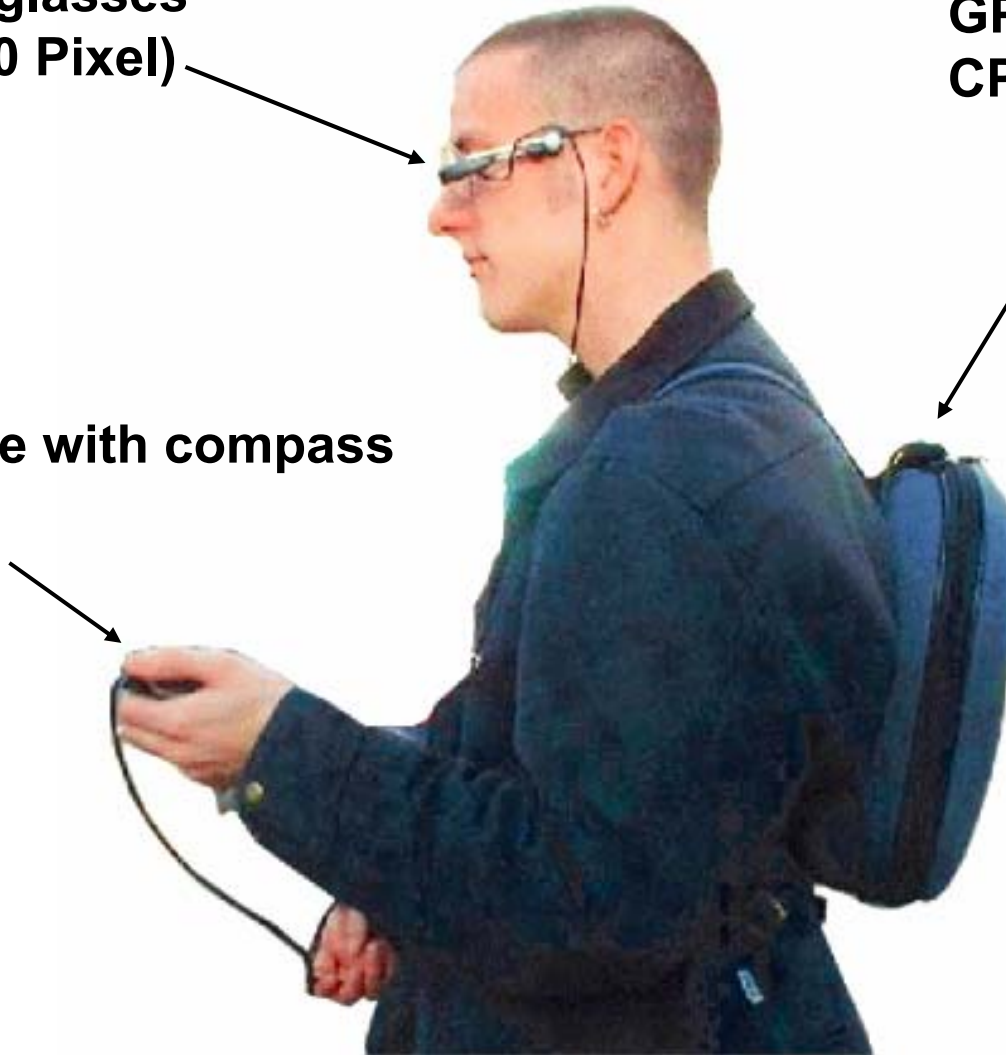
Adaptation to the **walking speed** and **orientation of the user** by using a stochastic broadcast protocol

# Components of ARREAL

**Clip-on glasses  
(640x320 Pixel)**

**GPS-System  
CPU (Sony Vaio C1XN)**

**3D-Mouse with compass**



# ARREAL: Outdoor Navigation Example



Adaptation to **speed, quality of position and orientation** by changing the level of detail, the scale and the textual and graphical annotations

# The lecture's overall structure

- Three blocks
  - **Instrumented Environments**: visions, hardware-development and trends, network and communication, software infrastructures, sensors, displays, tangible interfaces
  - **Intelligent IE**: basics of knowledge representation, inference, context, adaptivity, intelligent user interfaces
  - **Systems overview**: existing instrumented environments, actual research questions

# Course Material

- Web site: [www.mimuc.de](http://www.mimuc.de) → Lehre
- Literature
  - Relevant scientific articles will be given as necessary
- Presentation slides
  - will be available shortly after each appointment (in pdf format)

# Final examn (Corrected!)

- In contrast to what I said in the first lecture, there will be **no lecture certificate** („Schein“)
  - Lecture certificates can only be given for exercises
  - We don't have any exercises...
- You can use this lecture as a topic for examns
  - If I hold the examn, I will check whether you have **understood** the main principles from the lecture
  - You should be able to **explain them** on examples
  - No need to **blindly memorize** slides...