Physical & Tangible User Interfaces

(PhysikalischeBenutzungsschnittstellen)

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About Us

- ## Albrecht Schmidt
  Studied computing in Manchester,UK and Computer Science at the University of Ulm, Germany. Worked as Research assistant at University of Karlsruhe, Germany and as research associate at Lancaster University, UK. His PhD was on "Ubiquitous Computing – Computing in Context". He worked on various research projects on embedded, physical, tangible and sensor-based user interfaces. Currently he is with the media informatics group at the LMU München.

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- ## Christian Decker
  Studied computing at University of Karlsruhe, Germany where he is now working as research assistant at TecO. His interest is in networked interactive systems that have a physical presents.
  http://www.teco.uni-karlsruhe.de/~cdecker/

Introduction and Motivation

Physical & Tangible User Interfaces ...
...are not new

- Our environment is full of physical and tangible user interfaces
- In industrial design and product design the physical user interface is central
- Nearly everything we interact with in our daily life has a physical appearance and physical properties
- The way *how things are* influence the way *how we use things*

Physical & Tangible User Interfaces …
…are novel in the context of computers

- The physical interface to traditional computers has evolved but is still mostly limited to…
  - Keyboard & screen
  - Mouse
  - Speakers & microphone

- These interfaces dictated and limit the way we are using computers today

- **… but these interfaces are general and you can do everything with these interfaces!**

These interfaces are general and you can do everything with these interfaces! Can you?

- basically yes, **but …**

… the way people can interact will be limited!

# We are doing computing and software. This is not about us!

- … there are some trends that may make you think again
  - Computers and software become part of many devices and everyday objects
  - These systems are often networked and embedded
  - User interfaces become physically embedded in their host objects

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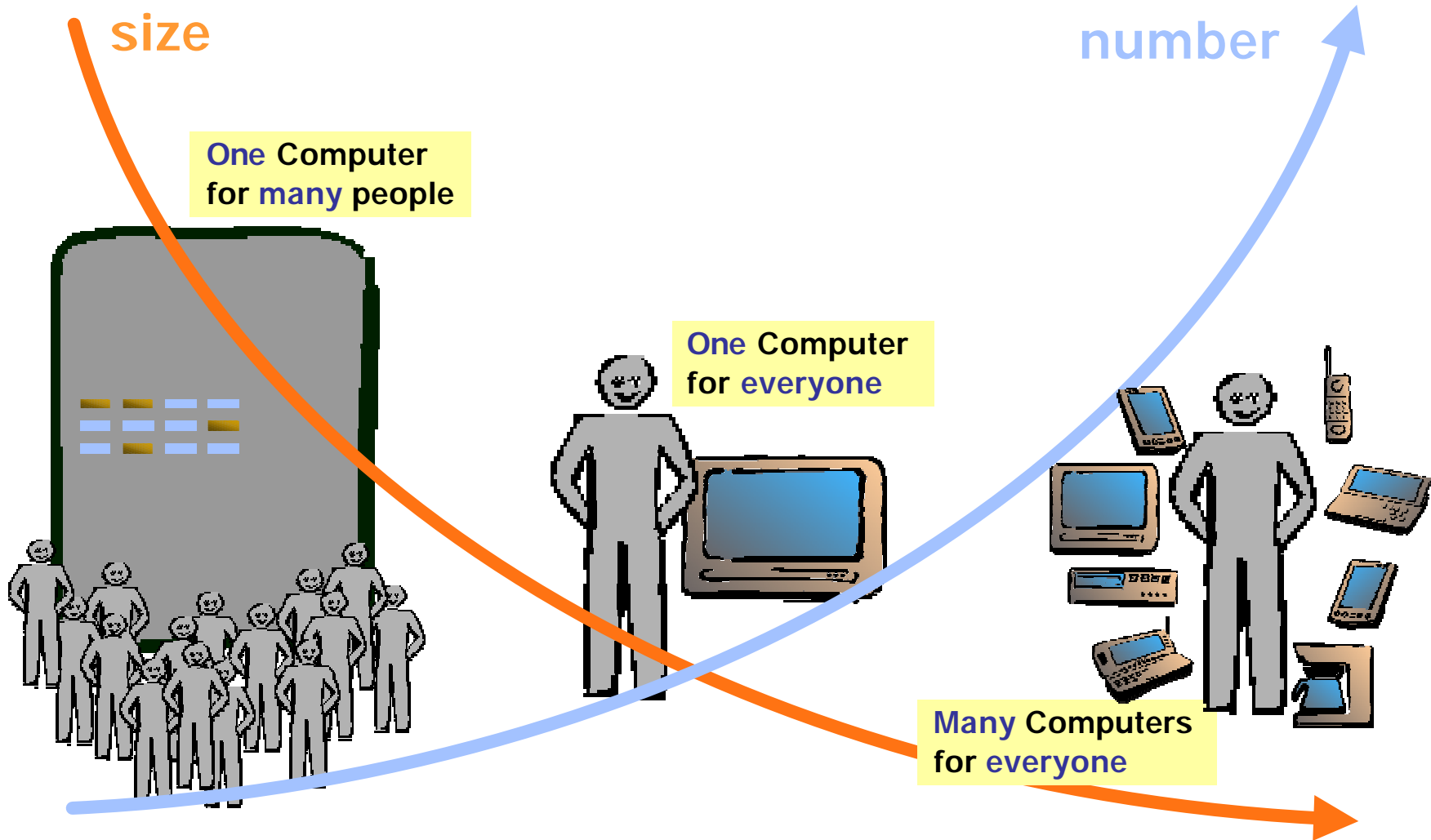A.Schmidt, C.Decker, Mensch & Computer 2003,
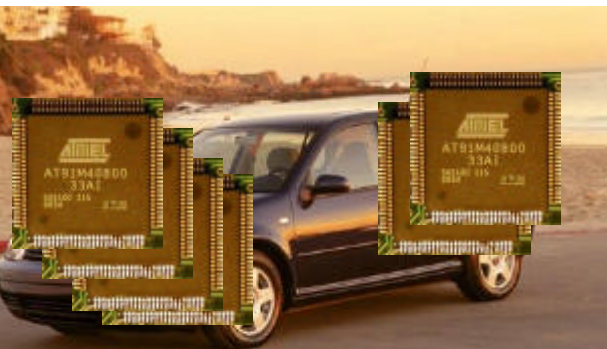
Overview of the tutorial

- **Trends in computing**

- **Exercise A**

- **Research Overview**

- **ID based Systems (Barcode)**

- **Lunch**

- **ID based Systems (RFID)**

- **Sensors for UIs**

- **Prototyping Physical Interfaces**

- **Design Exercise**

- **Summary, Discussion, Wrap-Up**

Computing Trends

Computers: Size + Number

size

number

One Computer
for many people

One Computer
for everyone

Many Computers
for everyone

What makes this possible ?

- <u>Microprocessors</u> and <u>Microcontrollers</u> so small that they can be embedded in practically everything

- <u>Storage</u> so inexpensive and dense that it can be provided everywhere

- <u>Wireless networking</u> for inexpensive and fast short-range connectivity

- New materials for new forms of appearance (e-ink, flexible displays, conductive fibers etc)
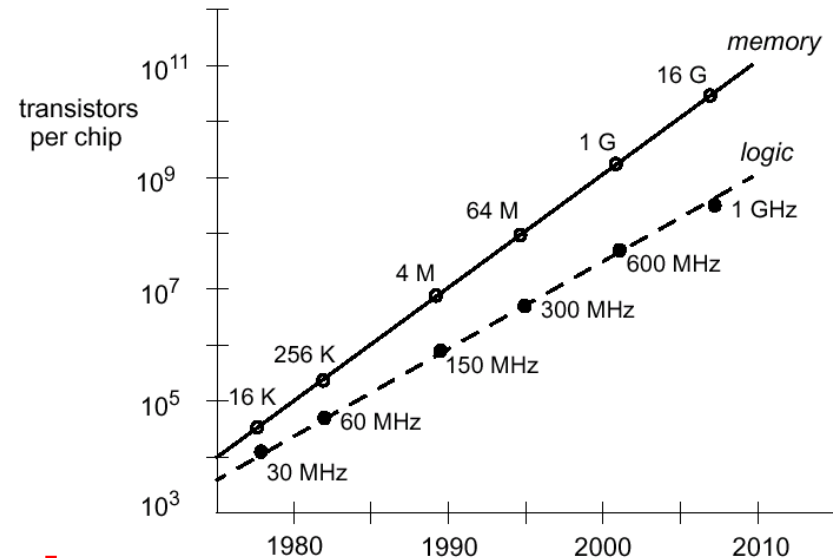
Physical size
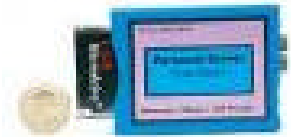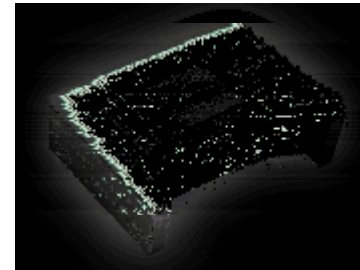
Implictations of Moore's Law

"Processing speed and storage capacity double every 18 months"

- Exponential increase of transistors per die
- Cheaper, smaller, faster
- Similar for communication bandwidth
- Predicted in 1965
- Expected to hold at least for another 10 years

Does not apply everywhere!

- Human attention is a limited resource
- People's willingness to devote bigger mind share to computing concerns is not likely to increase
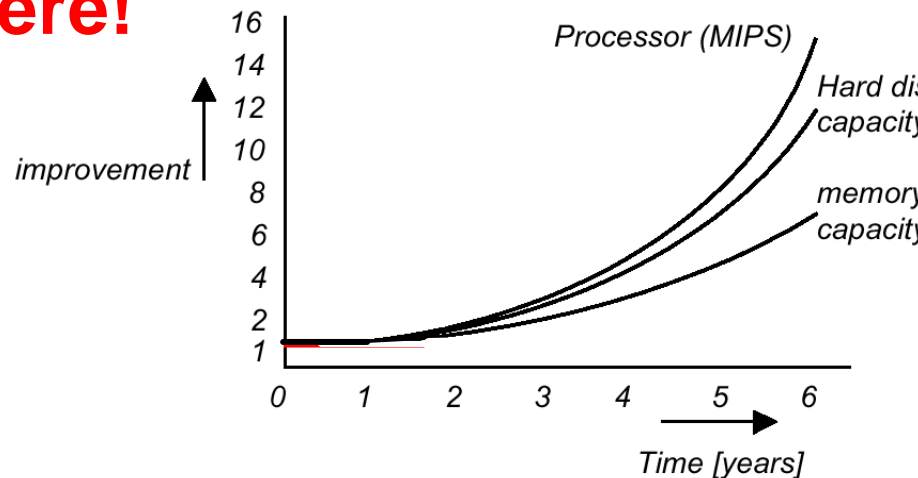
Ubiquitous Computing

Influential Visions …

- Ubiquitous Computing (Mark Weiser, 1991)
- The Invisible Computer (Don Norman, 1998)
- Disappearing Computer (European IST, 2000)

Related terms …

- Appliance Computing
- Pervasive Computing
- Situated Computing
- Ambient Intelligence
- Calm Computing
- Ambient Displays
- Context-Aware Computing
- …

Ubiquitous Computing starts to happen… and Interaction will be different

Some Vision Statements …

- *"The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it."* (Mark Weiser)

- *"Such a disappearance is a fundamental consequence not of technology, but of human psychology. **Whenever people learn something sufficiently well, they cease to be aware of it**. […] in this way are we freed to use them without thinking ..."* (Mark Weiser)

- *"… use the term "embodied virtuality" to refer to the process of drawing computers out of their electronic shells. The "virtuality" of* **computer-readable data** *[…] is brought into the physical world."* (Mark Weiser)

- *"[…] the primary motivation behind the information appliance is clear: simplicity. **Design the tool to fit the task so well that the tool becomes part of the task**, ..."* (Don Norman)

Context-Awareness

# Human to human communication and interaction is based on context

- *Language*
  „She says to John: „It is raining, take the umbrella"

- Interaction forms and communication setup
  – Essential social skill

- Approach
  – Share basis of common knowledge (e.g. conventions)
  – Acting on observation

- Human-Computer-Communication has long ignored context!

Location Based Services / Context-aware Computing

- Location is providing the context
- Information is related to the user's location

- Examples
  - Navigation systems
  - "Show me restaurants close by"
  - Print on the "nearest" printer
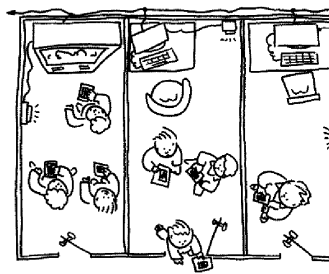
ParcTab Context-Aware Computing System

Classification of Applications
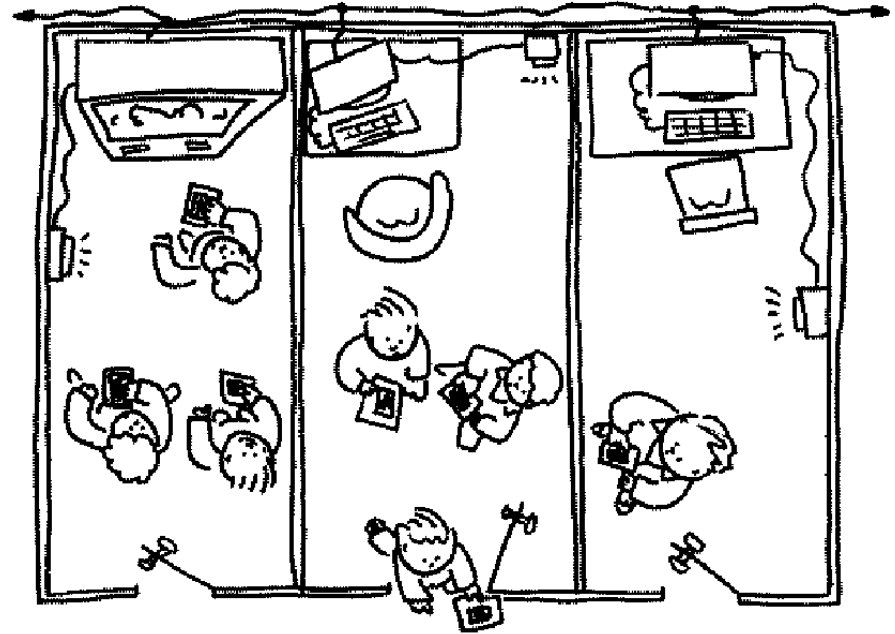
	manual	automatic
information	proximate selection & contextual information	automatic contextual reconfiguration
command	Contextual command	commands context-triggered actions

ParcTab Context-Aware Computing System

- Context dependent information, e.g. show devices in proximity

Name	Room	Distance
caps	35-2200	200ft
claudia	35-2108	30ft
perfector	35-2301	20ft
snoball	35-2103	100ft

(a)

Distance	Name	Room
20ft	perfector	35-2301
30ft	claudia	35-2108
100ft	snoball	35-2103
200ft	caps	35-2200

(b)

Name	Room	Distance
caps	35-2200	200ft
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(c)

Name	Room	Distance
caps	35-2200	200ft
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(d)

Context-Awareness

- *"Context is any information that can be used to characterize the situation of an entity. An entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and application themselves."* [Anind Dey]
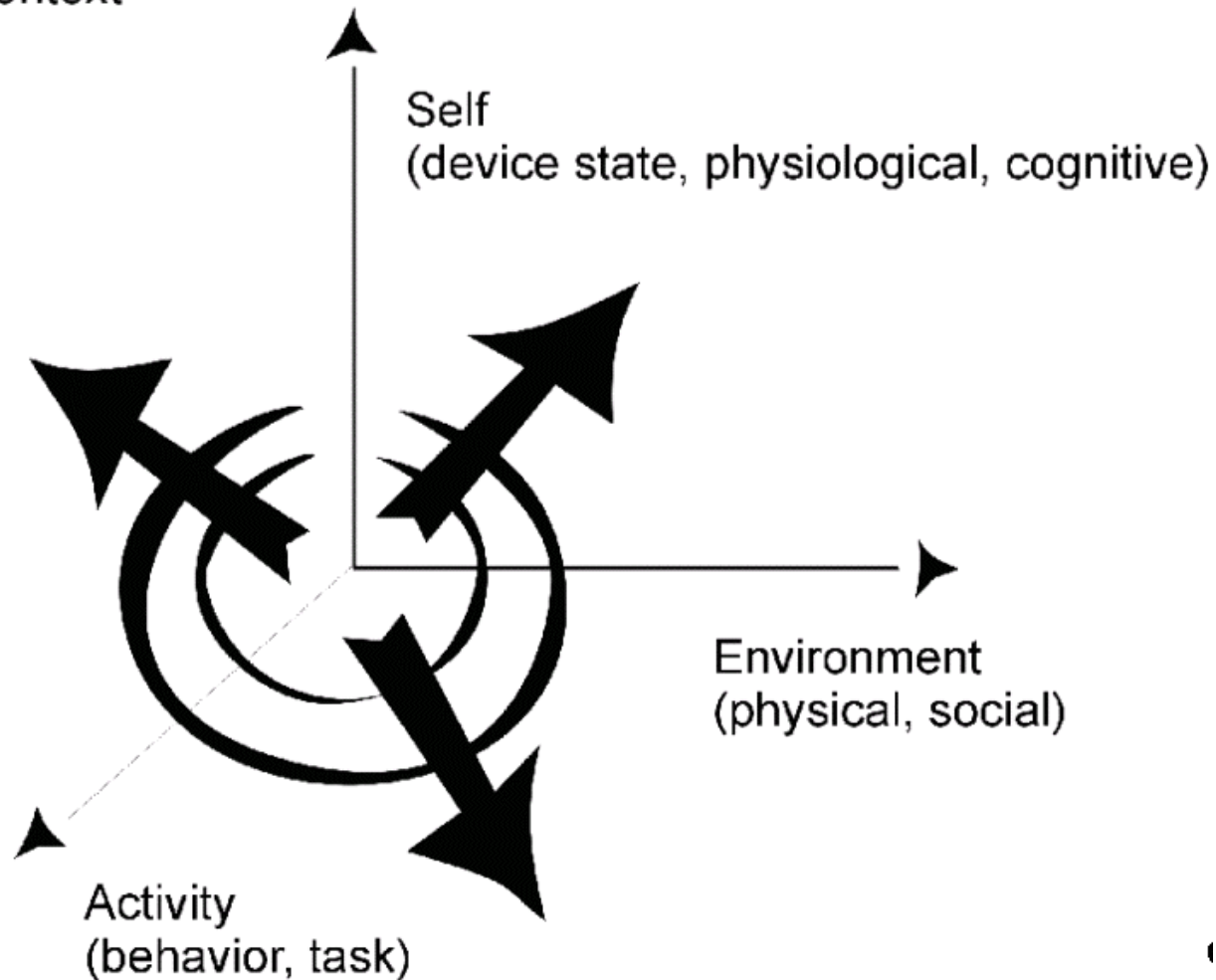
Context-Awareness
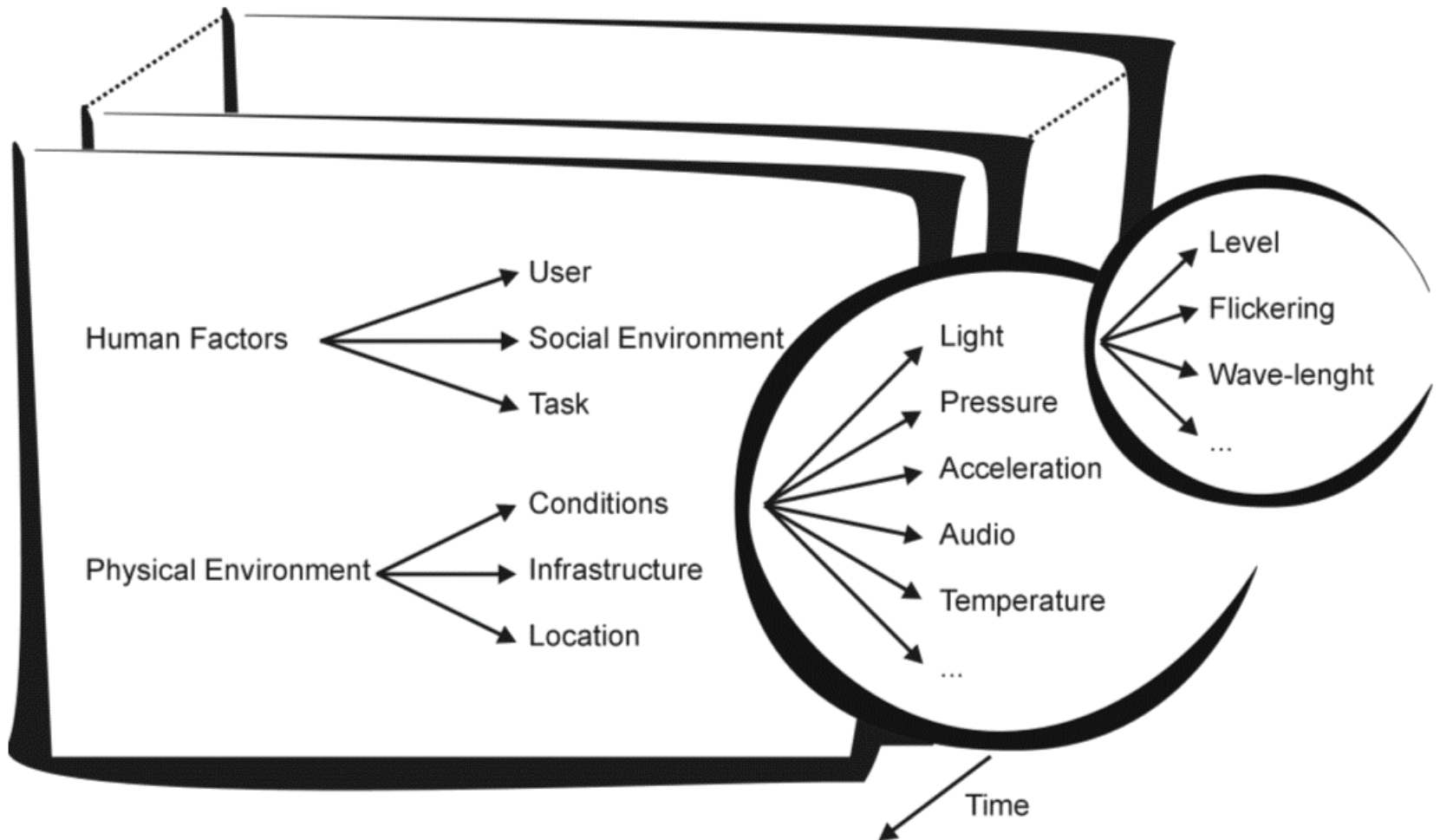
Context-Awareness

- *"Such context-aware software adapts according to the location of use, the collection of nearby people, hosts, and accessible devices, as well as to changes to such things over time. A system with these capabilities can examine the computing environment and react to changes to the environment."* [Bill Schilit]*.*

Context-Awareness

Context

Self
(device state, physiological, cognitive)

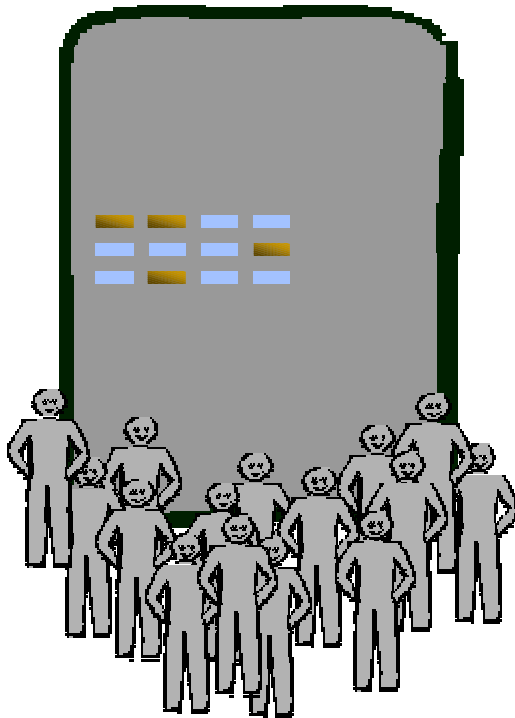Environment
(physical, social)

Activity
(behavior, task)

Implications for Interaction

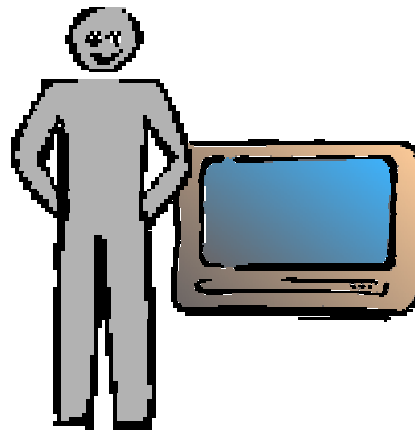# A New Era of Interaction?
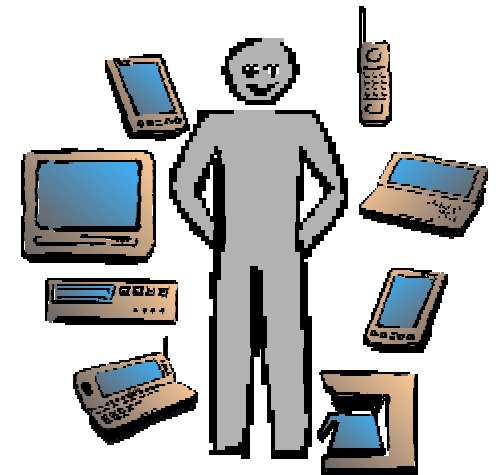
Paradigm Shift in Interaction with Computers

Mainframe Era
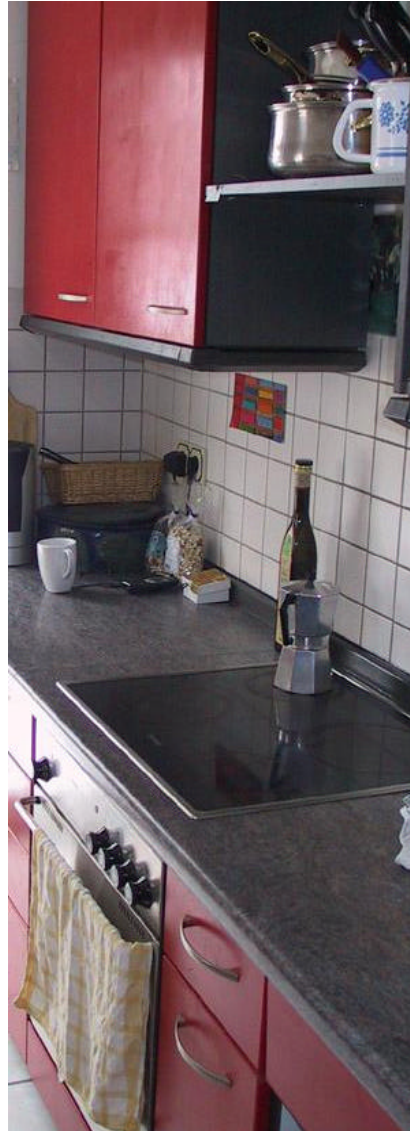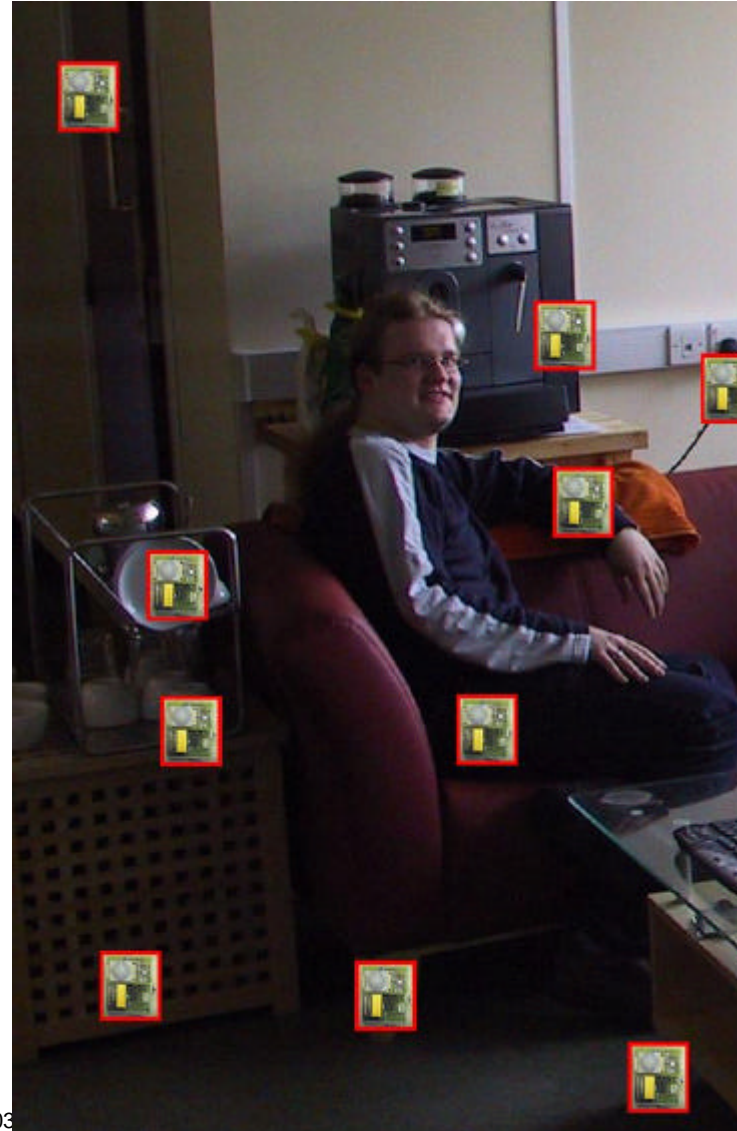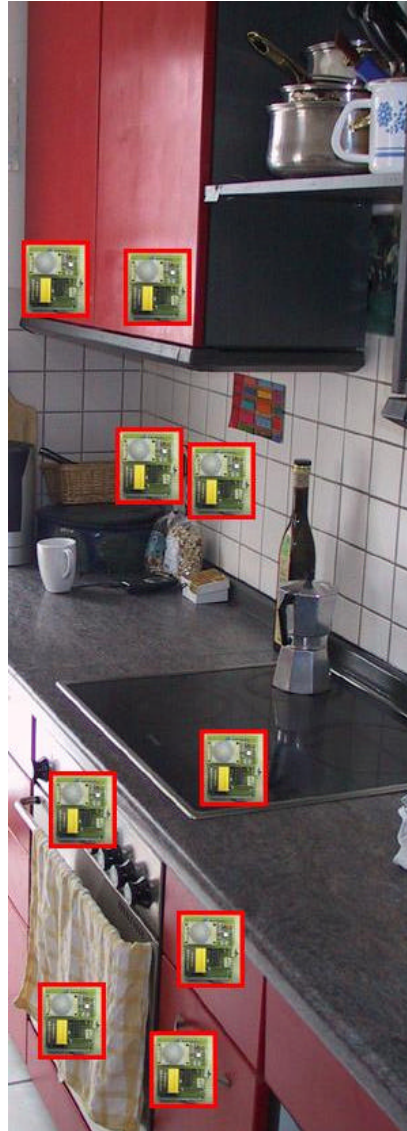- batch processing

PC Era
- direct manipulation

Ubicomp Era
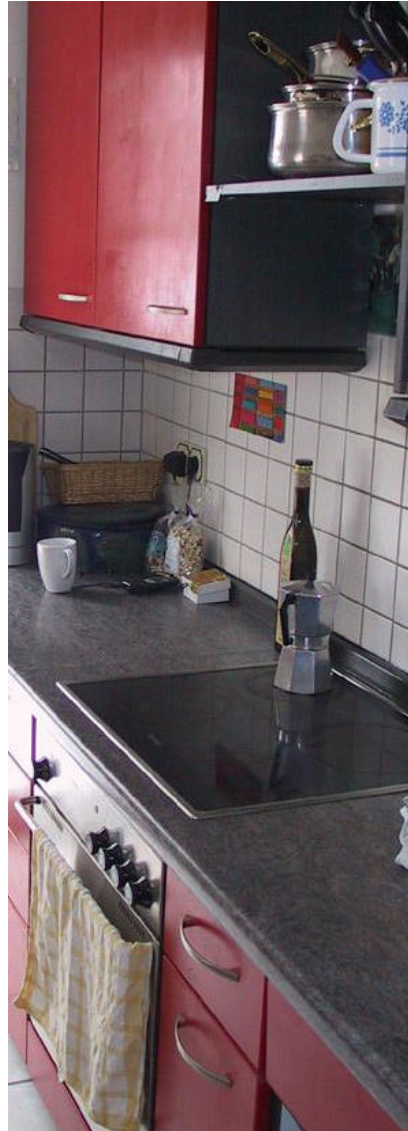- situated interaction

Vision of future environments

Vision of future environments

Vision of future environments

Paradigm Shifts

From Mainframe to PC:
"Human Integration"

From PC to Ubicomp:
"Physical Integration"

MainframeComputing

- Machine-defined user interface
- Shared use
- Requiring Preparation

PersonalComputing

- Direct manipulation
- Isolated: not aware of context
- Isolating: Monopolizing attention

Paradigm Shift to Personal Computing

- Taking the Human in the Loop
- User interface software as main concern
- Human-Computer Interaction as discipline

Paradigm Shift to Ubiquitous Computing

- Taking context of human-computer use into the loop
- Context: "what surrounds"
  - i.e. the location, the environment, the user's activity, the situation

…two steps back

From text-based UIs to GUIs and direct manipulation
- Empowering non-expert users
- Teaching by demonstration
- Immediate feedback
- Actions are comprehensible and reversible
- New level of "explorability"

It was a major step, but it was (and still is) a learning process…
- many early GUIs were worse than command lines
- an interface is not good because it is graphical…
- or bad because it is command line…
- the interface has to be well designed and appropriate for the context of use

Facilitated the move towards widespread Personal Computing
- Considering the user as integral part of the system

Resulted in novel applications and new interfaces

The next step…
Physical Interaction

Ubiquitous Computing – trying for the next step in interaction

- Considering also "what surrounds" computer and user as integral part of the system
  - Physical and social context: observable context, world knowledge, affordances, social values, …
- What is the next big step? How to get there?

Being-in-the-world

- Martin Heidegger, Philosopher (1889-1976)
- "the nature of human experience is based in engaged participation in the world"

Physical → Experience

- More senses than vision and hearing
- Simple examples show how tempting it is
- But you have to have it physical – otherwise you can't create the experience

Beyond the Vision (1)
… living rooms are different

Major research challenge – compatibility with everyday life

Context Acquisition in Everyday Environments
- Information about users, environments, and interaction

Including the Design Perspective (Human in the loop)
- Focus on foreground activity
- Interaction with accustomed physical environments
- Exploiting rich affordances of physical artefacts and structures that incorporate surfaces

Challenges
- Resolving the mismatch between traditional HCI and the vision of invisible computing
- Everyday environments are not controlled setting
- Unobtrusive and robust implementation

Beyond the Vision (2)
… living rooms are different

Observations

- Computing has moved beyond the desktop and becomes part of everyday environments
- Real world artefacts are augmented with computers
- No "computer users" anymore - user experience becomes a central concern (the challenge has moved beyond task efficiency)
- New interfaces and ways for interaction become feasible

Modes of Interaction

- No interaction with the system
- Transparent/invisible/implicitinteraction
- Explicit interaction

Extending the Design Space for User Interfaces

	Explicit Interaction
Text UI	
GUI & direct manipulation	
Gestures & Speech	

Extending the Design Space for User Interfaces

	Explicit Interaction
Text UI	
GUI & direct manipulation	
Gestures & Speech	
Physical Interaction	

Implicit Interaction (1)

Implicit Human-Computer Interaction (iHCI)

- iHCI is the interaction of a human with the environment and with artefacts which is aimed to accomplish a goal. Within this process the system acquires *implicit inputs* from the user and may present *implicit output* to the user.
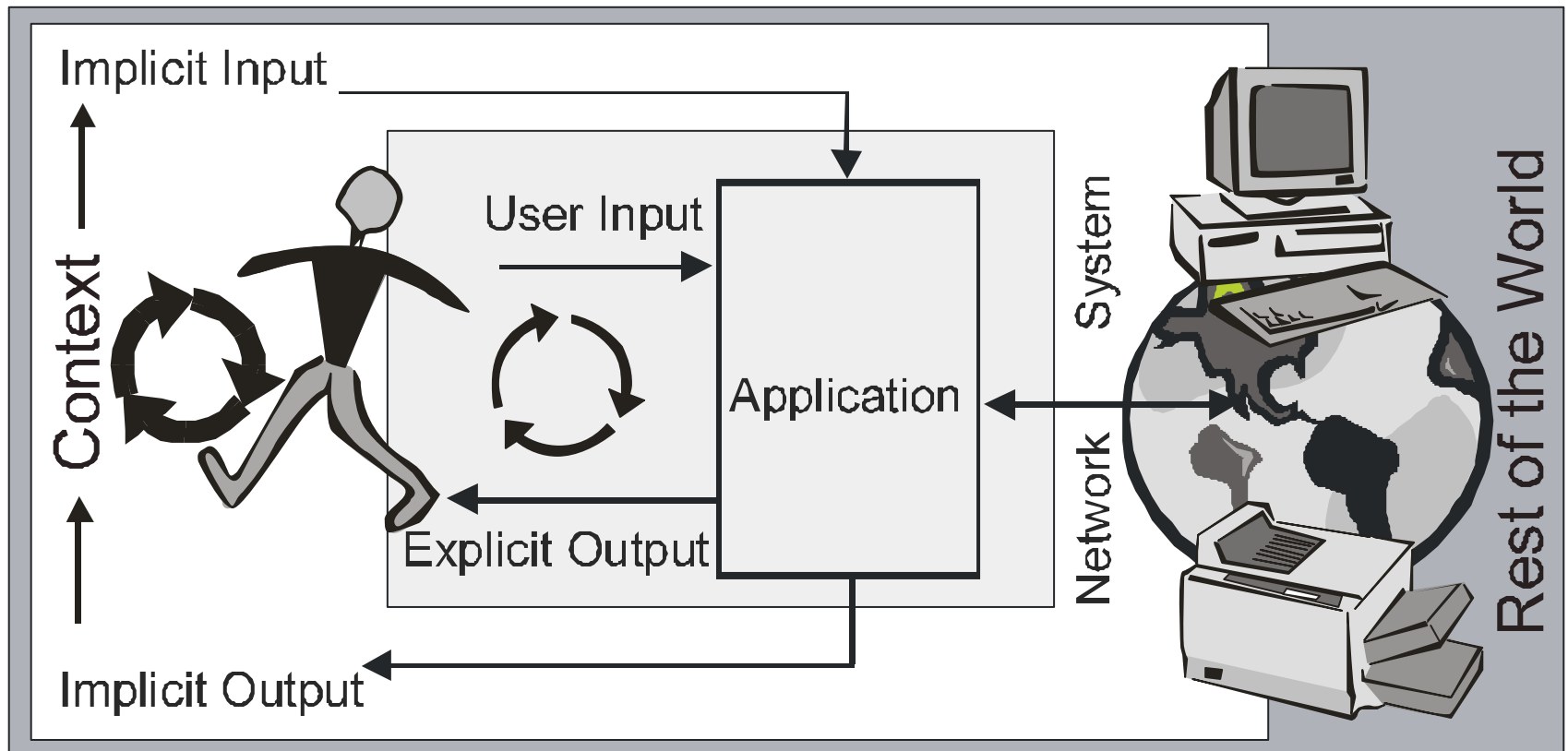
Implicit Input

- Implicit input are actions and behaviour of humans, which are done to achieve a goal and are not primarily regarded as interaction with a computer, but captured, recognized and interpret by a computer system as input.

Implicit Output

- Output of a computer that is not directly related to an explicit input and which is seamlessly integrated with the environment and the task of the user.

Implicit Interaction (2)

**Invisibility & transparent use vs.
 traditional explicit human computer interaction**

Extending the Design Space for User Interfaces

	Explicit Interaction	Implicit Interaction
Text UI		
GUI & direct manipulation		
Gestures & Speech		
Physical Interaction		

How to interact with the Ubiquitous Computer?

Physical World becomes an integral part of the UI

- Everyday objects and spaces become the interfaces to otherwise invisible computing systems
- Interaction away from the desktop and as part of human activity in a physical world
- Experience is a central issue

Departure from Standard User Interfaces

- Non-traditional technologies: sensors, embedded systems, perceptual components, variety of output devices…
- New interaction metaphors will emerge
- New models will be required (e.g. considering a door handle a widget may not be the best way of modelling the problem)

How to get there?

- Prototyping, exploring the possibilities…

Short Break…

→ Exercise A