Prototyping Physical User Interfaces

Short Course @ IT University of Göteborg

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About Me

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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Brief Course Outline

- **Breaking Interface Conventions?**
- **Exercise – creating a cooperative multi user game**
- **Nature and Value of Physical Prototyping**
- **Break**
- **Smart-its basics**
- **Smart-its enhanced light**
- **Lunch break**
- **Students project (afternoon) Smart-its enhanced light**
- **Smart-its enhanced light – results**
- **Building Smart-its hardware**
- **Break**
- **Developing Smart-its Software**
- **Smart-its Examples**
- **Wrap-Up**

Breaking Interface Conventions?

Please draw a computer…

- Select one of your choice…
  - 1960
  - 1980
  - 1990
  - 2000
    - office computer
    - mobile computer
    - wearable computer

Please draw a computer…

…highlight what is determined by the user interface

- Select one of your choice…
  - 1960
  - 1980
  - 1990
  - 2000
    - office computer
    - mobile computer
    - wearable computer

Modern computers are determined by the user interface

- the computer is disappeared – the interface is left (at least we are heading there)
- user perceive the system by the interface
- processing, power, storage, and networking gets smaller

Computers are used in context

- That is not new … traditionally context is taken into account at design time
  - Personal computers
  - PDAs …
  - Mobile phones …
- Interfaces are generally highly optimized for the context of work they are designed for
  - E.g. a keyboard for typing … 200 characters a minutes is not fast … this is about 25 words/minutes = 1500 words/h = 12000 words/day … a book in a week? Very few people…
  - For new products it may be interesting to optimize the 'book/week' rather than at the 'characters/minute'
- Usage contexts are often very general
  - a keyboard for inputting text – rather than a device for writing emails and one for writing books
  - Has advantages and disadvantages

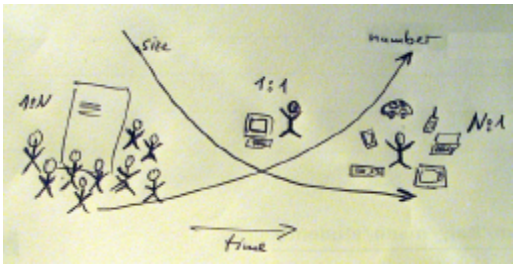
Computers react to context

- This is new… taking context into account at run-time is a great opportunity but also a major challenge
- This means basically
  - giving senses to systems to make them aware of the world around
    - digital information
    - seeing
    - hearing
    - …
  - Mechanism for perception
  - Strategies to act on the context
- Technology trends provide increased freedom for the design of systems
- … Ubiquitous computing starts to happen - technically

Ubiquitous Computing starts to happen

- We are surrounded by computing
- Computing and processing is embedded into everyday devices
- There are many computers/processors per person
- Information access and communication is possible virtually everywhere
- Dedicated computing devices – information appliances – are all around us
- Devices can be connected and networked

Ubiquitous Computing
more than a quantitative relationship!



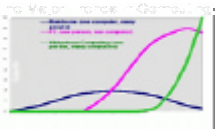
Ubiquitous Computing not yet there…

Quotes from Mark Weiser's paper:

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

"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 ..."*

"… 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****."*



Ubiquitous Computing enabling technologies

- Processing
  cheaper, faster, smaller, more energy efficient
- Storage
  big and fast
- Networking
  global, local, ad-hoc, low-power, high bandwidth, low latencies
- Displays
  projection, flexible materials, power consumption
- Sensors
  types, speed, accuracy, price, robustness
- Actuators
  many, nowadays computer controlled anyway

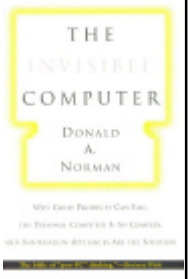


Examples and implications

- Storage
  - How much music can you carry?
  - Lets assume: 1 minute is about 1MByte
  - Current harddrives are 250 GBytes
    …about 6 month of music
  - Doubling in less 2 years
    … how far is a digital media player that comes with all movies ever released inside?
- Networking
  - Getting information onto devices
  - Assuming a 10Mbit/s wireless connection
  - Could give you 10 MByte of news when walking by a hotspot
  - Provide you with a SVCD movie on a 10 minutes bus ride
- Should make us re-think computers, architectures, interaction, and business models …

Appliance Computing Post-PC Era

- Dedicated devices
  - mobile phone, digital camera, hard drive VCR, tablet PC, smart -boards, PDAs, …
- Multimodal input
  - GUIs, speech, pen, touch-screen
- Non expert users
  - kids and elderly enjoy these technologies
- Zero Maintenance
  - Pre-configured, ok over the whole lifetime of the device



Appliance Computing Post-PC Era

- We don't rely on the PC anymore
  We have specific tools!


*"the primary motivation behind the information appliance is clear: simplicity. **Design the tool to fit the task so well that the tool becomes pa rt of the task**, feeling like a natural extension of the work, a natural extens ion of the person."* (Don Norman)

Appliance Computing Post-PC Era ?

- often the transition is still like this…


- And there are more chances to come to mess it up again!
  - new functionality
  - new connectivity
  - new features

What is the goal? What are we interacting with?

*"The real power of the concept comes not from any one of thes e devices; it emerges from the interaction of all of them. The hun dreds of processors and displays are **not a "user interface"** like a mouse and windows, **just a pleasant and effective "place" to get things done**."* (Mark Weiser)

- …the Ubiquitous Computer –
  an (computing)-environment equipped with (computing)-tools to help us to get things done
- What does this require? Quite simple!
  ways and opportunities …
  - to access information
  - to create information
  - for communication

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 …**

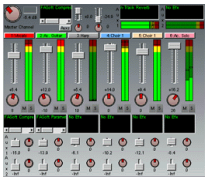

… the way people can interact will be limited!

Some 35 years later …

Throw away your keyboard and mouse.

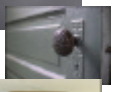
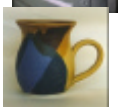
(Cooperstock et al., 97)

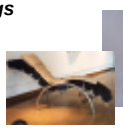
- So what is the problem with mouse & keyboard?
  - Time multiplexing is implied!
  - One operation at the time (e.g. slider can be only be moved sequentially with the mouse)

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***



Context-Awareness

Human to human communication and interaction is based on context

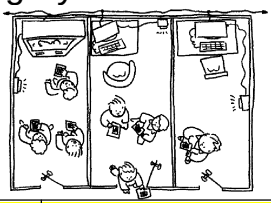
- *Language*
  „She says to John: „It is raining, take the umbrella“
- Interaction forms and communication setup
  - Essential social skill
- Approach
  - Share basis of common knowledge (e.g. conventions)
  - Acting on observation
- Human-Computer-Communication has long ignored context!

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

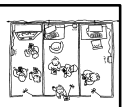
ParcTab Context-Aware Computing System



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 (from Schilit 94)

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
claudia	**35-2108**	**30ft**
perfector	**35-2301**	**20ft**
snoball	35-2103	100ft

(c)

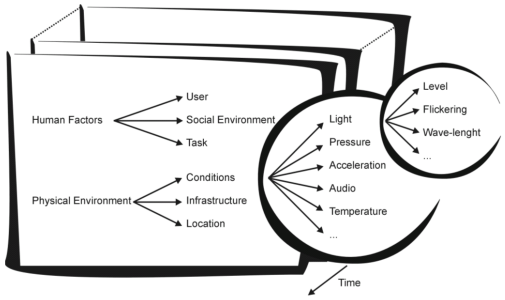
Name	Room	Distance
caps	35-2200	200ft
claudia	35-2108	30ft
perfector	35-2301	20ft
snoball	35-2103	100ft

(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]

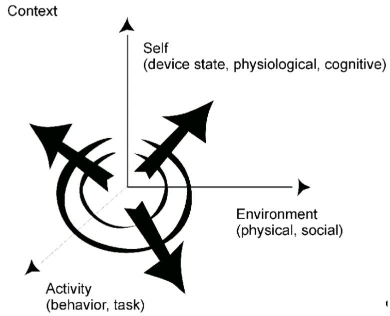
Context-Awareness



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].

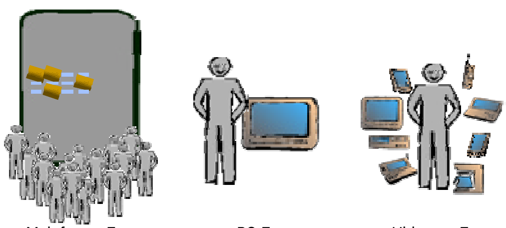
Context-Awareness



Implications on 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 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

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

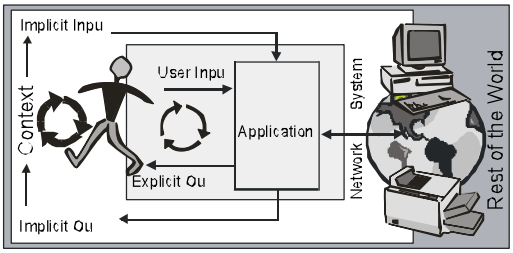
- Implicit input are actions and behaviour of humans, which are done to achieve a goal and are not primarily regarded as interaction with a computer, but captured, recognized and interpret by a computer system as input.

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

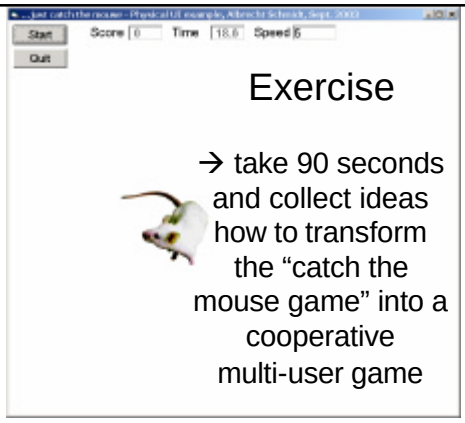
- Everyday objects and spaces become the interfaces to otherwise invisible computing systems
- Interaction away from the desktop and as part of human activity in a physical world
- Experience is a central issue

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…



Exercise

→ take 90 seconds and collect ideas how to transform the “catch the mouse game” into a cooperative multi-user game

One solution

- Take an optical mouse up-side down and use a towel (hold by two people) to move the curser…

Interface Conventions…

- New tasks require to re-think interfaces we use!
- Re-thinking includes **Hardware**!